



City of Lincoln

LTU-StarTran

Project Manual

Construction Documents

June 5, 2026

HDR Project No. 10383454

HDR Engineering, Inc.

CA-0443

1917 S 67th Street

Omaha, NE 68106



I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and that I am a duly registered architect under the laws of the State of Nebraska.

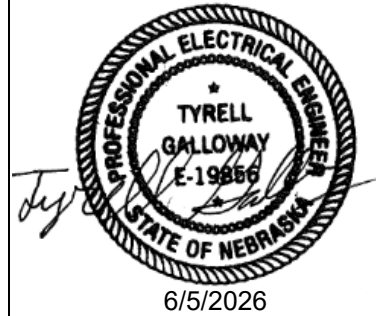
Tyrell Galloway

June 5, 2026
Date

My license renewal date is December 31, 2027.

Pages or sheets covered by this seal:

Division 26 – ELECTRICAL
Division 27 – COMMUNICATIONS
Division 28 – ELECTRONIC SAFETY AND SECURITY
Division 48 – ELECTRICAL POWER GENERATION



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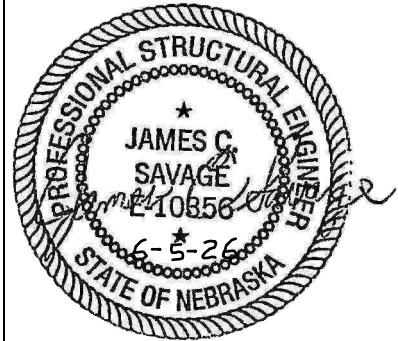
James Savage

June 5, 2026
Date

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03 11 00 – CONCRETE FORMING
03 20 00 – CONCRETE REINFORCING
03 31 00 – CONCRETE MATERIALS AND PROPORTIONING
03 31 10 – CONCRETE MIXING, PLACING, JOINTING, AND CURING
03 35 00 – CONCRETE FINISHING
05 12 10 – STRUCTURAL STEEL
05 36 00 – COMPOSITE METAL DECKING
05 45 23 – EQUIPMENT SUPPORT SYSTEM
31 23 00 – BUILDING EXCAVATION, FILLING, AND BACKFILLING



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Shane King

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Division 48 – PUBLIC ROW IMPROVEMENTS



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Jeffrey Morrison

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22 11 13 – FACILITY WATER DISTRIBUTION PIPING
22 13 13 – FACILITY SANITARY SEWERS
31 10 00 – SITE CLEARING
31 20 00 – EARTH MOVING
32 13 13 – CONCRETE PAVING
33 41 00 – STORM UTILITIES DRAINAGE PIPING



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Dana Blaschko

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Date

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03 35 43 – POLISHED CONCRETE FINISHING
05 50 00 – METAL FABRICATIONS
05 51 00 – METAL STAIRS AND RAILINGS
Division 6 – WOOD, PLASTICS, AND COMPOSITES
Division 7 – THERMAL AND MOISTURE PROTECTION
Division 8 – OPENINGS
Division 9 – FINISHES
Division 10 – SPECIALTIES
Division 11 – EQUIPMENT
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Division 13 – SPECIAL CONSTRUCTION
Division 14 – CONVEYING EQUIPMENT



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Taylor Donner

June 5, 2026

Date

My license renewal date is February 10, 2027.

Pages or sheets covered by this seal:

06 41 00 – ARCHITECTURAL WOOD CASEWORK
Division 9 - FINISHES
10 11 00 – MARKERBOARDS AND TACKBOARDS
10 26 00 – WALL AND DOOR PROTECTION
12 24 13 – ROLLER WINDOW SHADES
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6/5/2026

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Don Foster

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Division 23 – HEATING VENTILATING AND AIR CONDITIONING
Division 25 – INTEGRATED AUTOMATION



I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and that I am a duly registered engineer under the laws of the State of Nebraska.

Jennifer Seacrest

June 5, 2026

Date

My license renewal date is January 1, 2028.

Pages or sheets covered by this seal:

01 56 39 – TEMPORARY TREE AND PLANT PROTECTION
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32 33 00 – SITE FURNISHINGS
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SECTION 00 01 07
SEALS PAGE

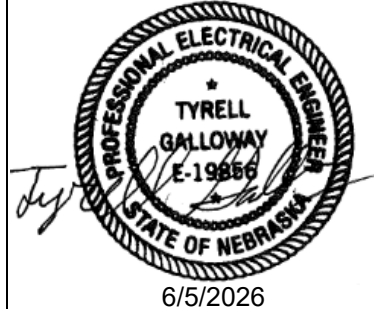
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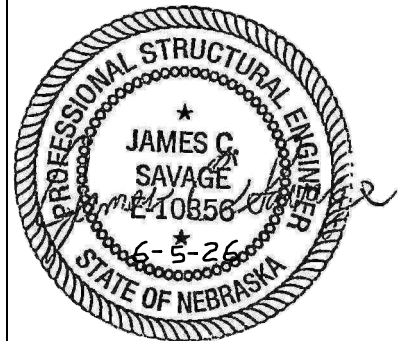
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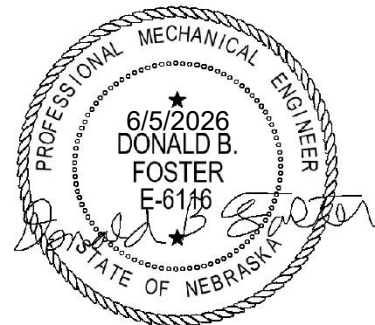
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TABLE OF CONTENTS

DIVISION 00 — PROCUREMENT AND CONTRACTING REQUIREMENTS

00 26 00 - SUBSTITUTIONS PRIOR TO BIDDING

DIVISION 01 — GENERAL REQUIREMENTS

01 10 00 - SUMMARY
01 11 16 - WORK BY OWNER
01 21 16 - CONTINGENCY ALLOWANCES
01 22 00 - UNIT PRICES
01 26 00 - CONTRACT MODIFICATION PROCEDURES
01 26 13 - REQUESTS FOR INFORMATION (RFI)
01 29 00 - APPLICATIONS FOR PAYMENT AND SCHEDULE OF VALUES (GC)
01 31 19 - PROJECT MEETINGS
01 32 16 - CONSTRUCTION PROGRESS SCHEDULE
01 33 00 - SUBMITTAL PROCEDURES
01 45 23 - TESTING AND INSPECTING SERVICES
01 56 39 - TEMPORARY TREE AND PLANT PROTECTION (Olsson)
01 61 00 - COMMON PRODUCT REQUIREMENTS
01 71 21 - SPECIALTY ENGINEERING REQUIREMENTS
01 74 19 - CONSTRUCTION WASTE MANAGEMENT
01 74 23 - CLEANING
01 77 00 - CLOSEOUT PROCEDURES (GC)
01 78 23 - OPERATION AND MAINTENANCE DATA
01 78 36 - WARRANTIES
01 78 39 - PROJECT RECORD DOCUMENTS
01 91 13 - GENERAL COMMISSIONING REQUIREMENTS

DIVISION 02 — EXISTING CONDITIONS

02 56 19 - GAS CONTAINMENT

DIVISION 03 — CONCRETE

03 08 13 - CONCRETE TESTING AND EVALUATION - OWNER
03 11 00 - CONCRETE FORMING
03 20 00 - CONCRETE REINFORCING
03 31 00 - CONCRETE MATERIALS AND PROPORTIONING
03 31 10 - CONCRETE MIXING, PLACING, JOINTING, AND CURING
03 35 00 - CONCRETE FINISHING
03 35 43 - POLISHED CONCRETE FINISHING

DIVISION 05 — METALS

05 12 10 - STRUCTURAL STEEL
05 36 00 - COMPOSITE METAL DECKING
05 40 00 - COLD-FORMED METAL FRAMING
05 45 23 - EQUIPMENT SUPPORT SYSTEM
05 50 00 - METAL FABRICATIONS
05 51 00 - METAL STAIRS AND RAILINGS

DIVISION 06 — WOOD, PLASTICS, AND COMPOSITES

06 10 00 - ROUGH CARPENTRY
06 16 43 - GYPSUM SHEATHING
06 41 00 - ARCHITECTURAL WOOD CASEWORK

DIVISION 07 — THERMAL AND MOISTURE PROTECTION

07 05 43 - CLADDING SUPPORT SYSTEMS
07 13 26 - SELF-ADHERING SHEET MEMBRANE WATERPROOFING
07 21 00 - THERMAL INSULATION
07 27 43 - VAPOR RESISTIVE AIR BARRIER
07 42 47 - ARCHITECTURAL ULTRA HIGH PERFORMANCE CONCRETE (AUHPC) FACADE PANELS

07 42 93 - ALUMINUM SOFFITS
07 53 25 - FULLY ADHERED EPDM ROOFING
07 62 00 - SHEET METAL FLASHING AND TRIM
07 72 13 - MANUFACTURED CURBS
07 72 33 - ROOF HATCHES
07 72 73 - MODULAR VEGETATED ROOF SYSTEM
07 76 16 - ROOF PAVERS
07 84 00 - FIRESTOPPING
07 84 53 - BUILDING PERIMETER FIRESTOPPING
07 92 13 - EXTERIOR JOINT SEALANTS
07 92 16 - INTERIOR JOINT SEALANTS

DIVISION 08 — OPENINGS

08 06 71 - DOOR HARDWARE SCHEDULE
08 11 13 - HOLLOW METAL DOORS AND FRAMES
08 14 16 - FLUSH WOOD DOORS
08 31 13 - ACCESS DOORS AND FRAMES
08 41 14 - MID-RISE ALUMINUM STOREFRONT
08 44 13 - CURTAIN WALL SYSTEM
08 71 00 - DOOR HARDWARE
08 71 13 - AUTOMATIC DOOR OPERATORS
08 81 23 - EXTERIOR GLASS GLAZING
08 81 26 - INTERIOR GLASS GLAZING
08 87 33 - DECORATIVE FILMS

DIVISION 09 — FINISHES

09 22 16 - NON-STRUCTURAL METAL FRAMING
09 29 00 - GYPSUM BOARD
09 30 00 - TILING
09 51 00 - ACOUSTICAL CEILINGS
09 54 27 - WOOD CEILING SYSTEM
09 65 13 - RESILIENT BASE
09 65 19 - RESILIENT TILE FLOORING
09 65 36 - STATIC DISSIPATIVE RESILIENT TILE FLOORING
09 66 23 - THIN-SET EPOXY TERRAZZO
09 67 81 - CONCRETE FLOOR SEALER
09 68 13 - TILE CARPETING
09 91 13 - EXTERIOR PAINTING
09 91 23 - INTERIOR PAINTING

DIVISION 10 — SPECIALTIES

10 11 00 - MARKERBOARDS AND TACKBOARDS
10 14 03 - IDENTIFICATION DEVICES - EXTERIOR
10 14 06 - IDENTIFICATION DEVICES - INTERIOR
10 21 12 - METAL TOILET PARTITIONS
10 26 00 - WALL AND DOOR PROTECTION
10 28 13 - TOILET ACCESSORIES
10 41 00 - EMERGENCY ACCESS AND INFORMATION CABINETS
10 44 00 - FIRE PROTECTION SPECIALTIES
10 82 00 - ALUMINUM SCREENS

DIVISION 11 — EQUIPMENT

11 24 26 - SAFETY TIE-BACKS

DIVISION 12 — FURNISHINGS

12 24 13 - ROLLER WINDOW SHADES
12 36 63 - SOLID SURFACE FABRICATIONS
12 36 65 - ENGINEERED QUARTZ FABRICATIONS

DIVISION 13 — SPECIAL CONSTRUCTION

13 45 13 - BULLET RESISTIVE MATERIALS

DIVISION 14 — CONVEYING EQUIPMENT

14 24 24 - HYDRAULIC ELEVATORS - MACHINE-ROOM-LESS

DIVISION 21 — FIRE SUPPRESSION

21 10 00 - FIRE PROTECTION SYSTEMS

DIVISION 22 — PLUMBING

22 08 16 - PLUMBING SYSTEMS COMMISSIONING

22 10 16 - PLUMBING PIPING

22 11 13 - FACILITY WATER DISTRIBUTION PIPING (Olsson)

22 11 23 - PLUMBING PUMPS

22 13 13 - FACILITY SANITARY SEWERS (Olsson)

22 33 00 - DOMESTIC WATER HEATERS

22 42 00 - PLUMBING FIXTURES

DIVISION 23 — HEATING VENTILATING AND AIR CONDITIONING

23 05 00 - SPECIAL MECHANICAL REQUIREMENTS

23 05 10 - MECHANICAL ACCESS PANELS

23 05 15 - VARIABLE FREQUENCY DRIVES AND CONTROLS

23 05 19 - PIPING SPECIALTIES

23 05 23 - MANUAL VALVES

23 05 29 - PENETRATIONS AND SUPPORTS

23 05 50 - MECHANICAL SOUND AND VIBRATION CONTROL

23 05 53 - MECHANICAL IDENTIFICATION SYSTEMS

23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

23 07 00 - PIPE, DUCT AND EQUIPMENT INSULATION

23 08 16 - HVAC SYSTEMS COMMISSIONING

23 11 00 - MECHANICAL PIPE AND FITTINGS

23 21 13 - HYDRONIC PIPING SYSTEMS

23 21 14 - GEOTHERMAL LOOP HEAT EXCHANGER

23 21 23 - HVAC PUMPS

23 23 00 - REFRIGERANT PIPING SYSTEM

23 31 13 - AIR DISTRIBUTION SYSTEM

23 35 00 - EXHAUST AND VENTILATING FANS

23 52 33 - BOILER - HYDRONIC

23 72 13 - TOTAL ENERGY HEAT RECOVERY UNIT

23 81 26 - UNITARY SPLIT AIR CONDITIONERS

23 81 46 - GROUND SOURCE HEAT PUMPS

23 82 43 - ELECTRIC HEATERS

DIVISION 25 — INTEGRATED AUTOMATION

25 08 16 - BMS SYSTEMS COMMISSIONING

25 10 00 - BUILDING MANAGEMENT SYSTEM (BMS)

25 30 00 - BUILDING MANAGEMENT SYSTEM (BMS) - FIELD EQUIPMENT

25 90 00 - BMS SEQUENCE OF OPERATION

DIVISION 26 — ELECTRICAL

26 00 10 - ELECTRICAL GENERAL REQUIREMENTS

26 00 11 - WIRING EQUIPMENT FURNISHED BY OTHERS

26 05 19 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

26 05 33 - CONDUITS

26 05 34 - BOXES

26 05 35 - SURFACE METAL RACEWAYS AND WIREWAYS

26 05 36 - CABLE TRAY

26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

26 05 73 - POWER SYSTEM STUDIES

26 09 43 - NETWORKED LIGHTING CONTROL SYSTEM

26 22 13 - LOW VOLTAGE DISTRIBUTION TRANSFORMERS
26 24 13 - SWITCHBOARDS
26 24 16 - PANELBOARDS
26 24 19 - MOTOR CONTROL EQUIPMENT
26 27 26 - WIRING DEVICES
26 28 00 - OVERCURRENT PROTECTIVE DEVICES
26 28 16 - ENCLOSED SAFETY SWITCHES
26 32 14 - NATURAL GAS DRIVEN GENERATOR SET
26 32 90 - GENERATOR CONNECTION CABINET
26 36 23 - AUTOMATIC TRANSFER SWITCHES
26 41 13 - LIGHTNING PROTECTION SYSTEM
26 43 13 - SURGE PROTECTIVE DEVICES
26 51 13 - BUILDING LIGHTING
26 56 00 - SITE LIGHTING

DIVISION 27 — COMMUNICATIONS

27 05 01 - COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS
27 10 00 - STRUCTURED CABLING

DIVISION 28 — ELECTRONIC SAFETY AND SECURITY

28 05 01 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY SYSTEMS
28 10 01 - ACCESS CONTROL
28 20 01 - VIDEO SURVEILLANCE SYSTEM
28 31 00 - FIRE ALARM SYSTEM

DIVISION 31 — EARTHWORK

31 10 00 - SITE CLEARING (Olsson)
31 20 00 - EARTH MOVING (Olsson)
31 23 00 - BUILDING EXCAVATION, FILLING, AND BACKFILLING

DIVISION 32 — EXTERIOR IMPROVEMENTS

32 13 13 - CONCRETE PAVING (Olsson)
32 13 14 - CONCRETE PAVING FINISHES (Olsson)
32 13 73 - CONCRETE PAVING JOINT SEALANTS (Olsson)
32 33 00 - SITE FURNISHINGS (Olsson)
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32 94 33 - PLANTERS (Olsson)

DIVISION 33 — UTILITIES

33 41 00 - STORM UTILITIES DRAINAGE PIPING (Olsson)

DIVISION 48 — ELECTRICAL POWER GENERATION

48 14 00 - SOLAR PHOTOVOLTAIC SYSTEMS
49 00 00 - PUBLIC ROW IMPROVEMENTS (Olsson)

SECTION 00 26 00
SUBSTITUTIONS PRIOR TO BIDDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for handling requests for substitutions made prior to bid.
 - 1. Any product proposed by Contractor which does not meet requirements of Contract Documents, whether in product characteristics, performance, quality, manufacturer, or brand name is considered a substitution.
 - 2. In case of non-availability of materials contact Architect for review and action.
- B. Manufacturers and Products: See Section 01 61 00.
- C. For bidding purposes, base all bids on materials, equipment, and procedures specified, or approved by Addenda.

1.2 SUBSTITUTION PRIOR TO BID

- A. Submit complete data substantiating compliance of proposed substitution with Contract Documents.
- B. Products and Systems:
 - 1. Product identification, including manufacturer's name.
 - 2. Manufacturer's literature marked to indicate specific model, type, size, and options to be considered:
 - a. Product description.
 - b. Performance and test data.
 - c. Reference standards.
 - d. Difference in power demand, air quantities, construction, etc.
 - e. Dimensional differences from specified unit.
 - 3. Samples:
 - a. Architect reserves right to retain sample until physical units are installed on project for comparison purposes.
 - b. Requester pay all costs of furnishing and return of samples.
 - c. Architect is not responsible for loss of or damage to samples.
 - 4. Name and address of at least three similar projects that proposed product has been in use on for at least four years, and name and phone number of owner's and architect's or engineer's representative, which Owner or Architect can contact to discuss product, installation, and field performance data.
- C. Construction Methods:
 - 1. Detail description of proposed method.
 - 2. Illustrate with drawings.
- D. Itemized comparison of proposed substitute to specified item; **make variations clear**.
- E. Identify effect and changes required by other trades, subcontractors, or contracts.
- F. Data related to change in construction time.

- G. Cost of proposed substitution in comparison with product, system or method specified.
- H. Availability of maintenance and repair services, and sources of repair or replacement items.
- I. Warranty comparison with specified product or system.

1.3 PRODUCT SELECTION

- A. Certain types of products are described in Project Manual by means of trade names, catalog numbers or manufacturer's names, or both.
 - 1. This is not intended to exclude products from consideration which may be capable of accomplishing purpose indicated.
- B. Other types of products may be considered acceptable to Owner and Architect in place of those specified.
- C. Listing of a manufacturer implies acceptance of them only as supplier of a product which complies with specified item.
 - 1. See Section 01 61 00 for definition of Base and Optional manufacturers.
- D. **No substitution permitted after execution of contract**, unless allowed by Contract Documents.
- E. Conditional bids and voluntary alternates will not be considered unless allowed by Instructions to Bidders.

1.4 SUBSTITUTION REQUESTS

- A. Only written requests with complete data for evaluation will be considered.
 - 1. Request must be received at least 10 calendar days prior to bid date. **Requests received late will not be considered.**
 - 2. Submit evaluation data with attached form to Architect.
- B. In making request for substitution, Suppliers represent:
 - 1. Personal investigation of proposed product, system, or method has been conducted and determined it equal or superior in all respects to that specified and will perform intended function.
 - 2. Product, system, or method is in full compliance with applicable codes and regulations, such as BABA.
 - 3. Warranty for substitute item as for product, system or method specified meets or exceeds specified product.
 - 4. Finish products shall comply relative to color and pattern with base specified items. Contractor will coordinate installation of accepted substitution into Work, to include building modifications if necessary, and be responsible for such modifications as may be required for Work to be complete and functional in all respects.
 - 5. Certified cost data is complete and includes all related costs, excluding Architect's review and redesign cost.
 - 6. Waives claims for additional costs or time extensions related to substitution which subsequently become apparent or are caused by substitution.
 - 7. Pay additional costs to other trades, subcontractors or contracts caused by substitution.
 - 8. Pay all Architect's review and redesign cost, special inspections, and other costs incurred by substitutions or revisions made necessary by acts or omissions of Contractor, due to product submittal or product not being ordered in a timely

manner, due to ease of construction progress or Work, or which are in interest of or are for convenience of supplier, subcontractor, or Contractor.

9. Acknowledge acceptance of these provisions.
- C. Supplier to sign substitution request in space provided on form acknowledging acceptance of terms.

1.5 APPROVAL OF SUBSTITUTION REQUEST

- A. No verbal or written approvals other than by Addenda will be valid.
 1. Addendum listing approved substitutions will be published prior to Bid date.

1.6 REJECTION OF SUBSTITUTION REQUEST

- A. Substitutions may not be considered if:
 1. Submitted after stipulated date or time period.
 2. Not submitted in accord with this Section.
 3. Acceptance will require substantial revision of Contract Documents, building or system.
 4. Substitution request does not indicate specific item for which request is submitted.
 5. Substitution Request form is not properly executed and signed.
 6. Substitution request for manufacturer acceptance only.
 7. Insufficient information submitted.
 8. Substitution color or pattern wise does not comply with base specified item.
 9. Substitution does not appear to comply with requirements of specifications for base item.

END OF SECTION

SUBSTITUTION REQUEST

PROJECT: StarTran
Multimodal
Transportation
Center

PROJECT NUMBER:
10383454
To Office of Architect:

SPECIFIED PRODUCT:

Substitution request for: _____
Specification Section number: _____
Article(s)/paragraph(s): _____

REASON FOR SUBSTITUTION REQUEST:

- | | |
|--|---|
| <input type="checkbox"/> Fails to comply with building code requirements | <input type="checkbox"/> Not available |
| <input type="checkbox"/> Unavailable to meet Project schedule | <input type="checkbox"/> Reduce Project construction time |
| <input type="checkbox"/> No qualified installer for specified item | <input type="checkbox"/> Project cost savings |
| <input type="checkbox"/> Supplier refuses to warrant item or installation | <input type="checkbox"/> Unsuitable for application |
| <input type="checkbox"/> Supplier, Subcontractor or Contractor convenience | <input type="checkbox"/> Constructability issue |
| <input type="checkbox"/> Other: | |

Explanation in Detail: ☐ See attached: _____

SUPPORTING DATA:

Attach product description, specifications, drawings, photographs, performance data, test data, environmental criteria, and any additional data or information for evaluation of the proposed substitution in accord with requirements of Section 00 26 00.

Sample is included:	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
Sample will be sent if requested:	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
Maintenance Service Available:	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>

If yes, location: _____

Spare Parts Source: _____

Provide a one-to-one comparison of proposed substitution with ALL specified attributes and qualities of specified item(s)

[illegible]

REFERENCES:

LIST MINIMUM OF FIVE PREVIOUS INSTALLATIONS, WHICH PROPOSED PRODUCT HAS BEEN
INSTALLED FOR AT LEAST FOUR YEARS:

Project: _____
Address: _____
Architect (name & phone): _____
Owner (name & phone): _____
Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

Project: _____
Address: _____
Architect (name & phone): _____
Owner (name & phone): _____
Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

Project: _____
Address: _____
Architect (name & phone): _____
Owner (name & phone): _____
Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

Project: _____
Address: _____
Architect (name & phone): _____
Owner (name & phone): _____
Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

Project: _____
Address: _____
Architect (name & phone): _____
Owner (name & phone): _____
Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

Project: _____
Address: _____
Architect (name & phone): _____
Owner (name & phone): _____
Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

EFFECT OF SUBSTITUTION:

Substitution affects other parts of Work: No ☐ Yes ☐ (If yes, explain below)
Substitution requires dimensional revision or redesign of structure or mechanical and electrical Work: No ☐ Yes ☐ (If yes, explain below)
Same warranty provided as specified base product: No ☐ Yes ☐ (If no, explain below)
Explanation: _____

Cost difference: \$ _____ (add / deduct).
Total cost implications of substitution on Project: \$ _____ (add / deduct).
Total time implications: \$ _____ (add / deduct) calendar days.

STATEMENT OF CONFORMANCE OF REQUEST TO CONTRACT REQUIREMENTS:

Supplier, Subcontractor and Contractor in making substitution request or in using an approved substitution represent:

- ☐ Has personally investigated the proposed substitution and determined it is equal or superior in all respects to specified product or system and will perform intended function, except as stated above.
- ☐ Is in full compliance with applicable code requirements.
- ☐ Will provide same warranty for substitute item as for product, system or method specified.
- ☐ Will coordinate installation of accepted substitution into Work, to include building modifications if necessary, making such changes as may be required for Work to be complete in all respects.
- ☐ Waive all claims for additional costs or time extensions related to substitution that subsequently become apparent or are caused by substitution.
- ☐ If a finish product, color wise and pattern wise complies with base specified items.
- ☐ Certifies cost data presented is complete and includes all related costs under this Contract, excluding Architect's review and redesign cost.
- ☐ Will pay Architect's review and redesign cost, special inspections, and other costs caused by substitution.
- ☐ Will pay additional costs to other contractors caused by substitution.
- ☐ Will modify other parts of Work as may be needed, to make all parts of Work complete and functioning.
- ☐ Acknowledge acceptance of these provisions.

List of Attachments: _____

ACKNOWLEDGEMENTS:

FOLLOWING FIRM HEREBY REQUESTS CONSIDERATION OF FOLLOWING PRODUCT OR SYSTEMS AS A SUBSTITUTION IN ACCORD WITH PROVISIONS OF CONTRACT DOCUMENTS:

Supplier/Vender:
Acknowledged by (print & sign): _____ Date: _____
Position: _____ Phone: _____

Subcontractor:
Acknowledged by (print & sign): _____ Date: _____
Position: _____ Phone: _____

Contractor:
Acknowledged by (print & sign): _____ Date: _____
Position: _____ Phone: _____

END OF SUBSTITUTION REQUEST



DIVISION 01

GENERAL REQUIREMENTS



SECTION 01 10 00

SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Phased construction.
 - 4. Future work.
 - 5. Purchase contracts.
 - 6. Owner-furnished products.
 - 7. Contractor-furnished, Owner-installed products.
 - 8. Specification and Drawing conventions.
 - 9. Miscellaneous provisions.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 01 11 16 - Work by Owner.

1.2 PROJECT INFORMATION

- A. Project Identification: LTU - StarTran
 - 1. Project Location: Block 146, Lincoln, NE 68508.
- B. Owner: The City of Lincoln, StarTran
 - 1. Owner's Representative: Liz Elliott.
- C. Architect: HDR
- D. Web-Based Project Software: Project software administered by Architect will be used for purposes of managing communication and documents during the construction stage.
 - 1. See Section 01 31 26 for requirements for establishing, administering and using web-based Project software.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
 - 1. The project is a type 2B construction with Group A-3/B occupancy 2 story (12,622 SF) building with attached parking for 50 passenger vehicles and 19 bus bays with canopies and other Work indicated in the Contract Documents.
- B. Type of Contract:
 - 1. Project will be constructed under a single prime contract.

1.4 PHASED CONSTRUCTION

- A. The Work shall be conducted in a single phase, with each phase substantially complete as indicated.
 - 1. Phase <Insert designation>: <Briefly describe work of this phase> Work of this phase shall commence [within <Insert number of days> after the Notice to Proceed] [by <Insert date>] and be substantially complete and ready for occupancy [within <Insert number of days>] [after the Notice to Proceed] [after commencement of construction of this phase] [by <Insert date>].

2. Phase <Insert designation>: The remaining Work shall be substantially complete and ready for occupancy at time of Substantial Completion for the Work.

1.5 PURCHASE CONTRACTS

- A. General: Owner has negotiated Purchase contracts with suppliers of material and equipment to be incorporated into the Work. Owner will assign these Purchase contracts to Contractor. Include costs for purchasing, receiving, handling, storage if required, and installation of material and equipment in the Contract Sum unless otherwise indicated.
 1. Contractor's responsibilities are same as if Contractor had negotiated Purchase contracts, including responsibility to renegotiate purchase and to execute final purchasing agreements.
- B. Purchase Contracts Information:
 1. Pantograph Charging Assembly: See Appendix A, B and C.

1.6 PROCUREMENT REQUIREMENTS

- A. All products must meet BABAA requirements.
- B. Contractor shall include Manufacturer's Certification for BABAA requirements with all applicable submittals. If a specific manufacture is used in the bidding, a statement that Manufacturer will comply with BABAA must be included with the bid submission. Contractor shall comply with BABAA requirements, including coordination with manufacturers, distributors, and suppliers to correct deficiencies in any BABAA documentation.
 1. Engineer/Architect approval of shop drawings or samples shall include review of BABAA documentation.
 2. Contractor shall certify upon completion that all work and materials have complied with BABAA requirements.
 3. For any change orders, Contractor shall provide BABAA documentation for any new products or materials required by the change.
 4. Installation of materials or products that are not compliant with BABAA requirements shall be considered defective work. Contractor should ensure that Engineer/Architect has an approved Manufacturer's Certification or waiver prior to items being delivered to the project site.
 5. By submitting an application for payment, based in whole or in part on furnishing equipment or materials, Contractor certifies that such equipment and materials, to contractor's knowledge, are compliant with BABAA requirements.
- C. Definitions:
 1. This project utilizes Federal Assistance through the Federal Transit Administration (FTA) and therefore must comply with the [Build America, Buy America \(BABA\) Act](#). (Additional information on BABA for FTA can be found [here](#).) Every contractor and subcontractor choosing to bid on this project must abide by the BABA requirements.
 2. All iron and steel items used in projects must be produced in the United States. This means all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States.
 3. All manufactured products used in projects must be produced in the United States. This means the manufactured product was manufactured in the United States, and the cost of the components of the manufactured product that are mined, produced, or manufactured in the United States is greater than 55 percent of the total cost of all components of the manufactured product.
 4. All construction materials used in projects must be manufactured in the United States. This means that all manufacturing processes for the construction material occurred in the United States.

1.7 OWNER-FURNISHED PRODUCTS

- A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products and making building services connections.
- B. Owner-Furnished Products:
 - 1. Pantograph Charging Assembly.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings and Specifications.
 - 3. Keynoting: Materials and products are identified by reference keynotes referencing Section numbers found in this Project Manual.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 11 16
WORK BY OWNER

PART 1 - GENERAL

1.1 SUMMARY

- A. Owner may perform work with their staff or may award separate contracts for performance of certain construction operations at site.
- B. Owner operations may be scheduled to be performed during Work under this Contract.
- C. Separate contracts include but are not limited to following:
 - 1. Equipment and items indicated in documents as Owner furnished.
 - 2. Owner furnished furnishing, such as, furniture, window coverings and artwork.
 - 3. Specialties identified in Division 10 as Owner installed.
 - 4. Equipment identified in Division 11 as Owner installed.
 - 5. System installation in empty conduit defined in Section 26 05 33.
 - 6. Asbestos Abatement or Abatement of other hazardous materials.
 - 7. Refer to Documents for additional items.
- D. Contractors holding separate contracts with Owner to perform work for Owner may be non-union contractors.
 - 1. By executing this Contract, the Contractor and subcontractors acknowledge and have no objection and agree it will not impact the Project negatively.
- E. Schedule activities to minimize interference with work of others and cooperate with other parties involved in such concurrent Work.
- F. Cooperation by Contractor shall not be grounds for a claim of delay or additional cost.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 21 16 CONTINGENCY ALLOWANCES

PART 1 - GENERAL

1.1 SUMMARY

- A. Contingency Allowance is for exclusive use of Owner and Architect for changes resulting from design refinements, clarifications, inconsistencies, errors, omissions, and unanticipated design issues.
1. Acceptable uses of contingency allowance:
 - a. Removal, relocation, and/or rerouting of work required as a result of a conflict in the location.
 - b. An omission on the plans. (i.e. the mechanical plans show a piece of equipment requiring power but the electrical drawings don't show a circuit to the equipment.)
 - c. Reasonable cost of power or other utility services to portions of the work installed by Owner or during Owner's setup of furniture and furnishings prior to substantial completion of the work
 - d. Uncovering of buried conditions.
 - e. A change of material or upgrade of material quality requested by the Owner shall be considered a change order to Owner.
 - f. Cost to correct or modify work required by the building inspector where work is installed according to the Contract Documents.
 - g. Additional public protection measures beyond that reasonably anticipatable where required by Owner or Authority Having Jurisdiction.
 2. Unacceptable uses of contingency allowance:
 - a. Correction of non-conforming work by a subcontractor except where approved by Owner unless installing contractor is terminated- then contingency can be used.
 - b. Repair of damages to the work caused by a subcontractor except where approved by Owner same as above.
 - c. Removal and relocation of incorrectly placed work by a subcontractor same as above.
 - d. Correction of non-conforming work, repair of damages, or removal and replacement of defective or incorrectly placed work self- performed by Construction Manager's own forces.
 - e. Contractor's failure to include an item of work or task as defined by the Contract Documents.
 - f. Cost of overtime to keep on schedule except where approved by Owner.
 - g. Cost for expediting the delivery of materials, equipment, or replacement parts except where approved by Owner or permitted by other provisions herein.
 - h. Cost of Contractor's supervision of subcontractors working extended hours or multiple shifts except where approved by Owner or permitted by other provisions herein.
 - i. Utility system shutdowns or after hours/Sunday work associated with connections to public utility mainlines, it being presumed that all such connections located in public rights-of-way or mainline facilities serving other surrounding businesses will require connection during non-business hours.
 - j. Cost to correct or modify work required by the building inspector where work is not installed according to the Contract Documents.
 - k. Cost to remove and replace work not meeting the minimum requirements specified discovered from quality control testing. Same as No.1 above.
 - l. Cost to repair finishes that do not meet required specifications. Same as above.

- m. Cost to repair damage to a subcontractor's completed work where the damage was caused by another subcontractor prior to acceptance of the work, except where otherwise approved by Owner where Contractor is unable to reasonably assign the damage to subcontractors.
- 3. Not for use by Contractor as Contractor's construction contingency.
- 4. Owner and Architect approval of contingency adjustment required prior to adjusting Contingency Allowance for approved changes.
- 5. Contingency Allowance adjustments will include Contractor's related costs, and reasonable overhead and profit as stipulated in Contract Documents.

1.2 ALLOWANCE

- A. A Contingency Allowance is included in Contract Sum, in the amount of One Million dollars (\$1,000,000.00).
 - 1. Base Bid Lump Sum and Contract Sum shall not include Contractor's overhead and profit on Contingency Allowance.
 - 2. At Project closeout and prior to Final Payment the final Contract Sum shall be adjusted accordingly by Change Order.
 - a. Amount of the Change Order shall reflect difference between actual costs of all approved contingency adjustments and the Contingency Allowance.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 22 00
UNIT PRICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for unit prices.
- B. Unit Price is an amount proposed by bidders, stated on Bid Form, as a price per unit of measurement for materials or services added to or deducted from Contract Sum by appropriate modification, if estimated quantities of Work required by Contract Documents are increased or decreased.
- C. Contractor to take all measurements and compute quantities.
 - 1. Assist by providing necessary equipment, workers, and survey personnel as required.
 - 2. Owner will confirm in field the Contractor's measurement of work-in-place that involves use of established unit prices.
 - 3. If disputes arise, Owner reserves the right to have this work measured, at Owner's expense, by independent surveyor acceptable to Contractor.

1.2 UNIT QUANTITIES SPECIFIED

- A. Quantities indicated in Bid Form are for bidding and contract purposes only.
- B. If actual work requires more or fewer quantities than those quantities indicated, provide required quantities at unit sum/prices contracted.
- C. If quantities originally contemplated are materially changed in a proposed change so that application of such unit prices to quantities of Work proposed will cause substantial inequity to Owner or Contractor, the applicable unit prices shall be equitably adjusted.

1.3 MEASUREMENT OF QUANTITIES

- A. Measurement of Weight:
 - 1. Concrete reinforcing steel, rolled or formed steel or other metal shapes shall be measured by handbook weights.
 - 2. Welded assemblies shall be measured by handbook or scale weight.
- B. Measurement by Volume:
 - 1. Measured by cubic dimension using mean length, width and height or thickness.
- C. Measurement by Area:
 - 1. Measured by square dimension using mean length and width or radius.
- D. Linear Measurement:
 - 1. Measured by linear dimension, at item centerline or mean chord.
- E. Stipulated Sum/Price Measurement:
 - 1. Items measured by weight, volume, area, or linear means or combination, as appropriate, as a completed item or unit of work.

1.4 PAYMENT

- A. Payment Includes:
 - 1. Full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection application or installation of an item of work; overhead and profit.

- B. Final payment for work governed by unit prices will be made on basis of approved measurements and quantities, multiplied by unit sum/price for work which is incorporated in or made necessary by the work.

**PART 2 - UNIT PRICES, ADDITIVE OR DEDUCTIVE, IN ACCORD WITH SECTION 49 00 00
AND BID FORMPRODUCTS (NOT USED)**

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 26 00
CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section defines administrative and procedural requirements for handling and processing Changes in Work.
- B. Provisions within this section take precedence over provisions in General Conditions governing Changes in Work.
- C. Provisions followed by an asterisk (*) include some or all provision as obtained from AIA Document A201- General Conditions of the Contract for Construction.

1.2 DESCRIPTION

- A. Changes in Work may be accomplished after execution of Contract, and without invalidating Contract, by Change Order (CO), Change Proposal Request (CPR), Construction Change Directive (CCD) or order for a minor change in Work, subject to the limitations stated in this Section and elsewhere in Contract Documents. *
 - 1. A Change Order or Change Proposal Request shall be based upon agreement among Owner, Contractor, and Architect. *
 - 2. A Construction Change Directive requires agreement by Owner and Architect and may or may not be agreed to by Contractor. *
 - 3. An order for a minor change in Work may be issued by Architect alone. *
- B. Changes in Work shall be performed under this Section and other applicable provisions of Contract Documents, and Contractor shall proceed promptly, unless otherwise provided in a Change Order, Change Proposal Request, Construction Change Directive, or order for a minor change in Work. *
- C. Contractor may anticipate a minimum of three change documents being issued during Project duration. However, such quantities shall not guarantee nor limit total quantity of changes.
- D. Manage changes issued so as not to adversely affect Project Schedule.
- E. Neither Owner nor Architect recognize "reservation of rights" or similar language from Contractor that would state or purport to preserve ability to make additional claims or demands related to a change, not in conformance with terms and provisions provided by Contract Documents.
 - 1. Claims or other demands for changes, compensation or an extension of time must be made in strict conformance with the provisions of Contract Documents.
 - 2. Agreement on any Change Order, Construction Change Directive or Change Proposal Request shall constitute a final settlement of the event and all matters related thereto.
 - 3. Contractor waives and releases Owner and Architect of direct material costs, labor costs, equipment costs, overhead and profit, costs, or losses due to productivity loss, morale, attitude, staffing changes, supervision, acceleration, delay, interference, logistics, fatigue, ripple effect, overtime, time extensions related to costs, and other costs related to any change that are not expressly included in an agreement on any Change Order, Change Proposal Request or Construction Change Directive.
- F. Verbal or other informal orders provided by Owner or Architect should be considered as temporary or emergency instructions.
 - 1. Verbal or other informal orders shall be formally documented, using one of procedures indicated in this Section.
 - 2. Should Contractor choose to proceed with any verbal or informal instructions, Contractor does so at their own risk.

3. Should Contractor not receive written verification of verbal or informal instructions in a timely manner, Contractor should request verification using Request for Information (RFI) process.
 4. Contractor shall not proceed with verbal or informal instructions which may result in a change to Contract Sum or Contract Time, until an approved Change Order or Change Proposal Request is received.
- G. Incorporate approved changes in Project Record Documents and Construction Schedules for Project.
1. Submit revised schedules for Project to Owner and Architect.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CHANGE ORDERS*

- A. A Change Order (CO) is a written instrument prepared by Architect and signed by Owner, Contractor, and Architect, stating their agreement upon following:
1. Change in Work,
 2. amount of adjustment, if any, in Contract Sum, and
 3. extent of adjustment, if any, in Contract Time.

3.2 CHANGE PROPOSAL REQUEST

- A. Change Proposal Request (CPR) is prepared and initiated by Architect at Owner's request or may be issued in response to an RFI (Request for Information) which has a cost or time impact, or some other required or desired change in the Work that may require an adjustment to Contract Sum or Contract Time.
1. Change Proposal Requests will include a description of proposed change and may include supplemental or revised Drawings and Specifications, or written instruments prepared by Architect.
 2. Initiation and issuance of a Change Proposal Request is not direction to either stop Work in progress or to proceed with change.
 3. Architect will issue Change Proposal Request via Newforma Info Exchange.
 4. Contractor can download electronic documents for further processing from email and/or from HDR's Newforma Info Exchange for the project.
 5. Submit upon receipt, Contractor and Subcontractors shall review and evaluate scope of change, and potential impact on Project.
 - a. If potential impact to schedule, Contractor shall immediately initiate and forward Change proposal to Owner for processing.
 - b. If potential impact, Owner may direct Contractor to stop Work in area affected by change to minimize cost impact or may issue a Construction Change Directive (CCD) directing Contractor to proceed with change.
 6. Evaluate Subcontractor's cost proposals, make recommendations and submit proposal to Architect on CPR form issued by Architect within twenty-one (21) calendar days of receipt so not to delay progress of Project.
 - a. Proposals shall include Contractor's Cost Summary form from Contractor and each Subcontractor with complete itemized accounting, together with appropriate supporting data to substantiate adjustments in Contract Sum and Contract Time, including labor, materials, and equipment.
- B. Method used to determine an adjustment in Contract Sum shall be limited to following:
1. Labor Wages:

- a. Itemized by each craft involved, indicating hourly rate for each and hours required, excluding premium pay, paid to employees directly engaged in Work.
 - b. Rates shall be actual rate paid the workman in accordance with established management labor agreements.
 - c. Labor rates indicated in Contractor Agreement or Subcontractor Agreements are not applicable if they cannot be substantiated in writing as direct labor burden when requested by Owner or Architect.
2. Labor Burden:
 - a. Percent of actual wages for each craft including:
 - 1) Mandatory fringe benefits required by established agreements.
 - 2) Health and Welfare.
 - 3) Pension.
 - 4) Apprenticeship and other required programs.
 - 5) Social Security.
 - 6) Unemployment Insurance.
3. Subsistence, Mileage, or both:
 - a. If in union agreements.
4. Materials and Equipment: Materials incorporated in Work at Contractor's actual invoice cost, including freight.
5. Amount of credit allowed for a deletion or change which results in net decrease in Contract Sum shall be net cost.
 - a. When both additions and credits covering related Work or substitutions are involved in a change, allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.
6. Overhead and Profit:
 - a. 15 percent of net increase of labor and material for work performed by own forces including, but not limited to:
 - 1) Project Manager.
 - 2) Estimating.
 - 3) Field supervision above foremen level superintendents.
 - 4) Assistant superintendents.
 - 5) General foremen.
 - 6) Engineers.
 - 7) Accountants.
 - 8) Timekeepers.
 - 9) Office managers and others on staff.
 - 10) Office supplies.
 - 11) Computers and software.
 - 12) Drinking water.
 - 13) Temporary heat.
 - 14) Temporary cooling.
 - 15) Light and power.
 - 16) Sanitation facilities.
 - 17) Small tools valued at \$500 or less.
 - 18) Record documents; and other.
 - 19) Cost of materials, equipment or both not incorporated in Work or directly associated with Work, including home office and on site office costs.
7. Directed Premium Time on Contract Work:

- a. Actual premium portion of wages for original contract Work which was directed by Owner to be performed other than normal working hours, including:
 - 1) Social Security Taxes.
 - 2) Unemployment Insurance.
 - 3) Union Fringe Benefits if required by Union Agreements.
- 8. Major Construction Equipment:
 - a. Owned:
 - 1) Cost not to exceed eighty-five percent (85 percent) of current prevailing rates or blue book rates for rental of appropriate equipment for job and time period of use.
 - b. Leased:
 - 1) Contractor's reasonable invoiced cost, except lease-purchase equipment which is considered "Contractor owned".
- 9. Contractor's overhead and profit on Subcontractor's Work:
 - a. Contractor's overhead and profit on Subcontractor's Work shall not exceed ten percent (10 percent) on net increase of Work performed by Subcontractor.
- 10. Subcontractor overhead and profit markup is not allowed on their Sub-subcontractor's Work.
- 11. Subcontractor Cost:
 - a. Quote in same manner as prescribed herein for "Contractor".
- 12. Bond and Insurance:
 - a. Actual amount based on net increase or deduct to be paid to surety and insurance carrier.
- C. Only delay impacting critical path of Work shall be considered when determining if Contractor is entitled to additional time.
 - 1. If proposals include a change in time, Contractor shall substantiate number of days proposed.
 - a. An estimate of cost and of probable effect of delay of the Work progress and Project schedule shall be included to substantiate potential delay, including a comparison of Project Construction Schedule and schedules prepared to substantiate a change in time.
 - b. Indicate in CPM format both critical and non-critical path activities affected, and show Project Construction Schedule and change sequences, durations, and float.
- D. Owner shall have right within its sole discretion to require Contractor to commence performance of changes to Work prior to submission by Contractor of proposal, or Owner's approval of proposal.
 - 1. Proceed with Work upon receipt of a Construction Change Directive from Owner and thereafter submit to Owner and Architect as soon as possible any cost proposal required for approval.
- E. Change Proposal Request signed by Contractor and Owner indicates agreement therewith and shall be considered a Change Order.
 - 1. Contractor is authorized to proceed with the change after Owner approval thereof.
- F. Construction Change Directive may be prepared if Contractor's proposal is not acceptable or change need be expedited to reduce or eliminate impact on project.

3.3 CONSTRUCTION CHANGE DIRECTIVES

- A. Written order prepared by Architect or Owner and signed by Owner, directing a change in Work prior to agreement on adjustment, if any, in Contract Sum, Contract Time, or both.

- B. Owner may by Construction Change Directive, without invalidating Contract, order changes in Work within general scope of Contract consisting of additions, deletions or other revisions, Contract Sum and Contract Time being adjusted accordingly. *
- C. Construction Change Directive may be used in absence of total agreement on terms of a Change Order or Change Proposal Request. *
- D. If Construction Change Directive provides for an adjustment to Contract Sum, the adjustment shall be based on one of following methods: *
 - 1. Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation, *
 - 2. Unit prices stated in Contract Documents or subsequently agreed upon, *
 - 3. cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee,
 - 4. or as provided in Paragraph 3.2 B and C.
- E. Upon receipt of a Construction Change Directive, proceed with change in Work involved and advise Owner and Architect of Contractor's agreement or disagreement with method, if any, provided in Construction Change Directive for determining proposed adjustment in Contract Sum or Contract Time. *
- F. Failure of Contractor and Owner to agree on an adjustment of Contract Sum or Contract Time shall not excuse Contractor from proceeding with prosecution and performance of Work. Contractor and Subcontractors, Sub-subcontractors and Suppliers shall administer all disputes in a manner that will permit Work to proceed on schedule while matter in dispute is being resolved.
- G. Construction Change Directive signed by Contractor indicates agreement of Contractor therewith, including adjustment in Contract Sum and Contract Time or method for determining them.
 - 1. Such agreement shall be effective immediately and shall be recorded as a Change Order. *
- H. The amount of credit allowed by Contractor to Owner for a deletion or change which results in a net decrease in Contract Sum shall be actual net cost. *
 - 1. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on basis of net increase, if any, with respect to that change. *
- I. Present an itemized accounting together with appropriate supporting data in accordance with Paragraph 3.2 B and C.
- J. When Owner and Contractor reach agreement upon the adjustments, such agreement shall be effective immediately and shall be recorded by preparation and execution of an appropriate Change Order. *
- K. For any portion of such cost that remains in dispute, Owner shall hire independent professional estimator to make determination. Resulting determination of cost shall adjust Contract Sum, subject to right of either party to disagree and assert a claim. *
- L. When Owner and Contractor agree with determination made by independent professional estimator concerning the adjustments in Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and shall be recorded by preparation and execution of an appropriate Change Order. *

3.4 MINOR CHANGES IN WORK

- A. Architect has authority to order minor changes in Work not involving adjustment in Contract Sum or extension of Contract Time and not inconsistent with the intent of Contract Documents. *
- B. Such changes shall be made by written order and shall be binding on Owner and Contractor. *
- C. Following may be used as a written order to order minor change in the Work:

1. Clarification-Interpretation (C-I) or Architect's Supplemental Instruction (ASI) issued by Architect.
 2. Response to a Request for Information by Architect.
 3. Architect's comments or direction on a Contractor's Submittal.
 4. Minor changes indicated in Architect's project visit report.
- D. Contractor shall carry out such written orders promptly. *
- E. If Contractor perceives direction in a written order requires adjustment to Contract Time or Contract Sum, Contractor shall not execute such direction and shall submit a claim to Architect along with substantiation within twenty-one (21) working days of receipt of such written order.

3.5 CONTRACTOR'S PROPOSED CHANGES TO WORK

- A. Architect and Owner may consider properly prepared, timely Contractor Proposed Changes (CPC) to Work, if requested by Owner or Architect, or at any time Contractor believes unforeseen conditions may require modifications to the Contract Sum or Contract time.
1. A Contractor Proposed Change shall be properly prepared, accompanied by proposed cost, sufficient supporting data, and information to permit Architect to make a reasonable determination without extensive investigation to determine if change may be considered warranted.
 - a. Include a statement outlining reasons for change and effect of change on Work.
 - b. Provide a complete description of proposed change.
 - c. Indicate effect of proposed change on Contract Sum and the Contract Time.
 - d. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made.
 - 1) Indicate separately any credit due Owner for products eliminated.
 - 2) If requested, furnish survey data to substantiate quantities.
 - e. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - f. Include costs of labor and supervision directly attributable to change and identify separately any credit for work previously bid but would be eliminated.
 - g. In event proposed change effects construction schedule, include an updated Contractor's Construction Schedule indicating effect of change, including, but not limited to:
 - 1) Changes in activity duration.
 - 2) Start and finish times.
 - 3) Activity relationship.
 - 4) Use available total float before requesting an extension of Contract Time.
 - 5) Document use of float or proposed alternate methods to maintain original schedule or both.
 2. Contractor Proposed Change shall be submitted to Architect in such format and on such form included herein or as Architect may require.
- B. Architect will take appropriate action on Contractor Proposed Changes.
1. Architect may issue an order for a minor change in Work if it is determined that proposed change is not materially different from requirements of Contract Documents.
 2. Architect may incorporate proposed change into a change document and issue for Owner's consideration.
 3. If Architect determines that implementation of proposed change would result in a material change to Contract that may cause an adjustment in Contract Time or Contract Sum, Architect may make a recommendation to Owner who may authorize further evaluation of proposed change or may authorize issuance of such change.

4. Architect may reject such proposed change if it will require substantial revisions to Contract Documents, building or systems or if Architect determines they are not appropriate or substantiated.

END OF SECTION

CHANGE PROPOSAL IMPACT EVALUATION

PROJECT: LTU -
StarTran

CPR NO.:

HDR PROJECT NO.: 10383454

TO OWNER:

We have reviewed and evaluated the scope of above referenced change and potential impact on Project. If the change is required or desired, we recommend the following action to expedite Work and avoid or minimize delays in the Work which may affect cost of the change or impact to the schedule:

- ☐ Recommend Work stop in area affected by this change for (____) calendar days so change can be priced and processed. Contract Sum or Contract Time due to stopping Work will not increase.
- ☐ Recommend proceeding with change immediately:
1. Proposed basis of adjustment to Contract Sum:
 - ☐ No additional cost.
 - ☐
 - ☐ Lump Sum (increase) (decrease) of \$ _____
 - ☐ Unit Price of \$ _____ per _____
 - ☐ Time & Materials, not to exceed \$ _____
(Daily time, material, and equipment documentation required for above)
 - ☐ As follows: _____
(Method used in determining above adjustments shall be as defined in Contract Documents)
 2. Contract Time is proposed to (be adjusted) (remain unchanged), by an (increase) (decrease) of _____ calendar days.

FROM CONTRACTOR:

BY: _____ DATE: _____

DISTRIBUTION: ☐ OWNER ☐ ARCHITECT ☐ _____

CONSTRUCTION CHANGE DIRECTIVE

TO CONTRACTOR:

You are hereby directed to:

- ☐ Stop work in area affected by above referenced change until it has been processed and appropriate action taken.
- ☐ Proceed with above referenced change immediately.

When signed by Owner and received by CM/Contractor, this document becomes effective IMMEDIATELY as a Construction Change Directive (CCD), and CM/Contractor shall proceed based per above.

FROM OWNER:

BY: _____ DATE: _____

DISTRIBUTION: ☐ CONTRACTOR ☐ ARCHITECT ☐ _____

CONTRACTOR'S COST SUMMARY

PROJECT: LTU
- StarTran

CHANGE DOCUMENT:

PROJECT NO.:
10383454

CONTRACTOR:
SUBCONTRACTOR:

DATE:
DATE:

This form, itemized accountings and appropriate supporting data must be attached to any change documents or claim.

(Only fill in applicable line items)

- | | | | |
|----|--|----|--|
| 1. | Labor * (including benefits) | \$ | (Attach Cost Summaries and breakdowns) |
| 2. | Materials and Products * | \$ | (Attach Cost Summaries and breakdowns) |
| 3. | (Subtotal of lines 1 and 2) | \$ | |
| 4. | Overhead and Profit (10 percent of line 3) | \$ | |
| 5. | Premium Time on Contract Work | \$ | |
| 6. | Major Construction Equipment Rental * | \$ | (Shall not exceed A.E.D. Schedules) |
| 7. | Subcontractor's name and cost: | | |

(Attach Cost Summaries and breakdowns)

Work Category:

- | | | |
|---|----|--|
| a | \$ | |
| b | \$ | |
| c | \$ | |
| d | \$ | |
| e | \$ | |
| f | \$ | |
| g | \$ | |
| h | \$ | |
| i | \$ | |
| j | \$ | |
| k | \$ | |
| l | \$ | |
| m | \$ | |
| n | \$ | |
| o | \$ | |
| p | \$ | |
| q | \$ | |
8. Total Subcontractor cost (total of lines 7a through 7q) \$
9. Contractor's O & P on Sub's. Work (5 percent of line 8) \$
10. (Subtotal of lines 3, 4, 5, 6, 8 and 9) \$
11. Bond (____) percent and Insurance (____) percent (if required) = \$
(____) percent of line 10
12. **TOTAL PROPOSED COST ADJUSTMENT** (total of lines 10 and 11): **\$**
13. **PROPOSED CONTRACT TIME ADJUSTMENT:** ☐ ADD ☐ DEDUCT (calendar days)
(Provide supportive data substantiating claim for additional days in accordance with Contract Documents)

* Attach complete breakdown of itemized accounting and supporting data, sufficient to permit evaluation.

CONTRACTOR PROPOSED CHANGE

PROJECT: LTU - StarTran

HDR PROJECT NUMBER: 10383454

TO: HDR Architecture, Inc.

REASON FOR PROPOSAL:

- | | |
|--|--|
| <input type="checkbox"/> Design to comply with building code requirements | <input type="checkbox"/> Product not available |
| <input type="checkbox"/> Product / material unavailable to meet Project schedule | <input type="checkbox"/> Reduce Project construction time |
| <input type="checkbox"/> No qualified installer for specified item | <input type="checkbox"/> Unanticipated / existing condition |
| <input type="checkbox"/> Supplier refuses to warrant product or installation | <input type="checkbox"/> Specified product / system unsuitable for application |
| <input type="checkbox"/> Project cost cutting / cost reduction | <input type="checkbox"/> Owner suggested or requested |
| <input type="checkbox"/> Supplier, Subcontractor or Contractor convenience | <input type="checkbox"/> Constructability issue |
| <input type="checkbox"/> Value Engineering (may be used for "Value Engineering Change Proposal" govern by Federal Acquisition Regulations) | |
| <input type="checkbox"/> Other: | |

Explanation in Detail: ☐ See attached: _____

REASON FOR NOT GIVING PRIORITY TO SPECIFIED METHOD, ITEMS OR SYSTEM: ☐ See attached: _____

REFERENCES:

Section number: _____ Article(s)/paragraph(s): _____

Drawings / Sections / Details: _____

DESCRIPTION OF PROPOSAL:

SUPPORTING DATA:

Attach description, specifications, drawings, photographs, performance data, test data, environmental criteria, and any additional data or information for evaluation.

Sample is attached: Yes ☐ No ☐

Sample will be sent if requested: Yes ☐ No ☐

Maintenance Service Available: Yes ☐ No ☐

If yes, location:

Spare Parts Source:

Provide a one-to-one comparison of proposed item with ALL specified attributes and qualities of specified item(s)

SPECIFIED PRODUCT

June 5, 2026
Construction Documents

REFERENCES:

LIST MINIMUM OF FIVE PREVIOUS INSTALLATIONS, WHICH PROPOSED METHOD / SYSTEM / PRODUCT HAS BEEN INSTALLED FOR AT LEAST FOUR YEARS:

Project: _____
Address: _____
Architect (name and phone): _____
Owner (name and phone): _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

Project: _____
Address: _____
Architect (name and phone): _____
Owner (name and phone): _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

Project: _____
Address: _____
Architect (name and phone): _____
Owner (name and phone): _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

Project: _____
Address: _____
Architect (name and phone): _____
Owner (name and phone): _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

Project: _____
Address: _____
Architect (name and phone): _____
Owner (name and phone): _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

Project: _____
Address: _____
Architect (name and phone): _____
Owner (name and phone): _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: \$ _____

EFFECT OF PROPOSAL:

Effects on other parts of Work: No ☐ Yes ☐ (If yes, explain below)
Proposal requires dimensional revision or redesign of
structure or mechanical and electrical Work: No ☐ Yes ☐ (If yes, explain below)
Same warranty provided as specified item: No ☐ Yes ☐ (If yes, explain below)
Explanation: _____

Cost difference: \$ _____ (increase / decrease)
Total Contract Sum implications of proposal on Project: \$ _____ (increase / decrease)
Total Contract Time implications: _____ (increase / decrease) calendar days.

STATEMENT OF CONFORMANCE OF PROPOSAL TO CONTRACT REQUIREMENTS:

Supplier, Subcontractor, Contractor, (CM) in making substitution request or in using an approved substitution represent:

- ☐ Has personally investigated the proposal and determined it is equal or superior in all respects to specified product, system or method and will perform intended function, except as stated above.
- ☐ Has same quality and life-cycle cost as design in the Contract Documents, except as stated above.
- ☐ Is in full compliance with applicable code requirements.
- ☐ Will provide same warranty for substitute item as for product, system or method specified.
- ☐ Will coordinate installation of proposal into Work, to include building modifications, if necessary, making such changes as may be required for Work to be complete in all respects.
- ☐ Waive all claims for additional costs or time extensions related to proposal that subsequently become apparent or are caused by proposal.
- ☐ If a finish product, color wise and pattern wise complies with base specified items.
- ☐ Certifies cost data presented is complete and includes all related costs under this Contract, excluding Architect's review and redesign cost.
- ☐ Will pay Architect's review and redesign cost, special inspections, and other costs caused by proposal.
- ☐ Will pay additional costs to other contractors caused by proposal.
- ☐ Will modify other parts of Work as may be needed, to make all parts of Work complete and functioning.
- ☐ Acknowledge acceptance of these provisions.

List of Attachments:

ACKNOWLEDGEMENTS:

FOLLOWING FIRM HEREBY REQUESTS CONSIDERATION OF PROPOSAL:

Requested by (firm): _____
Acknowledged by (print & sign): _____ Date: _____
Position: _____ Phone: _____

Subcontractor: _____
Acknowledged by (print & sign): _____ Date: _____
Position: _____ Phone: _____

Contractor: _____
Acknowledged by (print & sign): _____ Date: _____
Position: _____ Phone: _____

CONSTRUCTION MANAGER'S ACKNOWLEDGMENT AND RECOMMENDATION:

- ☐ Recommend approval for following reasons:
- ☐ Do not recommend approval for following reasons:
- ☐ Returned to requester - Need more information:

Comments: _____

Construction Manager: _____
Acknowledged by (print & sign): _____ Date: _____
Position: _____
Distribution: ☐ Architect ☐ file

ARCHITECT'S ACTION / RECOMMENDATION:

- ☐ Recommend Owner's approval.
☐ Submitted to Owner for authorization for Architect's as Change in Service to further evaluate and make recommendation.
☐ Submitted to Owner for authorization for Architect's as Change in Service to revised Contract Documents to incorporate proposal, and issue change document to the contractor for submitting a complete cost proposal for Owner's consideration.
☐ Do not recommend (see comments below).
☐ Rejected:
☐ Acceptance will require substantial revision of Contract Documents, building or systems.
☐ Request does not indicate specific item, system or method which is being proposed.
☐ Requested for manufacturer acceptance only.
☐ Request form is not properly executed and signed.
☐ Subcontractor or supplier requested directly.
☐ Insufficient information submitted.
☐ Does not comply color wise or pattern wise with base specified items.
☐ Insufficient information submitted to evaluate.
☐ Does not appear to comply with requirements of specifications for base specified product.
☐ Other:
☐ Additional information needed - Returned to CM/Contractor for providing following:

Comments: _____

Architect: _____
By (print & sign): _____ Date: _____
Position: _____
Distribution: ☐ Owner ☐ CM/Contractor ☐ file

OWNER ACTION:

- ☐ Reject - Do not want to consider.
☐ Product substitution approved - Contractor may proceed with request as a submitted.
☐ Approved - Architect directed as Change in Services to issue change document to incorporate substitution into contract Documents and adjust Contract Sum and/or Contract time.
☐ Architect authorized as Change in Services to further evaluate and make recommendation.
☐ Architect authorized as Change in Services to revised Contract Documents to incorporate proposal, and issue change document to the contractor for submitting a complete cost proposal for Owner's consideration.
☐ Additional information needed - Returned for providing following:

Comments: _____

Owner: _____
By: (print & sign) _____ Date: _____
Position: _____
Distribution: ☐ Architect ☐ CM/Contractor

ARCHITECT FURTHER ACTION / RECOMMENDATION (if needed):

- ☐ Incorporating into change document as directed by Owner. Change document _____ will be used.
- ☐ Recommend Owner's approval.
- ☐ Submitted to Owner for authorization for Architect's as Change in Service to revised Contract Documents to incorporate proposal, and issue change document to the contractor for submitting a complete cost proposal for Owner's consideration.
- ☐ Do not recommend (see comments below).
- ☐ Rejected:
 - ☐ Acceptance will require substantial revision of Contract Documents, building or systems.
 - ☐ Request does not indicate specific item, system or method which is being proposed.
 - ☐ Requested for manufacturer acceptance only.
 - ☐ Request form is not properly executed and signed.
 - ☐ Subcontractor or supplier requested directly.
 - ☐ Insufficient information submitted.
 - ☐ Does not comply color wise or pattern wise with base specified items.
 - ☐ Insufficient information submitted to evaluate.
 - ☐ Does not appear to comply with requirements of specifications for base specified product.
 - ☐ Other:
- ☐ Additional information needed - Returned to CM/Contractor for providing following:
- ☐ Recommend Owner's approval.
- ☐ Do not recommend.

Comments:

Architect:

By: (print & sign) _____ Date: _____

Position: _____

Distribution: ☐ Owner ☐ CM/Contractor ☐ file

OWNER FURTHER ACTION (if needed):

- ☐ Reject - Do not want to consider.
- ☐ Product substitution approved - Contractor may proceed with request as a submitted.
- ☐ Approved – Architect directed as Change in Services to issue change document to incorporate substitution into contract Documents and adjust Contract Sum and/or Contract time.
Architect authorized as Change in Services to revised Contract Documents to incorporate proposal, and issue change document to the contractor for submitting a complete cost proposal for Owner's consideration.
- ☐ Additional information needed - Returned for providing following:

Comments:

Owner:

By: (print & sign) _____ Date: _____

Position: _____

Distribution: ☐ Architect ☐ CM/Contractor ☐ file**END OF FORMS**

SECTION 01 26 13
REQUESTS FOR INFORMATION (RFI)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section specifies administrative and procedural requirements for handling and processing Requests for Information (RFI).
- B. RFI is intended for requesting clarifications and interpretations of Contract Documents due to inconsistencies, errors or omissions in Contract Documents, and unanticipated existing conditions.
- C. RFI is not intended for general communication, requesting substitutions, Contractor's proposed changes, resolution of nonconforming work, and coordination between contractors or for general questions not related to Contract Documents.
- D. RFI process is a cooperative enterprise between Architect and Contractor to expedite RFI response and maintain progress of Work.
- E. Architect shall evaluate alternate proposed methods of processing RFI to that indicated within this Section for potential impact on Architect's services.
 - 1. If Architect agrees to utilize another proposed method, Architect will be reimbursed for any special training, usage fees, extra time required to implement, maintain, utilize, and administer such a system.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 REQUESTS FOR INFORMATION

- A. Review of Contract Documents and Field Conditions:
 - 1. Contract Documents are complementary. Before starting each portion of Work, Contractor shall carefully study and compare various Drawings, Specifications and other Contract Documents, coordination drawings, shop drawings, prior correspondence, or documentation relative to that portion of Work, as well as information furnished by Owner.
 - 2. Contractor and Subcontractors shall evaluate and take field measurements of conditions related to that portion of Work and shall observe any conditions at site affecting it.
 - 3. These obligations are for purpose of facilitating coordination and construction by Contractor and are not for purpose of discovering errors, omissions, or inconsistencies in Contract Documents.
 - 4. Contractor and subcontractors acknowledge that all documents pertaining to Work has been examined, have examined character of site and any existing conditions, and are satisfied with nature of Work, and other matters which can affect Work.
 - 5. In event of inconsistency between portions of Contract Documents or within Contract Documents; provide better quality or greater quantity of Work, and comply with more stringent requirement, either or both in accordance with Architect's interpretation.
 - 6. Report errors, inconsistencies or omissions discovered in Contract Documents promptly to Architect as a properly prepared and timely RFI.
 - 7. Contractor and Subcontractors are not required to ascertain Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, and rules and regulations, unless they bear upon construction means, methods, techniques or safety and health precautions, but the Contractor shall promptly report to Architect any nonconformity discovered by or made known to Contractor as an RFI.

8. On condition that Contractor or Subcontractor fail to give such notice and knowingly proceeds with Work affected by errors or omissions in Contract Documents, Contractor shall correct any such errors, inconsistencies, or omissions at no additional cost.
9. Prior to bid, Contractor shall review existing facilities related to this contract and shall be familiar with utility requirements and construction.
 - a. Existing facility documents may be available through Owner for review.
 - b. Perform preliminary investigations as required to ascertain extent of Work.
 - c. Conditions which would be apparent by such investigation will not be allowed as cause for claims for extra costs.

B. Contractor's and Subcontractor's Responsibilities:

1. Process request through Contractor when interpretation, clarification, or explanation of portion of Construction Documents is needed by Contractor, Subcontractor, Vendor or Supplier.
 - a. Review request for completeness, quality, proper referencing to drawing or specification section and reason submitted.
 - b. In event request is not acceptable return to submitter with comments regarding reason for being returned.
 - c. Make every attempt to validate, resolve or respond to RFI by thoroughly researching and reviewing Contract Documents and field conditions.
 - d. Respond to RFI accordingly if review of RFI discloses a response or is related to coordination of construction or other issue not related to Contract Documents.
 - e. If request is unclear, rewrite and state in clear, concise, correct, complete and easily understood manner.
 - 1) Include additional information if necessary and submit to Architect for response.
2. Submit request for interpretation, clarification, or explanation of Contract Documents to Architect through Contractor.
 - a. List specific Contract Documents researched when seeking information being requested.
 - b. Reference applicable Contract Drawings by sheet number, section, detail, room number, door number, etc., Specifications by section and paragraph number, and reference other relevant documents.
 - c. The field titled "Regarding" on attached RFI form must be clear for future reference in reports or correspondence.
 - d. Clearly state request and provide Contract Document references and any additional information needed so request can be fully understood, including sketches, photos, or other reference material.
 - e. Fully assess issues, suggest any reasonable solutions, and include various factors, including potential costs, schedule impacts, if any, and recommendations which will aid in determining a solution or response.
 - 1) In event a reasonable solution cannot be suggested, a statement to that effect should be so stated.
 - f. Indicate reason request is being submitted.
 - g. Clearly indicate critical RFI requiring a rapid response with an explanation as to why RFI is critical.
 - h. Indicate priority for responses when multiple RFI are submitted within short period of time.
3. Distribute copies of responses to RFI to all parties affected.
4. Response to RFI shall not be considered a notice to proceed with a change that may revise the Contract Sum or Contract Time, unless authorized by Owner in writing.

5. In event response to RFI is determined incomplete, resubmit with explanation for unacceptability of response and necessary additional information within 5 days of receipt to RFI response.
6. On condition Contractor determines or believes additional cost or time is involved due to clarifications, interpretations or instructions issued by Architect in response to a RFI, resubmit RFI within 5 days of receipt of response with reason and alternate solution or suggestion for performing work at no additional cost.
 - a. In event no other solution is possible or desirable, submit Claim in accordance with Contract Documents within 21 days of receipt of response to RFI.

C. RFI Submittal Process:

1. Draft and submit RFI to Architect by Contractor utilizing web based application, Newforma Info Exchange (Newforma).
 - a. A unique username and password will be assigned to Contractor for access to system, project data and submittal of RFI.
 - b. Employ systems RFI module to submit RFI by Contractor.
 - c. Insert entire question or requested information in "Question" portion of system.
 - d. Electronic file of sketches, photos or other pertinent information may be uploaded with a RFI request in system to clarify request.
 - e. RFI automatically receives current date stamp upon submittal of RFI in system.
 - f. System will assign a unique RFI number in sequential order (1, 2, 3, 4, etc.).
 - g. In event previously submitted RFI request requires revision to provide additional information, initiate a new RFI.
 - 1) New RFI shall be renumbered with previous submitted RFI succeeded by ".1 " to indicate revision one of RFI (i.e.: RFI No. 34.1 for revision 1 to RFI No. 34).
2. Architect will respond to RFI utilizing Newforma.
 - a. Architect may upload electronic files with RFI response in system to help clarify response.
 - b. Upon response to RFI by Architect, the current date will be automatically entered into system.
 - c. To protect responding data from being altered, "Answer" portion of screen and submitted date cannot be changed once RFI has been closed.
3. After receipt of RFI response, the system can be accessed for RFI response, attachments, and printing.
4. Status of RFI submitted and data regarding RFI may be viewed or printed from system.
5. RFI and a variety of different RFI summaries, and filtered reports may be generated, viewed, or printed from system.

D. Architect's Response to Request for Information (RFI):

1. Clarifications, interpretations, and decisions of Architect in response to RFI will be consistent with intent of and reasonably inferable from Contract Documents, in writing, and may be provided in form of drawings and other attachments, or both.
2. When making such interpretations and decisions, Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either and will not be liable for results of interpretations or decisions rendered in good faith.
3. Architect's decisions on matters related to aesthetic effects will be final if consistent with intent expressed in Contract Documents.
4. Architect will not undertake to settle differences between Contractor, Subcontractors, trades suppliers, fabricator or manufacturer, or act as arbiter as to which Subcontractor, trade, supplier, or manufacturer is to furnish or install various items indicated or required.
5. Architect shall provide responses to RFI with reasonable promptness but will endeavor to respond within 10 business days from date of receipt.

- a. If multiple RFI are submitted on same day or within a 5 day period, review time may be extended by mutual agreement of parties.
- b. Architect will provide a written response to RFI if Architect believes response only involves an interpretation, clarification, supplemental information, or a minor change in Work not involving an adjustment in Contract Sum or extension of Contract Time, and is consistent with intent of Contract Documents, and shall be binding.
- c. If Architect believes response may result in a change to Contract Sum or Contract Time, response will indicate that a change document will be issued for the response, and appropriate change document will be issued indicating changes to Contract Documents.
- d. Architect will provide any additional or supplemental drawings, specifications or other information as Architect may deem necessary to facilitate response.
- 6. Architect may return RFI without response for following reasons:
 - a. Is considered a "Contractor Proposed Change."
 - b. Response is consistent with the intent of the Contract Drawings.
 - c. Request is unclear or incomplete.
 - d. Is due to Contractor's lack of adequate coordination.
 - e. Is related to construction means, methods or techniques.
 - f. Response is required by another party.
 - g. Is considered a "Substitution Request."
- E. If requested information is available from careful study and comparison of Contract Documents, field conditions, other Owner-provided information, coordination drawings, or prior Project correspondence or documentation, Architect may invoice Owner as a change in services for costs involved in Architect's review, analysis, responding and processing of such RFI.
 - 1. Contractor shall reimburse Owner for such costs.

END OF SECTION

REQUEST FOR INFORMATION

Project: _____

RFI Number: _____

Project No.: _____

☐ (other?) _____

☐ Action

☐ Info

Pages _____

Regarding: _____

References: _____
(List specific Contract Documents researched when seeking the information being requested)

Spec. No.: _____

Dwg. No.: _____

Request: _____
(Provide complete description of request with document references and sketches or photos if necessary, and present status of work)

Requester's Recommended Solution: _____

(If RFI concerns a site or construction condition, provide a recommended solution, including cost & schedule considerations)

Response Priority:

☐ Normal

☐ Rush (Work in progress)

Reason For
Request:

☐ Existing
Condition

☐ Non-
conformance

☐ Clarification /
Interpretation

☐ Agency
Generated

☐ Other

Subcontractor: _____

Date: _____

CM/Contractor: _____

By: _____

Date: _____

Response: _____

END OF FORM

SECTION 01 29 00

APPLICATIONS FOR PAYMENT AND SCHEDULE OF VALUES (GC)

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Project Information:
 - 1. Submittals, prior to first application for payment:
 - a. Copy of Executed Contract.
 - b. Copy of Performance and Payment Bonds.
 - c. Schedule of Values.
 - d. Copy of Owner's Notice to Proceed.
- B. Contract Closeout Information:
 - 1. See Section 01 77 00.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULE OF VALUES

- A. Prior to first Application for Payment, submit to Architect a Schedule of Values allocated to various portions of Work, prepared in such form, and supported by such data to substantiate its accuracy as Owner and Architect may require.
- B. Subdivide into following allocated items:
 - 1. Bond.
 - 2. Insurance.
 - 3. General condition items including but not limited to:
 - a. Mobilization.
 - b. Temporary facilities.
 - c. Temporary utilities.
 - d. Submittals.
 - e. Demobilization.
 - f. Other similar general condition items.
 - 4. Phases or areas or both of building.
 - 5. Sections.
 - 6. Individual components of Work, and major pieces of equipment.
 - 7. Labor amount and material or equipment amount, listed separately.
 - 8. Contract closeout items including but not limited to:
 - a. Manuals.
 - b. Spare parts.
 - c. Maintenance material.
 - d. System demonstrations.
 - e. Record documents.
 - f. Operation and maintenance data.
 - g. Other similar contract closeout items.
 - 9. Individually approved changes.

- C. Labor amount shall include all onsite installation costs including labor, applicable labor taxes, insurance, fringe benefits, erection equipment, tools, overhead and profit.
- D. Material and equipment shall include all material and manufactured equipment costs including delivery costs, taxes, insurance, overhead and profit.
- E. Schedule, unless objected to by Owner or Architect, shall be used as a basis for reviewing percent complete of line items on Contractor's Applications for Payments.

3.2 APPLICATION FOR PAYMENT

- A. On or before [_____] day of month, Contractor submit to Architect itemized Application for Payment for work completed during previous calendar month, in accordance with schedule of values.
 - 1. Submit on AIA Document G702 - Application and Certificate for Payment, and AIA Document G703 - Continuation Sheet, or similar format acceptable to Architect.
 - a. Itemize in accordance with approved Schedule of Values, and as indicated in AIA documents.
 - b. Bond and insurance costs may be requested for payment on first application.
 - c. Equal monthly payments may be made for general conditions based upon number of months Contractor is scheduled to be on site.
 - d. May include amounts for changes in work that have been authorized by Construction Change Directives, or by Change Proposal Requests approved by Owner.
 - e. Furnish in electronic PDF format, via electronic mail, secure electronic file transfer site, or other methods acceptable to the Owner.
 - f. Signed by duly authorized agent of Contractor.
 - 2. Furnish copies of requisitions from Subcontractors and suppliers to substantiate values.
 - 3. Shall not include request for payments for portions of Work for which Contractor does not intend to pay to a Subcontractor or supplier unless such Work has been performed by others whom Contractor intends to pay.
 - 4. Provide additional supporting data substantiating Contractor's right to payment, as Owner or Architect may require.
- B. Application for Payment serves as certification of status by Contractor of Project.
- C. Contractor warrants that title to all Work covered by an Application for Payment will pass to Owner upon receipt of payment.
- D. Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from Owner shall, to the best of Contractor's knowledge, information and belief, be free and clear of liens, claims, security interests or encumbrances in favor of Contractor, Subcontractors, material suppliers, or other persons or entities making a claim by reason of having provided labor, materials and equipment relating to Work.

3.3 PAYMENT FOR STORED MATERIAL AND EQUIPMENT

- A. Application for Payment may include materials and equipment ready, but not yet incorporated in Work, delivered, and suitably stored at site.
- B. Owner retains right to verify storage by physical inspection prior to partial payment, and at any time thereafter.
- C. Warranty and guarantee period does not commence until Substantial Completion of work.
- D. Payment will be treated same as "work-in-place," with evidence of delivery to job site, except that payments will not include value of labor and mark-up.
- E. Each subsequent Application for Payment will restate prior month's materials and equipment not incorporated in Work, and current month additions and deletions for materials and

equipment incorporated into work. Inventory must be updated and included with each subsequent application to indicate current status.

- F. Upon making of partial payments by Owner, all materials and equipment covered thereby become sole property of Owner. Partial payments, however, do not constitute Owner's acceptance of material, equipment, or work, nor be construed as waiver of any right or claim by Owner.
- G. Contractor shall be deemed as having care, custody, and control of items.

3.4 RETAINAGE

- A. Until Substantial Completion of entire project, 10 percent retainage will be withheld from value of Work completed and material stored.
- B. Any reduction of retainage beyond that allowable by Contract Documents and including adjustments at Substantial Completion requires Consent of Surety, recommendation of Architect, and approval of Owner prior to incorporating into an Application for Payment.
 - 1. Provide Request for Reduction of Retainage on form included herein and Consent of Surety; AIA Document G707A.
 - 2. If approved by Architect and Owner, Contractor may incorporate reduction in next Application for Payment.
 - 3. Include copy of approved form with Application for Payment.

END OF SECTION

STORED MATERIAL AND EQUIPMENT AFFIDAVIT

PROJECT:

PROJECT NO:[]

Item Number	Quantity	Unit	Material or Equipment Description	Value

LOCATION STORED: [][]

IDENTIFICATION METHOD: [][]

AFFIDAVIT:

Items listed above have been purchased exclusively for use on above referenced Project and have been received in good condition, and items are identified as property for use only on above referenced Project. Owner may enter upon premises for verification, inspection, or for any other purpose considered necessary. It is expressly understood and agreed that this affidavit is furnished to the Owner for purpose of obtaining approval for payment for said items, and that storage thereof at location indicated and payment by Owner shall not relieve Contractor of full responsibility for the protection, safeguarding, insurance, transporting, and proper installation at Project referenced above, and will warrant and defend against claims and demands of all persons. Upon making of partial payment by Owner, said items covered thereby become sole property of Owner.

Attached are receipted invoice(s), bills of sale(s), and/or other documents as evidence that Contractor is unconditional owner of said items, and they are free from all encumbrance, security agreements, mortgages, or liens.

FROM CONTRACTOR: _____

BY: _____ DATE: _____

SUBSCRIBED AND SWORN TO BEFORE ME THIS _____ DAY OF _____, [].

NOTARY PUBLIC: _____ MY COMMISSION EXPIRES: _____

Owner (APPROVES) (DISAPPROVES) location of off-site storage, and Contractor's inclusion of cost for above items in an Application for Payment.

OWNER'S APPROVAL:

BY: _____ DATE: _____

Contractor shall include this affidavit and other required documents with Application for Payment and shall maintain an inventory of all stored materials for submittal with future applications.

END OF FORM

STORED MATERIAL AND EQUIPMENT INVENTORY

PROJECT:

FOR APPLICATION NO.:

PAGE: of

The following inventory represents our accounting of the current status of material and equipment in storage which we have received payment for:

[illegible]

FROM CONTRACTOR: _____

BY: _____ DATE: _____

This form is required to be updated and submitted with each application for payment.

END OF FORM

REQUEST FOR REDUCTION OF RETAINAGE

PROJECT:

PROJECT NO.:

CONTRACT FOR:

Contractor hereby requests that the percentage of partial payment retained by Owner under provision of contract be REDUCED to [_____] % for following reasons:

CONTRACTOR:

BY: _____ DATE: _____

Power of Attorney and AIA Document G707A must be attached.

Architect (RECOMMENDS) (DOES NOT RECOMMEND) the reduction of retainage to [_____]%.
Percentage of completion as of [____], [____] is [____] %.

ARCHITECT:

BY: _____ DATE: _____

Owner hereby (APPROVES) (DISAPPROVES) reduction of retainage to [_____] % and authorizes Architect to certify the reduction in an Application for Payment.

OWNER:

BY: _____ DATE: _____

If approved, Contractor may incorporate reduction by including a copy of this document in the next Application for Payment.

DISTRIBUTION: ☐ OWNER ☐ ARCHITECT ☐ CONTRACTOR

END OF FORM

SECTION 01 31 19

PROJECT MEETINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for the following types of conferences and meetings required during the Work:
 - a. Requirements applicable to all conferences.
 - b. Preconstruction conference(s).
 - c. Construction progress conferences.
 - d. Closeout conference(s).
 - e. Other construction conferences.

B. Scope:

1. This Section addresses the types of conferences indicated in Paragraph 1.1.A of this Section.
2. Requirements for coordination meetings, including meetings between Contractor and its Subcontractors and Suppliers, as well as meetings between Contractor and contractors on other projects at or adjacent to the Site, are in Section [01 31 13 - Project Coordination] [01 31 16 - Multiple Contract Coordination].
3. Requirements for pre-installation conferences, if any, are in the Specifications of Divisions 02-49.

C. Related Requirements: Include, but are not necessarily limited to:

1. Section 01 29 76 - Progress Payment Procedures.
2. Section 01 31 13 - Project Coordination.
3. Section 01 32 16 - Construction Progress Schedule.

1.2 REQUIREMENTS APPLICABLE TO ALL CONSTRUCTION CONFERENCES

A. Requirements of this Article apply to all conferences required under this Section.

B. Participants:

1. Lead participant for each participating entity of each conference shall be authorized to represent their employer and its interests on the Project and shall be sufficiently familiar with the status of their employer's work, services, and activities related to the Project for purposes of the associated conference.
2. Required participants for each type of conference are indicated elsewhere in this Section.
3. Failure to participate by required participants:
 - a. Should a required participant be unavailable for a required conference, inform the designated conference chair not less than one day prior to start of the subject conference. Furnish both oral (either in person or via telephone) and written communication regarding planned non-attendance. Expressly indicate the authorized substitute person who will be empowered to represent that entity at the conference.
 - b. Failure to properly inform the conference chair as required, or repeated or habitual non-participation by mandatory participants, will be grounds for Owner to withhold (as "set-offs") amounts for mandatory meeting attendance from payments due Contractor under the Contract.
 - c. Sending as a substitute lead participant an authorized representative who is ill-informed of their organization's work status and administrative matters related to the Project, or who is not properly authorized to represent their employer for all required matters

indicated on the agenda, will be grounds for Owner to withhold payment, as set-offs, of amounts associated with such unpreparedness.

- d. Should Contractor fail to attend without proper, advance notice to conference chair or furnish ill-prepared or unauthorized substitute lead participant, Contractor shall bear full responsibility, including cost- and time-related impacts, for lack of coordination, progress, and other, potentially adverse effects.
4. Conduct:
 - a. Conference participants shall, at all times, exhibit appropriate, professional conduct and demeanor.
 - b. Inappropriate conduct, including shouting, unprofessional language, threatening attitudes, or other types of insult or intimidation are unacceptable.
 - c. Conference chair has the authority to eject from a conference, participants exhibiting inappropriate conduct.
 - d. People exhibiting repeated or habitual inappropriate conduct will not be allowed to participate in conferences. Such person's employer and the contracting party they represent shall bear full responsibility for consequences of actions by its employees and representatives.
5. Virtual Participation:
 - a. "Virtual participation" means participating in a required conference without being physically present at the conference location. Virtual participation includes participating via telephone, video conference, or other, similar means.
 - b. Virtual attendance at conferences may be acceptable for certain participants and at certain times, depending on equipment and communications services availability and reliability at the conference location.
 - c. People desiring to participate virtually are responsible for their own, appropriate, functioning systems and equipment to enable virtual participation.

C. Agenda:

1. Each conference required by this Section shall have an established written agenda prepared and distributed by the Contractor to all required attendees not less than one day prior to the conference, unless extenuating circumstances dictate a shorter time period.
2. Unless written agenda specific to a given conference is issued in writing, the default agenda shall be in accordance with this Section.
3. The agenda may be amended at the outset of the conference, at the sole discretion of the conference chair. Thereafter, the conference will be conducted, and topics discussed will be in accordance with the established agenda, as may be modified in accordance with this paragraph.

D. Conference Date, Time, and Location:

1. Date, start time, anticipated duration, and location of each required conference will be established by conference chair, unless otherwise indicated in the Contract Documents.
2. Conference chair will advise, in writing, required participants of conference date, start time, anticipated duration, and location. Such information may be transmitted as part of an agenda. Upon mutual agreement of required participants, date, start time, anticipated duration, and location of recurring conferences, such as construction progress conferences, may be initially established at the outset of the series and, therefore, do not require written advisory for each individual conference.
3. Change of Conference Date, Time, or Location:
 - a. In general, required conferences will be held on the date, at the time, and at the location required.
 - b. Designated conference chair may, at their sole discretion, elect to change the conference date, start time, duration, location, or any combination thereof. Such change, if any, shall be communicated in writing to all required conference participants,

and others as appropriate. Contractor is responsible for communicating changes to its Subcontractors and Suppliers.

- c. Notice of such change shall be communicated in accordance with Section 01 31 26 – Electronic Communication Protocols, not later than [one] day prior to scheduled start of the subject conference. Such changes may be communicated by distributing a written agenda for the subject conference, expressly indicating changes from previous arrangements.
- d. When changes in date, time, or location are necessary less than the period indicated in the paragraph immediately above, such changes shall be communicated orally, whether in-person or via telephone. When communicated via telephone, calls shall be made to all of the participant's designated telephone numbers on file with the conference chair. Persons intending to participate in such conference are encouraged to check their voicemail and written communications prior to departing for the conference.

E. Minutes:

1. For each conference required in this Section, the conference chair will be responsible for preparing and distributing a written record ("minutes") of the conference proceedings, unless expressly indicated otherwise for a specified type of conference.
2. Purpose of minutes is to furnish a written record of the following for the associated conference: participants (indicating whether each individual participated in-person, virtually, arrived late, or departed early), topics discussed, questions asked and answered, and decisions made, and other pertinent matters as indicated on the established agenda for the associated conference. Minutes are not intended as a transcript or as complete record of minutia discussed at the associated conference.
3. Distribution of Minutes:
 - a. Minutes will be distributed promptly after the associated conference.
 - b. Minutes will be distributed, in accordance with Section 01 31 26 - Electronic Communication Protocols.
 - c. Minutes will be distributed to all conference participants, personnel invited to or required to attend the conference but who did not attend or participate, and others as appropriate.
 - d. Unless indicated otherwise in this Section or elsewhere in the Contract Documents, minutes of conferences required by this Section will be distributed to Owner, [Owner's facility manager,] Contractor, [indicate other entity, if any] and Engineer.
4. Amendment of Minutes:
 - a. Minutes distributed by, or on behalf of, the conference chair are subject to comments and potential amendments by other attendees of the subject conference. The period for commenting on, or requesting amendments to, minutes is limited to 7 days following initial distribution of the minutes, unless indicated otherwise elsewhere in the Contract Documents.
 - b. Comments or requests for amendments should be furnished at the next, subsequent meeting in the same series of conferences. For example, comments on minutes of a construction progress conference should be presented at the next, subsequent construction progress conference. Comments on the minutes of the preconstruction conference should be presented at the first construction progress conference unless the designated time limit for requesting amendments has elapsed prior to the first progress conference.
 - c. Minutes may be amended either by issuing revised minutes for the subject conference or by appropriate indication in the minutes of the next, subsequent conference in the same series, at the sole discretion of the conference chair.
 - d. [Conference chair] has sole authority to accept or reject comments or requests for amendments on previously issued minutes.
 - e. In general, requests, by persons who participated in the subject conference, for amendments to minutes will be given greater consideration by [conference chair] than

request for amendments received from persons who did not participate in the subject conference.

- f. Should a person or entity believe the final minutes do not accurately reflect their opinion of how events transpired at the subject conference, such person or entity may prepare and submit appropriate correspondence presenting their viewpoint.

1.3 PRECONSTRUCTION CONFERENCES

- A. The requirements of Article 1.2 of this Section also apply to this Article.
- B. Preconstruction Conferences - General:
 1. Purpose of preconstruction conference is reviewing administrative and procedural requirements, site mobilization, site security, parking, coordination with utility owners, coordination with authorities having jurisdiction and related matters. Required agenda, unless otherwise amended by conference chair, is indicated in this Article.
 2. Conference Chair: Chandra Wondercheck or Liz Elliott.
 3. Location, Date, and Time:
 - a. Preconstruction conference will be held at a site, date and time TBD.
 - b. Preconstruction conference will be held following the Effective Date of the Contract on a day and at a time to be established by Architect following consultation with principal representatives of Owner, Contractor, and other required participants. Preconstruction conference will be held prior to commencement of the Work at the Site.
 - c. Anticipated duration of preconstruction conference is ninety minutes, followed by time necessary for visiting the Site.
 - d. Location, date, and time will be established in accordance with requirements of Article 1.2 of this Section.
 4. Required Participants:
 - a. Owner: Project manager.
 - b. Contractor: Project manager and site superintendent.
 - c. Architect: Project manager or delegate.
 5. Required participants may invite to the preconstruction conference others they deem necessary or appropriate.
 6. Designation of Authorized Representatives:
 - a. Either prior to or at the preconstruction conference, Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.
- C. Agenda:
 1. Procedural and Administrative:
 - a. Personnel and Teams:
 - 1) Designation of roles and personnel.
 - 2) Limitations of authority of personnel, including personnel who will sign Contract modifications and make binding decisions.
 - 3) Subcontractors and Suppliers in attendance.
 - 4) Authorities having jurisdiction.
 - b. Procedures for communications and correspondence, including electronic communication protocols.
 - c. Copies of the Contract Documents and availability.
 - d. The Work and Scheduling:
 - 1) General scope of the Work.
 - 2) Contract Times, including Milestones (if any).

- 3) Phasing and sequencing.
- 4) Preliminary Progress Schedule.
- 5) Critical path activities.
- e. Safety and Protection:
 - 1) Responsibility for safety.
 - 2) Contractor's safety representative.
 - 3) Emergency procedures and accident reporting.
 - 4) Emergency contact information.
 - 5) Hazardous materials communication program.
 - 6) Impact of the construction on public safety.
 - 7) Responsibilities for protection of property.
- f. Review of insurance requirements and insurance claim procedures.
- g. Coordination:
 - 1) Coordination of Subcontractors and Suppliers.
 - 2) Construction coordinator (for projects with multiple prime construction contracts and locations where multiple projects may be underway simultaneously in reasonable proximity to each other).
 - 3) Coordination with Owner's operations.
 - 4) Construction progress conferences – schedule and frequency.
 - 5) Coordination conferences with other, separate projects.
- h. Submittals:
 - 1) Current Critical Submittals:
 - a) Preliminary schedules – Progress Schedule, Schedule of Submittals, Schedule of Values.
 - b) Preconstruction photographic documentation.
 - c) List of proposed Subcontractors and Suppliers using the form included in Section 01 29 76 - Progress Payment Procedures.
 - d) List of emergency contact information.
 - e) Notice of elements of Contractor's safety program with which Owner and Engineer are to comply.
 - f) Action Submittals required under Section 01 14 19 - Use of Site.
 - g) Evaluation of need for SPCC plan required under Section 01 35 44 – Spill Prevention Control and Countermeasures Plan.
 - h) Form of Contractor's site superintendent's daily reports, in accordance with Section 01 71 23 - Field Engineering.
 - 2) Work is ineligible for payment without approved or accepted Submittals (as applicable).
 - 3) Submittal procedures.
 - a) Compliance with accepted Schedule of Submittals.
 - b) Actions required of Contractor prior to furnishing Shop Drawings and other Submittals.
 - c) Contractor's Submittal approval stamp required; Contractor's coordination of Submittals.
 - d) Furnishing of Submittals.
 - e) Submittal types and meaning of Engineer's action on each.
 - f) Resubmittals—responsibility for, limitations on quantity.
 - 4) Identification of initial, critical Shop Drawings and product data.
 - 5) Construction photographic documentation.

- i. Substitutes and "Or-Equals":
 - 1) Product options.
 - 2) Procedures for proposing "or-equals".
 - 3) Procedures for proposing substitutes.
- j. Contract Modification Procedures:
 - 1) Requests for interpretation.
 - 2) Written clarifications.
 - 3) Field Orders.
 - 4) Proposal Requests.
 - 5) Change Proposals.
 - 6) Work Change Directives.
 - 7) Change Orders.
 - 8) Differing site conditions or discovery of unanticipated Hazardous Environmental Condition.
 - 9) Substantiating and documenting Change Proposals and Claims.
 - 10) Claims.
- k. Progress Payment:
 - 1) Owner's Project financing and funding, as applicable.
 - 2) Owner's tax-exempt status.
 - 3) Preliminary Schedule of Values
 - 4) Procedures for measuring for payment (Unit Price Work).
 - 5) Retainage.
 - 6) Progress payment procedures; documents to accompany Applications for Payment.
 - 7) Payment for stored items not yet installed.
 - 8) Date of Owner's payments; payment is due.
- l. Subcontractors and Suppliers:
 - 1) List of proposed Subcontractors and Suppliers; monthly updates.
 - 2) Coordination and management.
 - 3) Subcontracts and purchase orders.
- m. Testing and inspections:
 - 1) Owner-hired and contractor-hired.
 - 2) Identification of Owner-hired testing entity and special inspectors.
 - 3) Responsibility for advising testing entity and special inspectors of need for services.
 - 4) Results of code-required special inspections and tests.
 - 5) Prompt remedy of apparent defects.
 - 6) Notices of defective Work.
 - 7) Remedy of defective Work.
 - 8) Defective Work is ineligible for payment.
 - 9) Covering up defective Work.
 - 10) Cost responsibility for defective Work and retesting/re-inspection.
- n. Disposal of demolition and spoil materials.
- o. Record documents.
- p. Preliminary discussion of Contract closeout:
 - 1) Procedures for Substantial Completion.
 - 2) Partial utilization procedures; property insurance.
 - 3) Contract closeout requirements.

- 4) Correction period; duration of Contractor's general warranty and guarantee.
- 5) Duration of bonds and insurance.
2. Authorities Having Jurisdiction (if not covered in a separate conference):
 - a. Municipal licenses.
 - b. Municipal permits required.
 - 1) Permits required and status.
 - 2) Inspections for building code official.
 - 3) Code-required special inspections and tests (if not covered in Administrative and Procedures part of conference).
 - c. Right-of-way work permits; status of occupancy permit(s).
 - d. Environmental permits:
 - 1) Spill prevention control and countermeasures plan (40 CFR 112).
3. Site Mobilization (if not covered in a separate conference):
 - a. Working days, working hours, and overtime.
 - b. Use of Site and other areas; use of existing facilities.
 - c. Field offices, storage trailers, and staging areas.
 - d. Temporary facilities.
 - e. Temporary utilities and limitations on utility use (where applicable).
 - f. Utility company coordination (if not done as a separate conference).
 - g. Access to Site, access roads, and parking for construction vehicles.
 - h. Traffic controls.
 - i. Temporary controls:
 - 1) Erosion and sediment control; storm water pollution prevention plans.
 - 2) Dust control and air pollution control (including emissions control).
 - 3) Water control (storm water, surface water, groundwater).
 - 4) Water pollution control; spill prevention control and countermeasures plan.
 - 5) Solid waste control.
 - 6) Pest control.
 - 7) Other temporary controls.
 - j. Temporary security; temporary security fencing (where required).
 - k. Storage of materials and equipment to be incorporated into the Work.
 - l. Protection of the Work and property; protective barriers.
 - m. Field engineering:
 - 1) Reference points and benchmarks.
 - 2) Surveys and layouts.
 - 3) Professional services for Contractor's means and methods (not delegated design).
 - 4) Contractor's site superintendent's daily records and submittal requirements.
 - n. Site maintenance during the Project:
 - 1) Progress cleaning; removal of trash and debris.
 - 2) Maintenance and cleaning of existing access roads and parking areas.
 - o. Restoration.
4. Next conference.
5. Site visit, as necessary.

1.4 CONSTRUCTION PROGRESS CONFERENCES

- A. The requirements of Article 1.2 of this Section also apply to this Article.
- B. Construction Progress Conferences - General:

1. Purpose of construction progress conferences is to review and summarize Work performed since the previous construction progress conference; review and summarize planned progress through the next, subsequent construction progress conference; review and summarize compliance with the Progress Schedule; review progress and necessary actions on pending and critical administrative items; discuss matters pertinent to the Site and construction quality; and other matters.
2. Conference Chair: Contractor's Project manager or delegate.
3. Location, Date, and Time:
 - a. Construction progress conferences will be held at a site, date and time TBD. Frequency: construction progress conferences will be held at minimum once per month, increasing in frequency as required by project progress. Such conferences are in addition to other recurring conferences that may be required elsewhere in the Contract Documents.
 - b. Construction progress conferences will be held following preconstruction conference on a day and at a time to be established by Architect, following consultation with principal representatives of Owner, Contractor, and other required participants. Timing on which construction progress conferences will commence will be at the discretion of the designated chair of construction progress conferences.
 - c. Construction progress conferences required by this Section are separate from monthly schedule meetings required in Section 01 32 16 - Construction Progress Schedule.
 - d. Anticipated duration of each construction progress conference is two hours, plus time necessary for visiting the Site.
 - e. Location, date, and time will be established in accordance with requirements of Article 1.2 of this Section.
4. Required Participants:
 - a. Owner: Project manager.
 - b. Contractor: Project manager, site superintendent, and safety representative.
 - c. Principal Subcontractors: Project manager or site superintendent, for Subcontractors performing significant Work since the previous conference and that will perform significant Work prior to the next, subsequent construction progress conference. When Subcontractor's site superintendent represents Subcontractor at construction progress conferences, site superintendent shall be authorized and informed of administrative matters relating to Subcontractor's Work in accordance with Article 1.2 of this Section.
 - d. Major Suppliers: Field representative of Suppliers of significant materials and equipment, when such field representatives are performing onsite services under the Contract, or as otherwise deemed necessary by Contractor relative to conference participation.
 - e. Architect: Project manager or delegate.
5. Required participants may invite to construction progress conferences others they deem necessary or appropriate.

C. Deliverables:

1. Contractor shall provide at or before each construction progress:
 - a. List of Work accomplished since the previous construction progress conference and list of construction activities planned through the next, subsequent construction progress conference. Coordinate list of planned activities with both the updated Progress Schedule and a (minimum) 3 week look-ahead schedule.
 - b. Up-to-date Progress Schedule, in accordance with Section 01 32 16 - Construction Progress Schedule.
 - c. Up-to-date Schedule of Submittals, in accordance with Section 01 33 00 - Submittal Procedures.
 - d. "Look-ahead" schedule, in accordance with Section 01 32 16 - Construction Progress Schedule.

- e. When applicable, list of upcoming, planned time off (with dates) for personnel with significant roles on the Project, and the designated contact person in their absence.
- D. Preliminary Agenda for Construction Progress Conferences:
- 1. Review, comment, and amend (if necessary) of minutes of previous progress conference.
 - 2. Review of progress since the previous progress conference.
 - 3. Planned progress through next progress conference.
 - 4. Overview of Progress Schedule:
 - a. Review of the Contract Times; Contractor's ability to comply with Contract Times.
 - b. Identification of critical path activities.
 - c. Schedules for fabrication and delivery of materials and equipment.
 - d. Corrective measures, if necessary, including recovery schedule(s).
 - 5. Submittals:
 - a. Review status of critical Submittals.
 - b. Review revisions to Schedule of Submittals.
 - 6. Contract Modifications:
 - a. Requests for interpretation.
 - b. Written clarifications.
 - c. Field Orders.
 - d. Proposal Requests.
 - e. Change Proposals.
 - f. Work Change Directives.
 - g. Change Orders.
 - h. Claims.
 - 7. Progress Payment Requests:
 - a. Status and deadline for submittal.
 - b. Stored materials and equipment; observation by Engineer or RPR; documents required.
 - c. Set-offs to which Owner is entitled (as applicable).
 - d. Other matters related to progress payments.
 - 8. Problems, conflicts, and observations.
 - 9. Quality standards, testing, and inspections.
 - 10. Coordination between Project participants.
 - 11. Site management issues, including vehicular access and parking, traffic control, security, status of temporary controls and temporary utilities, site maintenance and cleaning, and other Site matters.
 - 12. Safety and protection.
 - 13. Permits and compliance.
 - 14. Construction photographic documentation.
 - 15. Record documents status.
 - 16. Completion matters (as appropriate):
 - a. Status of checkout, startup, field quality control activities.
 - b. Status of training of facility O&M personnel and O&M manuals.
 - c. Partial utilization; requesting and scheduling inspection for Substantial Completion.
 - d. Punch list status (as applicable).
 - e. Other closeout matters (if any).
 - 17. Other business.

1.5 CLOSEOUT CONFERENCES

- A. The requirements of Article 1.2 of this Section also apply to this Article.
- B. Closeout Conferences – General.
 - 1. Purpose of closeout conferences is to familiarize participants with administrative and procedural requirements for Substantial Completion (including partial utilization by Owner) and readiness for final payment, and status of the Work required for achieving Substantial Completion and readiness for final payment.
 - 2. Conference Chair: Same as indicated elsewhere in this Section for construction progress conferences.
 - 3. Location, Date, and Time:
 - a. Location, date, and time will be the same as indicated elsewhere in this Section regarding construction progress conferences.
 - b. In general, as the Work, or a designated part thereof, progresses toward Substantial Completion, topics addressed at construction progress conferences will transition to discussing closeout-related topics.
 - c. The conference chair may require one or more additional closeout conferences as the conference chair deems necessary. Required participants shall participate in such conferences without changes in the Contract Price or the Contract Times.
 - d. Should additional closeout conferences be necessary, or should location, date, or times for closeout conferences differ from those established for construction progress conferences, the conference chair will so advise required participants, and others as appropriate, in accordance with Article 1.2 of this Section.
 - 4. Required Participants: Same as required participants for construction progress conferences, unless otherwise indicated by conference chair.
- C. Preliminary Agenda for Closeout Conferences:
 - 1. Same as “Completion matters” portion of preliminary agenda for construction progress conferences as indicated elsewhere in this Section.
 - 2. Checkout and startup planning meeting, in accordance with Section 01 75 00 - Checkout and Startup Procedures.
 - 3. Training schedule conference, in accordance with Section 01 79 23 - Instruction of Operation and Maintenance Personnel.
 - 4. Additional closeout related topics as determined by closeout conference chair.

1.6 OTHER CONSTRUCTION CONFERENCES

- A. The requirements of Article 1.2 of this Section also apply to this Article.
- B. Other Construction Conferences – General.
 - 1. Other construction conferences may be scheduled and held as deemed necessary by Owner or Engineer. Such conferences may be focused on specific matters, such as discussing remedies and schedules for defective Work, negotiating changes in the Contract Price and Contract Times, or other matters related to the Project where time limits prevent addressing such items as part of other conferences addressed elsewhere in the Contract Documents.
 - 2. Conference Chair: Project manager or delegate.
 - 3. Location, Date, and Time:
 - a. Location: Same as location of construction progress conferences as indicated elsewhere in this Section, unless location is changed in accordance with Article 1.2 of this Section.
 - b. Other construction conferences will be held on a day and at a time to be established by Architect, following consultation with principal representatives of Owner, Contractor, and other required participants.

- c. Each other construction conference is one hour, plus time that may be necessary for visiting the Site when conference purpose warrants.
 - d. Location, date, and time will be established in accordance with requirements of Article 1.2 of this Section.
- 4. Required Participants: As deemed necessary by conference chair.
- C. Agenda: Agenda presenting topics to be discussed at each other construction conference will be developed by the conference chair and distributed to required participants, and others as appropriate, in accordance with Article 1.2 of this Section.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Includes:

1. Upon award of the Contract, Contractor shall prepare and submit a Contractor's construction schedule for the Work for the Owner's and Architect's information.
 - a. Submit in expeditious manner.
 - b. Schedule shall not exceed time limits current under Contract Documents, shall be revised at appropriate intervals as required by conditions of the Work and Project, shall be related to entire Project to extent required by Contract Documents, and shall provide for expeditious and practicable execution of Work.
2. Coordinate Subcontractors' schedules for entire Project:
 - a. Secure time commitments for performing critical elements of Work from parties involved.
 - b. Coordinate each element on the schedule with other construction activities; include minor elements involved in sequence of Work.
 - c. Show each activity in proper sequence.
 - d. Indicate graphically the sequences necessary for completion of related portions of Work.
 - e. Resolve conflicts among schedules of Subcontractors.
 - f. Revise as required by conditions and progress of Work.
 - g. Furnish copy of schedules for entire Project to each Subcontractor.
 - h. Coordinate with Section 01 50 00 - Temporary Facilities and Controls.
3. Contractor shall perform Work in general accordance with most recent schedules submitted to Owner and Architect.

1.2 SUBMITTALS

A. Project Information:

1. Preliminary Construction Schedule:
 - a. Submit to Owner and Architect prior to date set for Preconstruction Conference and prior to start of Work.
2. Project Schedules:
 - a. Provide to Owner and Architect within 30 days of start of construction.
3. Updated Project Schedules:
 - a. Provide to Owner and Architect quarterly.
 - b. Provide if completion date is revised or sequence of Work is revised.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 FORM OF SCHEDULES

A. Horizontal Bar Chart:

1. Provide separate horizontal bar column for each line item of the approved Schedule of Values.

2. Indicate each bar with start and completion date of each item, its total dollar value percent to be completed for each month.
 3. Identify each bar column:
 - a. By specification section number, Work element and major component.
 - b. By distinct graphic delineation.
 4. Horizontal time scale:
 - a. Identify first week day of each week.
 5. Scale and spacing:
 - a. Allow space for updating.
 6. As Work progresses, place contrasting mark in each bar to indicate actual progress and completion.
- B. Sheet Size:
1. Maximum 280 x 430 mm 11 x 17 inches.
- C. CPM Schedule:
1. Furnish a CPM schedule covering items of construction with, as a minimum, early/late start and early/late finish and normal float.

3.2 CONTENT OF SCHEDULES

- A. Provide complete sequence of construction by activity.
1. Shop drawings, product data and samples:
 - a. Submittal dates as indicated in approved Submittal Schedule.
 - b. Dates reviewed copies will be required.
 2. Product procurement and delivery dates.
 3. Dates product information and delivery of Owner furnished, installed equipment and materials is needed.
- B. Dates for early and late beginning, and completion of each element of construction.
- C. Identify Work of separate floors, or separate phases, or other logically grouped activities.
- D. Show how requirements for phased completion and partial occupancy by Owner affect sequence of Work.
- E. Indicate important stages of construction for each major portion of Work, including submittal review, testing, and installation.
- F. Identify punch list preparation and completion durations, agencies inspections, and Owner occupancy dates.
- G. Show projected percentage of completion for each item of Work as of last day of every month.
- H. Identify restraints and constraints.
- I. Identify critical path and critical portions of entire schedule. There shall be only one critical path and it shall be clearly identified.

3.3 UPDATING

- A. Show changes occurring since previous submission of updated schedules.
- B. Indicate progress of each activity, actual verses scheduled start and completion dates, and actual verses scheduled percent complete by month.
- C. Include:
1. Major changes in scope.
 2. Activities modified since previous updating.
 3. Review projections due to changes.

4. Other identifiable changes.
- D. Provide Narrative report Including:
1. Discussion of problem areas including current and anticipated delay factors and their impact.
 2. Corrective action taken or proposed and its effect.
 3. Effect of change in schedule.
 4. Description of revisions.
 - a. Effect on schedule due to changes to Contract.
 - b. Revisions in duration of activities.
 - c. Other changes that may affect schedule.

3.4 DISTRIBUTION

- A. Distribute copies of revised schedules to:
1. Owner.
 2. Architect.
 3. Contractors/Subcontractors.
 4. Other concerned parties.
- B. Instruct recipients to report inability to comply and provide detailed requirements and schedule, with suggested remedies.

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing Shop Drawings, Product Data, Samples, Project Information submittals including Contract Closeout submittals.
- B. Submittals are not to be used as a means for substitution requests.
 - 1. Submittals that include substitutions will be returned without review or action.
- C. Contact Architect in event of non-availability of specified product due to strikes, lockouts, bankruptcy, production discontinuance, proven shortage, or similar occurrences.
 - 1. Notify Architect, in writing, with substantiating data as soon as non-availability becomes apparent.
 - 2. Notify in time to avoid delay in construction.
- D. Appropriateness and accuracy of calculations is responsibility of Contractor, and Contractor's Professional Structural Engineer when such calculations are required to be professionally sealed.
- E. When professional or other certification of performance criteria of materials, systems or equipment is required by Contract Documents, Architect shall be entitled to rely upon accuracy and completeness of such calculations and certifications.

1.2 DEFINITIONS

- A. General:
 - 1. Submittals are not Contract Documents.
 - 2. Purpose of submittals is to demonstrate way by which Contractor proposes to conform to information given and design concept expressed in Contract Documents for those portions of Work for which Contract Documents require submittals.
- B. Shop Drawings Action Submittals:
 - 1. Drawings to scale, diagrams, schedules, and other data specially prepared for Work by Contractor or a Subcontractor, Sub-subcontractor, Manufacturer, Supplier, or Distributor to illustrate some portion of Work.
- C. Product Data Action Submittals:
 - 1. Illustrations, standard schedules, performance charts, instructions, brochures, color charts, performance curves, diagrams, test data and other information furnished by Contractor to illustrate material, product, equipment, or system for some portion of Work.
- D. Samples Action Submittals:
 - 1. Physical examples which illustrate size, kind, pattern, texture, materials, equipment, systems, or workmanship and establish standards by which Work will be judged.
 - 2. Samples also include job site Mock-ups and sample construction.
- E. Project Information Submittals:
 - 1. Examples of Information Submittals, which do not require review or action by Architect, include, but are not limited to:
 - a. Progress Reports
 - b. Contractor Coordination Drawings
 - c. Bonds.

- d. Construction Schedules.
 - e. Manufacturer's Installation or Adjustment Instructions.
 - f. Statements of Qualifications.
 - g. Certificates.
 - h. Field Service, Laboratory Test.
 - i. Start-Up Reports,
 - j. Design Calculations.
 - k. Material Safety Data Sheets.
 - l. Safety Programs and Reports.
 - m. Other Information Submittals identified in individual specification sections.
- F. "Contract Closeout Information" Submittals:
- 1. Items pertaining to quality control and Owner information, which are required at Substantial or Final Completion, and do not require review or action by Architect.
 - 2. Architect may review at its sole discretion, for general compliance with Contract Documents only.
 - 3. Review will not constitute a detailed check of submitted design calculations.
 - 4. Examples of Contract Closeout Information Submittals, which do not require review or action by Architect, include but are not limited to:
 - a. Pre-occupancy test reports.
 - b. Operation and Maintenance Data.
 - c. Warranties and Guarantees
 - d. Owner instruction reports.
 - e. Project Record documents.
 - f. Extra materials or tools.
 - g. Other Submittals identified in individual specification sections.
- G. Manufacturers and Products, Base and Optional: See Section 01 61 00.

1.3 SUBMITTALS

- A. Project Information:
- 1. Schedule of Submittals:
 - a. Provide in advance of transmittal of first submittal and prior to first application for payment.

1.4 SCHEDULE OF SUBMITTALS

- A. Complete Schedule of Submittals shall include Shop Drawings, Product Data, Samples, Project Information, and Contract Closeout Information required by specification section Submittal paragraphs.
- 1. Submittals Schedule shall be mutually agreed upon, in writing, by Architect and Contractor.
 - 2. Contractor or Subcontractors may require submittals for their coordination purposes even when submittals are not required by Contract Documents for Architect's review. Do not include or submit such submittals to Architect.
 - 3. Schedule shall be in horizontal bar chart format divided by weeks. Indicate proposed submittal dates for each submittal.
 - 4. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
 - a. Allow at least two weeks for Architect's review and processing of each submittal, excluding mailing.

5. Coordinate each submittal with fabrication purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
6. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
7. Architect reserves the right to withhold action on a submittal which, in the Architect's opinion, requires coordination with other submittals until related submittals are received, and will notify the Contractor, in writing, when they exercise this right.
8. Do not include or submit items not required to be submitted by Contract Documents.
9. Arrange submittals by specification section.
 - a. Submittals shall include items from one specification section only.
 - b. Submit Shop Drawings, Product Data, Samples, and Project Information (except for Field Test Reports) items specified in a section at same time for a complete review.
 - 1) Shop Drawings: Individual submittal item.
 - a) Subparagraphs represent description of items to include on separate or combined drawings in the submittal.
 - b) Indicate additional submittals that will be generated as result of dividing required submittal by building, floor, area of a floor, or other phased subdivision.
 - 2) Product Data: Individual submittal item.
 - a) Subparagraphs represent description of items to include as part of single submittal.
 - 3) Sample and Information submittals:
 - a) Each subparagraph represents an individual submittal item.
10. Indicate submittals that will be provided to agencies having jurisdiction. Schedule sufficiently in advance of date required to allow agency reasonable time for review, and Contractor resubmission if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
11. Submit all submittals required by a section at same time which are needed for a complete review except Contract Closeout Information Submittals and Shop Drawing submittals divided by building area or construction phasing.
12. Do not submit large quantities of submittals at one time.
13. Schedule Contract Closeout Information submittals during last quarter of construction period and prior to Substantial Completion.
14. Partial payment requests may be withheld until satisfactory Schedule of Submittals has been received.

1.5 SHOP DRAWINGS

- A. Shop Drawing Action Submittals are required as called for in each specification section Submittal paragraph.
 1. Do not use Contract Drawings as Shop Drawings.
- B. Submit high quality, high contrast copy of Shop Drawings in Portable Document Format (PDF).
 1. If drawings with titleblocks are in the submittal, label submittal pages with the same sheet number as listed on the title block.
 2. Use Newforma Info Exchange. See Section 01 31 26 for specific information.

1.6 PRODUCT DATA

- A. Product Data Action Submittals are required as called for in each specification section Submittal paragraph.
- B. Submit high quality, high contrast copy of Product Data in Portable Document Format (PDF).

1. Use Newforma Info Exchange. See Section 01 31 26 for specific information.
2. Include index if multiple items under specification section are included in submittal.
 - a. Bookmark indexed items in the file.
 - b. If drawings with titleblocks are in the submittal, label submittal pages with the same sheet number as listed on the title block.
3. Mark each copy to show exact item, model, and options submitted for review.
4. Show compliance with specified reference standards, performance characteristics, and capacities; wiring and piping diagrams and controls; component parts; finishes; dimensions; and required clearances; notation of coordination requirements.
5. Mark through items on manufacturer's standard sheets which are not being proposed. Submittals without indications and deletions will be returned without review.
6. Include scale details, sizes, dimensions, full product repeat where applicable, performance characteristics, capacities, wiring diagrams, controls, and other pertinent data.

1.7 SAMPLES

- A. Sample Action Submittals are required as called for in each applicable specification section Submittal paragraph.
 1. Identify samples with manufacturer's name, item, use, type, Project designation, specification section or drawing, detail reference, color, range, texture, finish, and other pertinent data.
 2. Send samples to address indicated, or Project site if required or requested.
 3. Samples shall have a label affixed or attached thereto of sufficient size to accommodate Contractor's approval stamp.
 4. Submit one sample of each color or type indicated.
- B. When specific colors, textures, or patterns are not specified, submit physical samples from full range of manufacturer's standards for selection. When custom or standard finishes are specified, submit samples of specified colors, textures, or patterns.

1.8 PROJECT INFORMATION AND CONTRACT CLOSEOUT INFORMATION

- A. Project Information and Contract Closeout Information submittals are required as called for in each specification section Submittal paragraph.
- B. Submit high quality, high contrast copy of Project Information and Closeout Information in Portable Document Format (PDF).
 1. Use Newforma Info Exchange. See Section 01 31 26 for specific information.

1.9 SUBMITTALS REQUIRING PROFESSIONAL SEALS AND SIGNATURES

- A. Shall be submitted per following:
 1. Unless otherwise agreed to by Architect, submit to Architect for records one original, or high quality high contrast copy of submittal suitable for reproduction, unless quantity is indicated elsewhere. Submit quantity indicated in specifications sections to Owner.
 2. Architect is not required to return submittal.
 3. Do not fold. Submit in envelope large enough for submitted items.

1.10 TRANSMITTAL

- A. Contractor is responsible for making submissions.
 1. Electronic submittals shall be submitted utilizing Newforma Info Exchange. See Section 01 31 26 for specific information.
 2. Submit samples and submittals that require hard copies to office of Architect:

HDR Architecture, Inc.

Attention: _____

- B. Transmit items with Submittal Transmittal form included at end of this section, or supplied by Architect, or similar format approved in advance by Architect.
1. Contact Architect for copy of form for Project use.
 2. Indicate Project name, Architect's project number, specification section title, description of submitted items or systems, manufacturer, and submittal type on transmittal form.
 3. Indicate submitted date, approval, and sign in appropriate space on transmittal form.
 4. Submittal Transmittal form shall stay with submittal throughout its routing.
 5. Indicate submittal number in space provided on Submittal Transmittal form. Following submittal numbering system shall be used:
 - a. Identify each submittal using applicable 5 or 6 digit specification section number from Contract Documents.
 - b. After section number, indicate sequence number. First submittal of section series would be numbered "##### -1, next would be "##### -2, etc.
 - c. If returned for re-submission, add a designation character. Second submission would be "##### -1a", third would be "##### -1b", etc.
 6. Indicate description of submitted items including drawing numbers, etc.
 7. Indicate "Submittal type" being submitted.
- C. Submittals shall only include items from one specification section.
1. Project Information Submittals and Contract Closeout Information Submittals shall be submitted separately from other submittals required by specification section.
 2. Submit all items specified in section at same time for complete review, except Contract Closeout Information Submittals.
- D. Do not submit following:
1. Submittals not required by specification section Submittal paragraph.
 2. Submittals required by other contractors or trades for their coordination that are not required by specification section Submittal paragraph.
 3. Submittal of products, systems or manufactures not specified.
 4. Submittal of substitution.
 5. Submittal of MSDS information.
 6. Large quantities of submittals at one time.
- E. Do not mark copies with highlighters that black out information, or turn opaque when reproduced, or will not scan or reproduce legibly.

1.11 CONTRACTOR AND SUBCONTRACTOR ACTION

- A. Submit submittals required by Contract Documents in accordance with submittal schedule approved by Architect or, in absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time, in the Architect's professional judgement, to permit adequate review.
- B. Direct specific attention in writing with submittal or on submittal, indicating deviations from requirements of Contract Documents.
1. Contractor shall not be relieved of responsibility for any deviation from requirements of Contract Documents by Architect's approval of submittals unless:

- a. Contractor has specifically informed Architect in writing of such deviation at time of submission, and
 - b. Architect has given written approval to specific deviation as a minor change in Work, or
 - c. Change Order or Construction Change Directive has been issued authorizing the deviation.
2. Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals by the Architect's approval thereof.
3. Completed Work shall match appearance of approved samples and mock-ups.
- C. Contractor represents and warrants that submittals shall be prepared by persons and entities possessing expertise and experience in the trade for which submittal is prepared, and if required by Architect or applicable law, by a licensed Professional Engineer or Structural Engineer, or other specialized Engineer, where so stipulated.
- D. Contractor is responsible for confirmation and correlation of dimensions at Project site; for information that pertains solely to fabrication processes or to techniques of construction; and for coordination of work of trades.
- E. Contractor and Subcontractor shall review submittal required by Contract Documents for compliance with Contract Documents, approve and submit to Architect.
- F. Submittal to Architect indicates Contractor, Subcontractor represent they have:
 1. Reviewed submittal for compliance with the Contract Documents and has approved submittal.
 2. Determined and verified field measurements, and field construction criteria related thereto, or will do so.
 3. Determined and verified quantities, materials, performance criteria, installation requirements, catalog numbers and similar data related thereto.
 4. Determined substitutions have not been included.
 5. Checked, determined, verified, and coordinated information contained within such submittals with requirements of Work, Contract Documents, and other submittals.
- G. Resubmit items returned by Architect and marked "Revise and Resubmit" or "Not Approved" until approval is received.
 1. Direct specific attention, in writing, or on resubmitted submittals to revisions other than those requested by Architect on previous submittals.
 2. In the absence of such written notice, the Architect's approval of a resubmission shall not apply to such revisions.
 3. Bubble or otherwise clearly identify all changes from previous submittal.
 4. Tag each re-submittal with a designation that reuses the previous submittal number and a suffix designating the re-submittal sequence in accordance with the numbering system indicated in this section.
- H. Contractor shall reproduce and distribute copies of submittals after Architect's review to:
 1. Project site: Copy of "Approved" or "Approved as Noted" submittals for use by Contractor's field staff, Owner, and Architect's representatives.
 2. Subcontractor or vendor.
 3. Other Contractors, Subcontractors or vendors as may be required for coordination purposes.
 4. Owner: Copy of "Approved" or "Approved as Noted" submittals.
 5. Authorities having jurisdiction: Copy of "Approved" or "Approved as Noted" submittals if required by Authority Having Jurisdiction (AHJ).
 6. Inspector (if any): Copy of "Approved" or "Approved as Noted" submittals.
 7. Testing and Inspection Agencies: Copy of "Approved" or "Approved as Noted" submittals required for them to perform inspections and testing.

- I. Contractor shall not be relieved from responsibility for coordination with other submittals or for errors or omissions in submittals by Architect's approval thereof.
- J. Material lists and quantity information included in submittals are sole responsibility of Contractor.
- K. Where a submittal is required by Specifications, any related Work performed prior to Architect's review and approval of the pertinent submission will be sole expense and responsibility of Contractor.

1.12 ARCHITECT ACTION ON SUBMITTALS

- A. Architect's action on submittals:
 - 1. "APPROVED": Submittal is in general conformance with the design concept of Project and in general compliance with information given in Contract Documents.
 - 2. "APPROVED AS NOTED": Submittal has minor issues. Noted corrections must be made in final installation. Architect has option to require re-submission for record.
 - 3. "REVISE AND RESUBMIT": Re-submission is required, due to nature or number of issues.
 - 4. "NOT APPROVED": Submittal does not meet contract requirements or is not required to be submitted.
 - 5. "NO ACTION REQUIRED": Submittal not required, Project Information or Contract Closeout Information Submittal.
- B. Architect will review and approve or take other appropriate action upon Contractor's submittals, but only for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
 - 1. Such review and action is limited to only those submittals identified in Contract Documents.
 - 2. Architect's review of such submittals is not conducted for purpose of determining accuracy and completeness of other details and information such as dimensions, quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain responsibility of the Contractor.
 - 3. Architect's review or approval of a specific item shall not indicate approval of an assembly of which the item is a component.
 - 4. Architect's review or approval shall not constitute a review of safety or health precautions, or of any construction means, methods, techniques, sequences, or procedures.
 - 5. Architect's review or approval on a resubmission shall not apply to revisions that Contractor has not directed specific attention to in writing on resubmitted submittals, other than those requested by Architect on previous submittal.
- C. Architect's action will be taken with such reasonable promptness as to cause no delay in Work or in activities of Owner, Contractor, or separate contractors, while allowing sufficient time in Architect's professional judgment to permit adequate review by Architect, Architect's consultants, and Owner, if needed.
 - 1. Architect's obligation to review or approve submittals and to return them with reasonable promptness is conditional upon prior review and approval of submittals by Contractor, and Contractor's transmittal of submittals in accordance with Contract Documents and approved Schedule of Submittals.
- D. Items not submitted in accordance with provisions of this section may be returned, without review or action.
 - 1. Submittals which do not indicate Contractor has reviewed submittal for compliance with Contract Documents, and approved submittal.
 - 2. Submittals which are not required by Contract Documents.
 - 3. Submittal on items not approved for use by Contract Documents.
 - 4. Submittals which include information from more than one specification section.

5. Project Information Submittals or Contract Closeout Information Submittals included with other submittals required by specification section Submittal paragraph.
 6. Submittals required by other contractors or trades for their coordination that are not required by specification section Submittal paragraph.
 7. Submittal of products, systems, or manufactures not specified.
 8. Submittal of substitution.
 9. Submittal of MSDS information.
 10. Information on only a portion of a submittal.
 11. If approved Submittal Transmittal form was not used.
- E. If a submittal must be delayed for coordination with other submittals not yet submitted, Architect may, as an option, either return submittal with no action or notify Contractor of other submittals which must be received before submittal will be reviewed.
- F. Additional copies of submittals not required or requested may not be returned.
- G. Architect may review Project Information Submittals or Contract Closeout Information Submittals at its sole discretion, for general compliance with design concept expressed in Contract Documents.
- H. Architect will return submittal utilizing Newforma Info Exchange indicating comments and action taken for Contractor's use and distribution.
1. Architect will notify Contractor by email when submittals have been reviewed and posted to Newforma.
 2. Architect is not required to return Samples, Project Information and Contract Closeout Information submittals.
 3. Submittals may be returned by regular mail at Architect's discretion.
- I. Architect will return submittal indicating comments and action taken for Contractor's use and distribution.
1. Submittals may be returned by regular mail at Architect's discretion.
 2. Architect is not required to return Samples, Project Information and Contract Closeout Information submittals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SUBMITTAL TRANSMITTAL

PROJECT: _____ **SUBMITTAL NO:** _____ - _____

SECTION NUMBER: _____
SEQUENCE NUMBER: _____
ARCH PROJ. NO.: _____ **RE-SUBMITTAL CHARACTER:** _____
SPECIFICATION TITLE: _____
MANUFACTURER: _____

- Do not submit on manufacturers not listed in Specifications.
- Architect's Action Taken in accordance with provisions of the Contract Documents.
- This Transmittal Form shall stay with the submittal throughout routing. Copy for file.

DESCRIPTION OF SUBMITTED ITEM: _____

Routing Sequence	Action Taken By	Date Received	Date Sent	Number Copies	Action Taken
Subcontractor/Supplier: _____					A Note 1
Construction Manager/Contractor: _____					A Note 1
Architect: _____					
Construction Manager/Contractor: _____					
Subcontractor/Supplier: _____			N.A.		
Owner: _____	N.A.		N.A.		N.A.

ACTION LEGEND

Indicated in Action Taken column above.

- A** APPROVED
- B** APPROVED AS NOTED
- C** REVISE AND RESUBMIT
- D** NOT APPROVED
- E1** NO ACTION REQUIRED - Informational
- E2** NO ACTION REQUIRED - Informational with Comments
- E3** NO ACTION REQUIRED - Submittal not required

Note 1: Submittal transmittal to Architect indicates [Construction Manager] [Contractor] and subcontractor have reviewed for compliance with Contract Documents and have approved submittal.

COMMENTS

- ☐ SEE ATTACHED COMMENTS ☐ SEE ENCLOSED SUBMITTAL FOR COMMENTS
- ☐ SUPPLEMENTAL INFORMATION REQUIRED

END OF SUBMITTAL TRANSMITTAL

SECTION 01 45 23
TESTING AND INSPECTING SERVICES

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. General:

1. Work shall be subject to inspection, testing, and approval by testing agency, inspector, and building official or public authorities having jurisdiction.
2. Approval as result of inspection or testing shall not be construed to be an approval of a violation of provisions of Contract Documents, or by governing codes, laws, ordinances, rules, or regulations.
3. Testing, inspections, and approvals presuming to give authority to violate or cancel provisions of Contract Documents, or by governing codes, laws, ordinances, rules, or regulations shall not be valid.
4. It shall be duty of Contractor to cause Work to remain accessible and exposed for testing and inspection purposes.
5. It shall be duty of Contractor to notify testing agency, inspector, and building official or public authorities having jurisdiction when Work is in conformance with Contract Documents and is ready for testing and inspection.
6. It shall be duty of Owner and Contractor to provide access to and means for testing and inspections of such Work required by Contract Documents or by governing codes, laws, ordinances, rules, or regulations.
7. Any portion that does not comply shall be corrected and shall not be covered or concealed until authorized by testing agency, inspector and public authorities having jurisdiction.
8. Tests, inspections, and approvals of portions of Work required by Contract Documents or by codes, laws, ordinances, rules, regulations, or orders of building official or public authorities having jurisdiction shall be made at an appropriate time.
9. Contractor shall give testing agency, inspector, building official or public authorities having jurisdiction and Architect, if requested, timely notice of when and where tests and inspections are to be made so that they may be present for such procedures.
10. In event such procedures for testing, inspection, and approval reveal portions of Work fail to comply with requirements established by Contract Documents, or by governing codes, laws, ordinances, rules or regulations, costs made necessary by such failure, including those of repeated procedures and compensation for Architect's services and expenses, shall be at Contractor's expense.
11. Required certificates of testing, inspection, and approval shall be secured by Contractor and promptly delivered to Architect, inspector, building official, and public authorities having jurisdiction, unless otherwise required by Contract Documents.
12. If Architect, Owner, building official, public authorities having jurisdiction, testing agency or inspector is to observe tests, inspections, and approvals required by Contract Documents, or by governing codes, laws, ordinances, rules or regulations or orders of building official or public authorities having jurisdiction, they will do so promptly, and where practicable, at normal place of testing.
13. Construction or Work for which a permit is required shall be subject to inspections by the building official and such construction or Work shall remain visible and able to be accessed for inspection purposes until approved.
 - a. Building officials are authorized to accept reports from approved inspection agencies, provided such agencies satisfy qualifications and reliability requirements.
 - b. See governing codes, laws, ordinances, rules, and regulations for additional requirements.

- B. Test and inspection method standards: See technical sections and governing codes, laws, ordinances, rules, and regulations.
- C. Qualifications of independent testing agencies:
 - 1. Testing agency shall comply with governing codes, laws, ordinances, rules, and regulations.
 - a. An approved agency shall provide all information as necessary for the building official to determine that the agency meets the applicable requirements.
 - b. An approved agency shall be objective, competent, and independent from Contractor responsibility for the Work being inspected. The agency shall disclose to the building official and the registered design professional in responsible charge possible conflicts of interest so that objectivity can be confirmed.
 - c. An approved agency shall have adequate equipment to perform required tests. The equipment shall be periodically calibrated.
 - d. An approved agency shall employ experienced personnel educated in conducting, supervising, and evaluating tests and special inspections.
 - e. See governing codes, laws, ordinances, rules, and regulations for additional requirements.
 - 2. Meet American Council of Independent Laboratories, Recommended Requirements of Independent Laboratory Qualification, latest edition.
 - 3. Meet requirements of ASTM E329, Standards of Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as used in Construction, latest edition.
 - 4. Meet requirements of AASHTO Materials Reference Library (AMRL) R18 Standard Practice for Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories.
 - 5. Meet requirements of ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories.
 - 6. Satisfy inspection criteria of Materials Reference Laboratory of National Institute of Standards and Technology.
 - 7. See technical sections for additional requirements.
- D. Testing equipment calibration shall be by accredited calibration agency, at maximum 12 month intervals, by devices of accuracy traceable to either:
 - 1. National Institute of Standards and Technology.
- E. Special Inspections and Tests:
 - 1. Owner or Owner's authorized agent, other than the contractor, shall employ one or more approved agencies to provide special inspections and tests during construction on the types of Work specified by governing codes.
 - a. These special inspections and tests are in addition to the inspections by the building official.
 - b. See governing codes, laws, ordinances, rules, and regulations for additional requirements.
- F. Structural Observations:
 - 1. Where required by the provisions of the governing codes, the Owner or the Owner's authorized agent shall employ a registered design professional to perform structural observations as defined in the governing codes.
 - a. See governing codes, laws, ordinances, rules, and regulations for additional requirements.

1.2 DESCRIPTION

- A. Owner will arrange and pay for following testing and inspections performed by testing agency or special inspector:

1. Site excavation and rough grading inspection: Section 31 22 13.
 2. Soil compaction inspection and testing: Section 31 23 00.
 3. Excavation inspection: Section 31 23 00, Section 31 23 16.
 4. Earth retention systems inspection and concrete testing: Section 31 50 00.
 5. Auger cast piling inspection: Section 31 63 16.
 6. Drilled pier excavation inspection and testing: Section 31 63 29.
 7. Pressure injected footings observation of load tests and concrete testing: Section 31 62 14.
 8. Concrete testing and evaluation of installed work: Section 03 08 13.
 9. Concrete reinforcing testing and inspection: Section 03 20 00.
 10. Underslab Vapor Retarder inspection of installed work: Section 03 31 10.
 11. Concrete floor finish tolerance testing: Section 03 35 00.
 12. Architectural Precast Concrete: Section 03 45 00.
 13. Concrete Tilt Up Wall Panels: Section 03 47 13.
 14. Portland cement-lime mortars and grout testing: Section 04 05 16.
 15. Masonry accessory installation inspection: Section 04 05 23.
 16. Dovetail slots installation inspection: Section 04 05 21.
 17. Brick masonry construction inspection: Section 04 21 13.
 18. Concrete masonry inspection: Section 04 22 00.
 19. Structural steel welding, bolts and stud testing and inspection, except testing to qualify welders: Section 05 12 10.
 20. Metal roof deck inspection: Section 05 31 23.
 21. Composite metal form deck inspection: Section 05 36 00.
 22. Roof deck: Section 05 31 23.
 23. Concrete Floor Moisture Testing: Section 07 16 04.
 24. Fireproofing testing and inspection: Section 07 81 16.
 25. Curtain Wall field testing: Section 08 44 13.
 26. Testing and balancing mechanical systems: Section 23 05 93.
- B. Owner shall bear costs of tests, inspections or approvals which do not become requirements until after bids are received or negotiations concluded.
- C. Contractor arrange and bear related costs for following tests, inspections and approvals with an independent testing agency or entity acceptable to Owner:
1. Concrete testing for qualification of proposed materials, establishment of mix design, and for Contractor's convenience: Section 03 08 13.
 2. Portland cement-lime mortars and grout testing for qualification of materials and for Contractor's convenience: Section 04 05 16.
 3. Structural steel welding testing to qualify welders: Section 05 12 10.
 4. Radiation Shielding: Section 09 29 00.
 5. Radiation Shielding: Section 13 49 00.
 6. Rebar locating for drilling, core drilling or cutting of concrete.
 7. Testing and inspections of Contractor provided shoring or forming.
 8. Additional inspection and testing required by public authorities having jurisdiction.
 9. Contractor's duties for Owner provided tests, as specified.
- D. Contractor shall arrange for, and bear related costs for following with Owner provided independent testing agency or entity acceptable to Owner:
1. Re-testing due to failure of initial test or due to nonconformance with Contract Documents.

2. Re-inspections of Work due to failure of Work to pass initial inspection or due to nonconformance with Contract Documents.

1.3 JOB CONDITIONS

- A. Employment of independent testing agency does not relieve Contractor of obligation to comply with Contract Documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PERFORMANCE

- A. Perform indicated inspections, sampling, and testing of materials and methods of construction.
- B. Use test and inspection or sampling methods or both conforming with methods indicated.
- C. Report each test and inspection, sampling, or both, as indicated.
- D. Report results called for by test method in form specified.
- E. Retest failed products and systems.

3.2 REPORTS

- A. Submit reports and logs promptly to Architect, Structural Engineer, Contractor, inspector, and public authorities having jurisdiction.
- B. Include following for test or inspection reports or both:
 1. Project name and number.
 2. Project location.
 3. Product and specification section applicable.
 4. Type of test or inspection or both.
 5. Name of testing agency, if used.
 6. Name of testing or inspecting personnel, or both.
 7. Date of test or inspection or both.
 8. Record of field conditions encountered, i.e., temperature, weather.
 9. Test location.
 10. Observations regarding compliance.
 11. Test method used.
 12. Results of test.
 13. Date of report.
 14. Signature of testing or inspecting personnel or both.
- C. Maintain log of tests which have failed:
 1. Type of test or inspection or both.
 2. Date of test or inspection or both.
 3. Test or inspection number or both.
 4. Reason failed.
 5. Date of retest or inspection or both.
 6. Results of retest.
 7. Method of retest.

3.3 INDEPENDENT TESTING AGENCY DUTIES AND LIMITATIONS OF AUTHORITY

- A. Cooperate with Architect and Contractor.
- B. Provide qualified personnel promptly on notice.

- C. Promptly notify Architect and Contractor of irregularities, or deficiencies of work which are observed during performance of services.
- D. Testing agency is not authorized to:
 - 1. Release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Approve or accept any portion of Work.
 - 3. Perform any duties of Contractor.

3.4 CONTRACTOR'S DUTIES

- A. Cooperate with testing agency personnel, inspector, and public authorities having jurisdiction and provide access to work.
- B. Provide preliminary representative samples of materials to be tested, in required quantities.
- C. Furnish copies of mill test reports.
- D. Furnish labor and facilities:
 - 1. To provide access to work to be tested.
 - 2. To obtain and handle samples at site.
 - 3. To facilitate inspections and tests.
 - 4. Storage and curing facilities for testing agency's exclusive use.
- E. Notify building official and testing agencies when Work is ready for inspections.
- F. Construction or Work for which Special Inspections are required shall remain accessible and exposed for special inspections purposes until completion of required special inspections.
- G. Provide access to and means for inspections by building officials and testing agencies of such Work that are required.
- H. Work shall not be done beyond point indicated in each successive inspection without first obtaining approval of building official.
- I. Any portion of Work that does not comply shall be corrected and such portions shall not be covered or concealed until authorized by building official.
- J. Notify appropriate testing agency, inspector or public authorities having jurisdiction sufficiently in advance of operations.

END OF SECTION

SECTION 01 56 39

TEMPORARY TREE AND PLANT PROTECTION - OLSSON

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The Work of this Section Includes: General protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

1.3 DEFINITIONS

- A. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape at a height 54 inches (1372 mm) above the ground line.
- B. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- C. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.
- D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For arborist and tree service firm.
- B. Certification: From Landscape Architect, certifying that trees indicated to remain have been protected during construction in accordance with recognized standards and that trees were promptly and properly treated and repaired when damaged.
- C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
- D. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
 - 1. Use sufficiently detailed photographs or video recordings.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.5 QUALITY ASSURANCE

- A. Arborist Qualifications: Certified Arborist as certified by ISA.
- B. Tree-Service Firm Qualifications: An experienced tree-service firm that has successfully completed temporary tree- and plant-protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
- C. Quality-Control Program: Prepare a written program, approved by Owner, to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work without damaging trees and plantings. Include dimensioned diagrams for placement of protection-zone fencing and signage, the arborist's and tree-service firm's responsibilities, instructions given to workers on the use and care of protection zones, and enforcement of requirements for protection zones.

1.6 FIELD CONDITIONS

- A. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.

2. Moving or parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
 8. Access for construction workers.
- B. Do not direct vehicle or equipment exhaust toward protection zones.
 - C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.
 - D. Take precautions to protect plants from airborne contaminants, such as paint or fireproofing overspray.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS.
- B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
 1. Type: As recommended by arborist.
 2. Color: Natural.
- C. Protection-Zone Fencing: Fencing fixed in position and meeting one of the following requirements:
 1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum 2-inch (50-mm) opening, 0.148-inch- (3.76-mm-) diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch- (60-mm-) OD line posts, and 2-7/8-inch- (73-mm-) OD corner and pull posts; with 1-5/8-inch- (42-mm-) OD top rails and 0.177-inch- (4.5-mm-) diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
 - a. Height: 72 inches (1800 mm).
 2. Gates: Single, removal panel.
- D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes pre-punched and reinforced; legibly printed with nonfading lettering and as follows:
 1. Size and Text: Do Not Enter or Move Fence.
 2. Lettering: 3-inch- (76-mm-) high minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- B. Prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

- A. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

3.3 TREE PROTECTION

- A. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas recommended by arborist. Do not exceed indicated thickness of mulch.
 - 1. Apply uniform thickness of organic mulch unless otherwise indicated by arborist. Do not place mulch within approximately 12 inches (150 mm) of tree trunks. Final distance to be determined on site with Owner approval.

3.4 PROTECTION ZONES

- A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
 - 1. Chain-Link Fencing: Install to comply with ASTM F567 and with manufacturer's written instructions.
 - 2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.
- B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Architect. Install one sign spaced approximately every 20 ft. (6 m) on protection-zone fencing, but no fewer than signs with each facing a different direction.
- C. Maintain protection zones free of weeds and trash.
- D. Maintain hydration of plants to assure plant survival.
- E. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.
 - 1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
 - 2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.5 CROWN PRUNING

- A. Prune branches that are affected by temporary and permanent construction. Prune branches under direction of arborist.
 - 1. Prune to remove only injured, broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.
 - 2. Do not remove or reduce living branches to compensate for root loss caused by damaging or cutting root system.
 - 3. Pruning Standards: Prune trees in accordance with ANSI A300 (Part 1).
- B. Pruning by arborist if approved by Owner and City Forestry. Do not cut tree leaders.
- C. Cut branches with sharp pruning instruments; do not break or chop.
- D. Do not paint or apply sealants to wounds.
- E. Provide subsequent maintenance pruning during Contract period under direction of arborist.

3.6 REGRADING

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
 - 1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
- C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- D. Minor Fill within Protection Zone: Where existing grade is 2 inches (50 mm) or less below elevation of finish grade, fill with backfill soil. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.7 FIELD QUALITY CONTROL

- A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.8 REPAIR AND REPLACEMENT

- A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours in accordance with arborist's written instructions.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Soil Aeration: Where directed by Architect, aerate surface soil compacted during construction.

END OF SECTION

SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Common requirements for materials and equipment.
2. Compatibility of materials and equipment.

1.2 REQUIREMENTS FOR MATERIALS AND EQUIPMENT

- A. This project utilizes Federal Assistance through the Federal Transit Administration (FTA) and therefore must comply with the [Build America, Buy America \(BABA\) Act](#). (Additional information on BABA for FTA can be found [here](#).) Every contractor and subcontractor choosing to bid on this project must abide by the BABA requirements.
1. All iron and steel items used in projects must be produced in the United States. This means all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States.
 2. All manufactured products used in projects must be produced in the United States. This means the manufactured product was manufactured in the United States, and the cost of the components of the manufactured product that are mined, produced, or manufactured in the United States is greater than 55 percent of the total cost of all components of the manufactured product.
 3. All construction materials used in projects must be manufactured in the United States. This means that all manufacturing processes for the construction material occurred in the United States.
- B. Unless otherwise indicated in the Contract Documents, furnish materials and equipment that:
1. have not previously been incorporated into another project or facility; and
 2. have not changed ownership after initial shipment from the manufacturer's factory or facility; and
 3. if stored since their manufacture or fabrication, have, while in storage, been properly maintained and serviced in accordance with the manufacturer's recommendations for long-term storage; submit documentation as required by Engineer that such maintenance and service has been performed; and
 4. that the item(s) have not been subject to degradation or deterioration since manufacture; and
 5. are the current model(s) or type(s) furnished by the Supplier.
- C. To the extent possible, furnish from a single source those materials and equipment that are of the same generic kind.
- D. Furnish materials and equipment complete with accessories, trim, finish, fasteners, and other items shown, indicated, or required for a complete installation for the indicated use and performance.
- E. Standard Items: When available, and unless custom or nonstandard options are specified or indicated, furnish standard materials and equipment of types that have been produced and used successfully in similar situations on other projects.
- F. Visual Matching: Where required in the Contract Documents, furnish materials and equipment that match (as determined by Engineer) referenced existing construction, and mock-ups and Sample(s) approved by Engineer.

- G. Where the Contract Documents include the phrase “as selected” for color of materials or equipment, finish pattern, option, or similar phrase, furnish materials and equipment selected by Engineer as follows:
1. Standard Range: Where the Contract Documents include the phrase “standard range of colors, patterns, textures” or similar wording, furnish color, pattern, density, or texture selected by Engineer from manufacturer’s product line that does not include premium items.
 2. Full Range: Where the Contract Documents include the phrase “full range of colors, patterns, textures” or similar wording, Engineer will select color, pattern, density, or texture from manufacturer’s entire product line, including standard and premium items.

1.3 COMPATIBILITY

- A. Similar materials and equipment by the same Supplier shall be compatible with each other, unless otherwise indicated in the Contract Documents or approved by Engineer.
- B. Furnish materials and equipment compatible with items previously selected or installed on the Project.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 71 21
SPECIALTY ENGINEERING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish engineering design, drawings, and calculations for Specialty Engineering Requirements, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 DEFINITIONS

- A. Structural Engineer of Record (SER):
 - 1. Structural engineer legally eligible to seal structural Contract Documents for project.
 - 2. Seal acknowledges SER performed or supervised analysis, design, and document preparation for building structure and has knowledge of requirements for structural system.
 - 3. The SER is responsible for the design of the primary structural system.
- B. Specialty Structural Engineer (SSE):
 - 1. Registered Engineer other than Structural Engineer of Record (SER), licensed to practice structural engineering in state in which project is located.
 - 2. Undertakes engineering calculations, design and drawing preparation of components, systems, or installation methods and equipment for specific temporary portions of Work or special items of permanent Work required to be furnished by Contractor.
 - 3. Provide designs and details for items of permanent Work declared to be minor or non-structural.
 - 4. Employee or officer of Contractor or fabricator, employee or officer of an entity providing components to a fabricator, or an independent consultant.
 - 5. The Contractor is responsible for any structural engineering tasks that are required for construction related services.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SYSTEM DESIGN

- A. Contract Documents show conceptually detailed components describing aesthetic intent and provides a performance-type prescription for the design, fabrication, and installation.
- B. Contractor is responsible for the engineering and design of components and materials as well as fabrication and installation.
- C. Develop conditions not shown in Contract Documents to same level of aesthetics in compliance with performance and aesthetic criteria specified and indicated for detailed areas.
- D. Provide engineering design with drawings and calculations sealed by registered Engineer, licensed to practice structural engineering where the project is located.
- E. Comply with requirements of Contract Documents, codes, regulations, standards, and guidelines including:
 - 1. Nationally published amendments.
 - 2. Local Amendments.
 - 3. Structural criteria provided.
 - 4. Additional requirements indicated in specification sections.

F. Reference Standards:

1. Refer to technical specification sections for listed standards.
- G. Minor deviations in dimensions and profiles may be considered provided design concept is unchanged or intended performance is not compromised as judged by the Architect.
- H. Where SSE exercises professional judgment and takes exception to specified criteria or reference standards, disclose exception in writing.

3.2 DOCUMENTATION

A. Include following items common to project:

1. Project Identification:
 - a. Project name.
 - b. Project location.
 - c. Identifying project numbers.
 - d. North arrow.
 - e. Scale.
2. Governing Codes:
 - a. Building code and edition.
 - b. Referenced codes and standards.
 - c. Design method used for the design.
3. Service Loads.
4. Strength loads or factors.
5. Design Load:
 - a. Dead loads.
 - b. Live loads.
 - c. Snow loads.
 - d. Wind loads.
 - e. Seismic loads.
6. Material Properties:
 - a. Design properties.
 - b. ASTM designations.
7. Computer Submittals:
 - a. Documentation of computer programs including the program name and version should be included with any submittal of computer calculations. In the case of custom software or spreadsheet developed in house it may be necessary to provide hand calculation of representative elements to verify the use of the program.

B. Include maximum design loads at connection points to primary structure.

1. Indicate values consistent with method used for design including service loads or strength loads with factors.
2. Design system to apply loads to the structure through the centerlines of the supporting element.
3. Assume building supports are free to rotate. Torsional or flexural fixed supports shall not be used unless approved by the SER.
4. When fixed or eccentric supports are used, provide additional framing as deemed necessary by the SER at no additional cost.

C. Include member sizes, required reinforcing, connection details and material specifications.

D. Include statements where the SSE has exercised professional judgment and takes exception to the specified criteria or referenced standard. Final authority and responsibility for decisions

concerning structural design criteria shall belong to the SER. When exceptions are stated as qualifications to the contractor's proposal, the SER shall be notified and respond prior to award.

- E. SSE shall review and approve the shop drawings and special erection drawings prepared by a fabricator or supplier and attest to that review with a signed shop drawing stamp, or other means, prior to submittal of the drawings to the SER. When standardized erection drawings are used, there is no need to provide a shop drawing approval stamp.

END OF SECTION

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Owner has established that this Project shall include proactive measures for waste management participation by all parties to the contract.
 - 1. The purpose of this program is to ensure that during the course of the Project all diligent means are employed to pursue practical and economically feasible waste management and recycling options.
 - 2. Upon award, each subcontractor shall be required to furnish documentation from suppliers or manufacturers regarding waste management and recycling options for those products and procedures furnished.
 - 3. Waste disposal to landfills shall be minimized.
- B. Definitions:
 - 1. Waste: Any material that has reached the end of its intended use. Waste includes salvageable, returnable, recyclable, and reusable construction materials that would otherwise be discarded or destroyed.
 - 2. Construction waste: Solid wastes including, but not limited to, building materials, packaging materials, debris and trash resulting from construction operations.
 - 3. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or Waste to Energy facility acceptable to authorities having jurisdiction.
 - 4. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
 - 5. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
 - 6. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the work.
 - 7. Hazardous waste: Any material or byproduct of construction that is regulated by the Environmental Protection Agency and that may not be disposed in any landfill or other waste end-source without adherence to applicable laws.
 - 8. Trash: Any product or material unable to be returned, reused, recycled, or salvaged.
 - 9. Landfill: Any public or private business involved in the practice of trash disposal.
 - 10. Waste Management Plan: A Project-related plan for the collection, transportation, and disposal of the waste generated at the construction site.

1.2 PERFORMANCE GOALS AND REQUIREMENTS

- A. General: Develop Waste Management Plan that results in end-of-Project rates for salvage/recycling of a minimum of 50percent by weight of total waste generated by the Work. Records indicating diverted materials must include a breakdown consisting of at least four material streams.

1.3 SUBMITTALS

- A. Implementation Plan:
 - 1. Construction Waste Management Plan.
- B. Progress Reports:

1. Submit reports concurrent with each Application for Payment, submit copies of report. Include separate report for demolition and construction waste. Include the following information:
 - a. Material category.
 - b. Total quantity of waste in tons.
 - c. Quantity of waste salvaged, both estimated and actual in tons.
 - d. Quantity of waste recycled, both estimated and actual in tons.
 - e. Total quantity of waste recovered (salvaged plus recycled) in tons.
 - f. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- C. Project Closeout:
 1. Waste Reduction Calculations: Before request for Substantial Completion, submit copies of calculated end of Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
 2. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
 3. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
 4. Recycling and Processing Facility Records: Indicate receipt and acceptance of waste by landfills and Waste to Energy facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Waste Management Conference: Project Manager shall conduct conference at Project site to review methods and procedures related to waste management including but not limited to, the following:
 1. Review and discuss Waste Management Plan.
 2. Review requirements for documenting quantities of each type of waste and its disposition.
 3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 5. Review waste management requirements for each trade.

1.5 CONSTRUCTION WASTE MANAGEMENT PLAN

- A. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Include separate sections in plan for demolition and construction waste. Indicate quantities by weight or volume but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of land-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed in landfill or Waste to Energy facilities. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.

2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone number.
 3. Recycled Materials: Assign recycling to recycling subcontractor, or list local receivers and processors, and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 4. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and Waste to Energy facility. List hazardous material waste and disposal separately.
 5. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.
- D. Waste Management Plan shall include locations of sorting and waste storage facilities on Site Plan of project.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT PLAN IMPLEMENTATION

- A. Implement waste management plan as approved by Owner.
1. Establish waste diversion goals for the project by identifying at least five materials (both structural and nonstructural) targeted for diversion. Approximate a percentage of the overall project waste that these materials represent.
 - a. Common materials may include drywall, wood, scrap metals, brick, and concrete. Finish materials such as floor or ceiling tiles may also be included.
 2. Specify whether materials will be separated or commingled and describe the diversion strategies planned for the project.
 3. Provide where the material will be taken and how the recycling facility will process the material.
 4. Alternative daily cover (ADC) does not qualify as material diverted from disposal.
 5. Land-clearing debris is not considered construction, demolition, or renovation waste that can contribute to waste diversion.
- B. Implement the following practices to ensure construction waste is handled and diverted properly.
1. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 2. Define specific areas to facilitate separation of materials for recycling, salvage, reuse, or return.
 3. If single-stream recycling is not used:
 - a. Separate construction waste by type at Project site to the maximum extent practical.
 - b. Do not mix recyclable materials.
 - c. Recycle and waste bin areas are to be maintained in an orderly manner and clearly marked to avoid contamination of materials. Inspect containers and bins weekly for contamination and remove contaminated materials if found.
 4. Stockpile processed materials on site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 5. Store materials away from construction area. Do not store within drip line of remaining trees.
 6. Store components off the ground and protect from weather.
- C. Source Reduction: Identify source reduction strategies. Strategies include:

1. Modular construction, reduced packaging, using industry-standard measurements, and prefabrication.
- D. Hazardous Wastes: Store in secure areas and comply with the following:
 1. Hazardous wastes shall be separated, stored, and disposed of in accordance with local and EPA regulations and additional criteria listed below:
 - a. Building products manufactured with PVC or containing chlorinated compounds shall not be incinerated.
 - b. Disposal of fluorescent tubes and ballasts to open containers is not permitted.
 - c. Disposal of building elements containing mercury to open containers is not permitted.
- E. Unused fertilizers shall not be co-mingled with construction waste.
- F. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
 1. Distribute waste management plan to everyone concerned within seven days of submittal return.
 2. Distribute waste management plan to entities when they first begin work on site. Review plan procedures and locations established for salvage, recycling, and disposal.
- G. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
 2. Comply with environmental controls specified in Division 01 Section 01 50 00 Temporary Facilities, Construction Controls and Facilities.

3.2 RECYCLING AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.

3.3 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or Waste to Energy facility acceptable to authorities having jurisdiction.
 1. Utilize a waste management company that can provide verifiable documentation that the percentage of construction and demolition waste material diverted from the landfill complies with this section.
 2. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 3. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials on site.
- C. Incineration/ Burning: Incineration/ burning of waste materials is not acceptable unless it is a part of a waste to energy diversion strategy.
- D. Disposal: Transport waste materials and dispose of at designated spoil areas on Owner's property.
- E. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION

SECTION 01 74 23

CLEANING

PART 1 - GENERAL

1.1 FIRE PROTECTION

- A. Store volatile waste in listed disposal containers.
- B. Maintain site and building so no condition provides a fire hazard.
- C. Remove combustible debris from building at end of each shift and from site daily.
- D. Sources of ignition and smoking are prohibited in flammable and combustible storage areas.
- E. Do not burn on-site.

1.2 POLLUTION CONTROL

- A. Conduct cleanup and disposal operations to comply with codes, rules, regulations, ordinances, and anti-pollution laws.
- B. Do not burn or dispose of combustible debris, rubbish, and waste material on site.
- C. Do not discharge volatile, harmful, or dangerous materials into storm or sanitary drains or sewer systems.
- D. Prevent accumulation of wastes that create hazardous conditions.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

- A. Use materials recommended by manufacturers of surfaces to be cleaned.
- B. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.
- C. Use only those cleaning materials which will not create hazards to health or property and will not damage surfaces.

2.2 CLEANING MATERIALS

- A. Use only those cleaning materials which will not create hazards to health or property, are non-toxic to both humans and aquatic life, and will not damage surfaces, and comply with the following:

PART 3 - EXECUTION

3.1 GENERAL

- A. Clean items installed under this Contract.
 - 1. Leave free of stains, dirt, dust, damage, or defects.
 - 2. Include washing, sweeping, polishing of wall surfaces, floors, windows, hardware, mirrors, lighting fixtures, equipment, etc.

3.2 DURING CONSTRUCTION

- A. Provide on-site listed disposal containers for collection of waste materials, debris, and rubbish.
 - 1. Dispose of off-site once a week at an approved solid waste disposal site.
 - 2. Cover container to prevent blowing by wind.
- B. Keep work areas clean so as not to hinder health, safety, or convenience of personnel in existing facility operations.
- C. Interior cleaning:

1. Clean and vacuum interior space prior to start of painting, and continue cleaning [as-needed] until substantial completion.
 2. Schedule cleaning operations so contaminants do not fall on wet, painted surfaces.
 3. Clean and protect Work in progress and adjoining materials in place, during handling and installation.
 4. Clean lunch/break area after each use.
- D. Exterior cleaning:
1. Wet down dusty materials and rubbish to prevent blowing dust during entire construction period.
 2. If use of water is prohibited by law, seek an alternate method to prevent blowing dust.
 3. Perform cleaning operations as required during construction to prevent accumulations of dust, soil, and debris.
 4. Keep weeds and other vegetation trimmed to 3 inches maximum height.
 5. Remove snow and ice from access to buildings.

3.3 FINAL CLEANING

- A. At Substantial Completion, perform final cleaning of Work and existing areas wherever any area are left less than clean by construction operations.
1. Complete cleaning operations before requesting review for Substantial Completion.
- B. Use experienced professional cleaners for final cleaning.
- C. Repair and touch-up marred areas.
- D. Broom clean and remove stains from paved surfaces; rake clean other surfaces of grounds.
- E. Ventilation systems:
1. Clean permanent filters and replace disposable filters if units were operated during construction.
 2. Clean ducts, blowers, and coils in air conditioning units operated during construction.
- F. Remove grease, dust, dirt, stains, labels, fingerprints, mastic, adhesive, and foreign materials from interior and exterior surfaces, and fixtures, hardware, and equipment.
- G. Wash and shine glazing, mirrors, stainless steel, etc., including existing materials in area of construction.
- H. Wipe lighting fixture reflectors, lenses, lamps, and trims clean.
1. Replace burned out lamps.
- I. Polish glossy surfaces to a clear shine.
- J. Remove temporary protection and facilities installed for protection of the Work during construction.

3.4 FIELD QUALITY CONTROL

- A. Prior to Owner occupancy, Contractor and Owner shall conduct an inspection of interior and exterior surfaces and Work areas to verify Project is clean to Owner's satisfaction.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES (GC)

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout.
- B. Provisions followed by an asterisk (*) include some or all of the provision as obtained from AIA Document A201 - General Conditions of the Contract for Construction.

1.2 SUBMITTALS

- A. Contract Closeout Information:
 - 1. For substantial completion:
 - a. Comprehensive list of all items to be completed or corrected.
 - b. Contractor's Notice of Substantial Completion.
 - c. Certificates of governing authorities.
 - d. Submittals required by other Sections.
 - 2. For final completion:
 - a. Contractor's Certificate of Completion.
 - b. Evidence of payments and release or waiver in digital form.
 - 1) Contractor's Affidavit of Payments of Debts and Claims: AIA Document G706.
 - 2) Contractor's Affidavit of Release of Liens: AIA Document G706A.
 - 3) Contractor's release or waiver of liens.
 - 4) Separate releases or waivers of liens for subcontractors, suppliers, and others with lien rights against Owner, together with list of all such parties.
 - 5) If required by Owner, other data establishing payment or satisfaction of obligations arising out of Contract.
 - c. Consent of Surety (if any) to Final Payment: AIA Document G707.
 - d. Certificates evidencing that insurance to remain enforce.
 - e. Final application for payment.
 - f. Initialed list(s) of items to be completed or corrected verifying completion of each items.
 - g. List of Subcontractors and equipment suppliers. Include:
 - 1) Name.
 - 2) Address.
 - 3) Telephone number.
 - 4) Representative.
 - h. Letter of site conformance.
 - i. Closeout submittals required by other Sections.

1.3 SUBSTANTIAL COMPLETION

- A. Substantial Completion is the stage in the progress of Work when the Work or designated portion thereof is sufficiently complete in general accordance with Contract Documents so Owner can occupy or utilize Work for its intended use. *
- 1. Work will not be considered for Substantial Completion until all systems and equipment are operational; all designated or required governing agency inspections and certifications have been made and posted, instruction of designated Owner's personnel in operation of systems and equipment has been completed, operation and maintenance data has been satisfactorily turned over to Owner, and finishes are in place. In general, the only remaining Work shall be minor in nature, such that Owner may occupy or utilize Work or designated

- portion thereof, and completion or correction of Work by Contractor would not materially interfere or hamper Owner's intended business use or operation.
2. Contractor shall certify that all remaining Work will be completed within 30 consecutive calendar days following date of Substantial Completion, or as agreed to in writing, and failure to do so shall automatically reinstate provisions for damages due Owner as contained elsewhere in Contract Document or as provided by law for such period of time as may be required by Contractor to fully complete Work whether Owner has occupied Work or not.
- B. Obtain evidence of compliance with requirements of governing authorities:
1. Certificates of inspection of:
 - a. Mechanical.
 - b. Electrical.
 - c. Plumbing.
 - d. Fire protection and life safety systems.
 - e. Elevators.
 - f. Etc.
 2. Health Department and other governing authorities as required.
 3. Certificate of Occupancy.
- C. When Contractor considers that Work, or a portion thereof which Owner agrees to accept separately, is substantially complete, Contractor shall thoroughly inspect Work, and prepare and submit to Architect [and Inspector of Record] a comprehensive list of items to be corrected or completed, and Contractor's Notice of Substantial Completion (utilize form at end of this Section). *
- D. Contractor certifies that:
1. Work performed under this Contract has been thoroughly inspected and considered to be sufficiently complete, in accordance with Contract Documents, so Owner can occupy or utilize Work for its intended use.
- E. Failure of Contractor to include an item on such list(s) does not alter responsibility of Contractor to complete all Work in accordance with Contract Documents. *
- F. Contractor shall proceed promptly to complete and correct the items on list.
- G. After receipt of Contractor's comprehensive list of items to be corrected or completed, and Contractor's Notice of Substantial Completion, Architect and Owner will, within reasonable period after notification, review list of items to be completed or corrected, or inspect Work, or designated portion thereof, to determine whether Work is Substantially Complete. *
- H. If Architect or Owner review or inspection discloses any item, whether or not included on Contractor's list, which is not sufficiently complete in general accordance with Contract Documents so Owner can occupy or utilize Work or designated portion thereof for its intended use: *
1. Contractor will be notified stating reasons.
 2. Contractor shall substantially complete or correct Work.
 3. Contractor shall thoroughly re-inspect Work.
 4. Contractor shall submit another Contractor's Notice of Substantial Completion, a revised list of items to be completed or corrected, and a request for another review.
 5. Architect and Owner will again review list of items to be completed or corrected and Work.
- I. If Contractor prematurely submits a Contractor's Notice of Substantial Completion or requests Architect [or Inspector of Record] review of Work, and Architect determines that Project or designated portion thereof is not Substantially Complete, Architect may invoice Owner as a change in services for such cost involved in evaluating and reviewing Work, and associated travel costs. Contractor shall reimburse Owner for such costs.

- J. Architect will not perform more reviews of sub-projects or phases than number indicated in Contract Documents or Owner – Architect Agreement, unless otherwise mutually agreed to by Architect and Owner.
- K. When Work or designated portion thereof is considered Substantially Complete, Architect will prepare a Certificate of Substantial Completion.
 - 1. The Certificate of Substantial Completion shall establish date of Substantial Completion, shall establish responsibilities of Owner and Contractor for security, maintenance, heat, utilities, damage to Work and insurance, and shall fix time within which Contractor shall complete and correct Work.
 - 2. Warranties and guarantees required by Contract Documents shall commence on date of Substantial Completion of Work or designated portion thereof unless otherwise provided in Certificate of Substantial Completion.
 - 3. The Certificate of Substantial Completion shall be submitted to Owner and Contractor for their written acceptance of responsibilities assigned to them in such Certificate. *
- L. Owner may occupy Project, or designated portion thereof, under provisions agreed to in Certificate of Substantial Completion, and if required, a certificate of occupancy has been issued by governing authorities.
 - 1. If Owner is going to occupy Project, or designated portion thereof, Contractor shall perform final cleaning immediately.
 - 2. If Owner or Architect discovers any Work which is not complete and/or is not in conformance with Contract Documents, during or after occupying or utilizes Work, whether included on a list or not, Owner shall notify Contractor to complete or correct item(s) identified.
- M. Contractor shall proceed expeditiously with adequate forces to complete or correct Work, and to complete all Project closeout requirements within designated time.
- N. Upon completion of Work, employ Licensed Surveyor to make survey of site to assure conformance of elevations, grade and site work to contours shown. Provide letter of site conformance.

1.4 FINAL COMPLETION

- A. After Contractor has completed all Work, and has thoroughly inspected Work to determine that it is sufficiently complete, it is in general accordance with Contract Documents, and Contract is fully performed, Contractor shall submit Contractor's Certificate of Completion to Architect, and the list(s) of items to be completed or corrected initialed to indicate Contractor has verified completion of each item. * Utilize form at end of this section. Contractor certifies that:
 - 1. Work has been thoroughly inspected by Contractor for compliance with Contract Documents.
 - 2. Work has been completed in accordance with Contract Documents.
 - 3. Equipment and systems have been tested and are operating satisfactorily.
 - 4. Contract closeout requirements have been completed satisfactorily and submitted.
 - 5. Contractor knows of no reason that insurance will not be renewable to cover period required by Contract Documents.
 - 6. Work is ready for final inspection and acceptance.
- B. Contractor submit final closeout submittals required by this and other Sections.
- C. Owner and Architect will make final walk through within a reasonable time after receipt of Contractor's Certificate of Completion and final Application for Payment. *
 - 1. If Contractor prematurely submits a Contractor's Notice of Final Completion or requests Architect's final review of Project, and Architect determines that Project is not satisfactorily complete, Architect may invoice Owner as a change in services for such cost involved in evaluating and reviewing Work, and associated travel costs. Contractor shall reimburse Owner for such costs.

- D. Contractor shall remedy any remaining deficiencies or incomplete Work, at Contractor's expense.
- E. When Owner and Architect find Work acceptable under Contract Documents and Contract satisfactorily performed, Architect will promptly issue a final Certificate for Payment. *
- F. Neither final payment nor any remaining retained percentage shall become due until Contractor submits to Architect the following:
 - 1. an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with Work for which Owner or Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied (AIA Documents G706 and G706A),
 - 2. a certificate evidencing that insurance required by Contract Documents to remain in force after final payment is currently in effect and will not be canceled or allowed to expire until at least 30 days' prior written notice has been given to Owner,
 - 3. a written statement that Contractor knows of no substantial reason that insurance will not be renewable to cover period required by Contract Documents,
 - 4. consent of surety, if any, to final payment (AIA Document G707),
 - 5. Contractor's and Subcontractor's final release or waiver of liens,
 - 6. if required by Owner, other data establishing payment or satisfaction of obligations, such as receipts, releases and waivers of liens, claims, security interests or encumbrances arising out of Contract, to extent and in such form as may be designated by Owner, for Owner's review, and
 - 7. if a Subcontractor refuses to furnish a release or waiver required by Owner, Contractor may furnish a bond satisfactory to Owner to indemnify Owner against such lien. If such lien remains unsatisfied after payments are made, the Contractor shall refund to Owner all money that Owner may be compelled to pay in discharging such lien, including all costs and reasonable attorneys' fees. *
- G. If Substantial Completion or Final Completion is delayed through no fault of Owner [, Inspector of Record,] or Architect, Architect may invoice Owner as a change in services for such costs, and associated travel costs. Contractor shall reimburse the Owner for such costs.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

CONTRACTOR'S NOTICE OF SUBSTANTIAL COMPLETION

PROJECT: _____

ARCH PROJ. NO.: _____ CONTRACT DATE: _____
CONTRACT
FOR: _____

WORK OR DESIGNATED PORTION SHALL INCLUDE: _____

Work performed under this Contract has been thoroughly inspected and is considered to be sufficiently complete, in accordance with Contract Documents, so Owner can occupy or utilize Work or designated portion thereof for its intended use.

- ☐ Certificates of inspections indicating compliance with requirements of governing authorities, are attached hereto.
- ☐ Certificate of Occupancy have been obtained from governing authorities, are attached hereto.
- ☐ A comprehensive list of items to be completed or corrected, prepared by Contractor is attached, hereto. Failure to include any items on such list does not alter responsibility of Contractor to complete all Work in accordance with Contract Documents.

Contractor will complete or correct Work
by: _____

CONTRACTOR: _____
BY: _____ DATE: _____

OWNER (agrees) (does not agree) to accept portion designated above separately from rest of Project.

Owner intends to utilize, occupy or take use
on: _____

OWNER: _____
BY: _____ DATE: _____

The Work designated above, has been determined to be:

- ☐ Substantially Complete and a Certificate of Substantial Completion will be issued.
- ☐ Not substantially complete for following reasons: _____

ARCHITECT: HDR Architecture, Inc.
BY: _____ DATE: _____

DISTRIBUTION: ☐ OWNER ☐ ARCHITECT ☐ CONTRACTOR

END OF CONTRACTOR'S NOTICE OF SUBSTANTIAL COMPLETION

CONTRACTOR'S CERTIFICATE OF COMPLETION

PROJECT: _____
ARCH. PROJECT
NUMBER: _____
CONTRACT FOR: _____
CONTRACT DATE: _____

This is to certify that I am an authorized official of, and have been properly authorized by said firm or corporation to certify following:

I know of my own personal knowledge, and do hereby certify on behalf of Contractor,
that Work has been reviewed and thoroughly inspected for compliance with Contract Documents,
that Work has been completed, in accordance with Contract Documents and Contract is fully performed,
that all equipment and systems have been tested and are operating satisfactorily,
that all Contract closeout requirements have been completed satisfactorily and submitted,
know of no substantial reason that insurance will not be renewable to cover period required by Contract Documents,
and Work is ready for final inspection and acceptance.

Attached are three (3) copies of following documents, which are required prior to final payment:

- ☐ Final Application for Payment.
- ☐ Contractor's Affidavit of Payments of Debts and Claims: AIA Document G706.
- ☐ Contractor's Affidavit of Release of Liens: AIA Document G706A.
- ☐ Contractor's Final Release or Waiver of Liens.
- ☐ Consent of Surety (if any) to Final Payment: AIA Document G707.
- ☐ Certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect and will not be canceled or allowed to expire until at least thirty (30) days' prior written notice has been given to Owner.
- ☐ The list(s) of if items which were to be completed and corrected, with each item initialed to indicate Contractor has verified completion or correction of each.
- ☐ List of subcontractors and equipment suppliers.
- ☐ Certified list of all sales and service taxes paid.
- ☐ Letter of site conformance by licensed surveyor.
- ☐ If required by Owner, other data establishing payment or satisfaction of obligations arising out of Contract.
- ☐ Bond satisfactory to Owner to indemnify Owner against liens from Subcontractors.
- ☐ Transmittal indicating Owner has received Project Record Documents.

I understand that acceptance of final payment by Contractor, a Subcontractor or material supplier shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at time of final Application for Payment.

CONTRACTOR BY: _____
:
TITLE: _____ DATE: _____

Subscribed and sworn to me _____ day of _____
this _____

NOTARY PUBLIC: _____

My commission _____
expires: _____

DISTRIBUTION: ☐ OWNER ☐ ARCHITECT

END OF CONTRACTOR'S CERTIFICATE OF COMPLETION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Contract Closeout Information:
 - 1. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE MANUALS

- A. Assemble data indicated and data required to completely describe operation and maintenance procedures.
- B. Assemble information in form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Index files by specification section, with each item clearly labeled.
 - 2. Identify each volume with Project name and contents.
 - 3. Identify each item in manner consistent with names and identification numbers used in Contract Documents, not with manufacturer's catalog numbers.
 - 4. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- C. Use electronic files prepared by manufacturer where available.
 - 1. Scan paper documents and configure scanned file for minimum readable file size.
- D. Include each item on Table of Contents.

2.2 DATA REQUIRED FOR EQUIPMENT AND SYSTEMS

- A. Sequence of Operation:
 - 1. List valves, switches, etc., used to start, stop and adjust systems.
 - 2. Provide flow diagrams, control sequences and valve directory.
 - 3. Submit valve directory for review prior to inclusion in manual:
 - a. Show valve number, location.
 - b. List equipment controlled.
- B. Lubrication Instructions:
 - 1. Frequency of inspection and lubrication recommended.
 - 2. Type of grease.
 - 3. Amount of lubrication recommended.
- C. Maintenance and Troubleshooting Data:
 - 1. Manufacturer furnished data.
 - 2. Project record wiring diagrams.
 - 3. Name and address of manufacturer.
 - 4. Name and address of local representatives who stock or distribute repair parts.

2.3 DATA REQUIRED FOR FINISH MATERIALS

- A. Maintenance Data:
 - 1. Precautions necessary.

2. Manufacturer's instructions and recommendations.
3. Maintenance materials and tools required.
4. Repair and/or replacement instructions.
5. Name and address of manufacturer.
6. Name and address of local supplier of materials.

PART 3 - EXECUTION

3.1 DELIVERY

- A. Deliver electronic copies to Owner sixty (60) days prior to Owner instruction of systems and equipment, and substantial completion.
- B. Use Operation and Maintenance Data Transmittal form at end of this Section.
- C. Acquire Owner's acceptance of items listed on transmittal form.
- D. Forward copy of transmittal form with Owner's acceptance to Architect.

END OF SECTION

OPERATION AND MAINTENANCE DATA TRANSMITTAL

Project:

To Owner:

Date:

From C.M./Contractor:

Assemble data required to describe operation and maintenance procedures. Deliver as an indexed electronic PDF file. Include name, address, and phone number of closest supplier for each item.

Section	Description	Quantity

Owner's Verification and Acceptance

Accepted by: _____

Date: _____

Forward copy of this transmittal to the Architect.

DISTRIBUTION: ☐ OWNER ☐ CONTRACTOR ☐ C. M. ☐ ARCHITECT

END OF TRANSMITTAL

SECTION 01 78 36

WARRANTIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Warranties specified in Divisions 02 through 48 Sections shall be in addition to and run concurrent with other warranties required by Contract Documents.
 - 1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to the Owner.
 - 2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for the Owner.
- B. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of Contract Documents.
- C. Manufacturer's Warranties:
 - 1. Provide for products, equipment, systems, and installations required by Divisions 02 through 48 Sections of Contract Documents for duration indicated.
 - 2. Where manufacturer's standard warranties or guarantees or both expire before duration required by other Sections of Contract Documents, obtain and pay for extensions as part of Contract Price.
- D. Special Warranties:
 - 1. Refer to Divisions 02 through 48 Sections for specific content requirements and particular requirements for submitting special warranties.
 - 2. Provide written Special Warranties for products, equipment, systems, installations, and joint responsibilities as noted and required by Divisions 02 through 48 Sections of Contract Documents for duration indicated.
 - 3. Prepare a written document that contains appropriate terms and identification, ready for execution.
 - a. Modified and properly executed Manufacturer's standard form to include project specific information.
 - b. Submit draft for approval before final execution.
 - 1) See Section 01 33 00.
- E. Provide Warranties, Special Warranties and Guarantees prior to final payment.
 - 1. Provide in electronic data format.
 - a. Coordinate format with Owner.
- F. Warranties, Special Warranties and Guarantees required by Contract Documents shall commence on date of Substantial Completion of Work unless otherwise indicated in Certificate of Substantial Completion.

1.2 SUBMITTALS

- A. Contract Closeout Information:
 - 1. Transmittal letter indicating Owner's receipt of electronic data format containing product equipment and system warranties or guarantees or both required by other Sections of Contract Documents.

1.3 JOB CONDITIONS

- A. If for any reason, Contractor cannot warrant or guarantee or both any portion of Work using products or construction methods indicated or required by other Sections of Contract

Documents, notify Architect in writing during bid period, and before contracts are awarded, indicating reasons and names of products and data on substitutions that can be warranted or guaranteed or both.

1. Should Contractor fail to notify Architect, Contractor will be considered as having agreed to warrant or guarantee the Work indicated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRODUCT, EQUIPMENT AND SYSTEM WARRANTIES AND GUARANTEES

- A. Compile approved warranties and guarantees or both required by other Sections of Contract Documents.
 1. Index by Section, with each warranty, guarantee, or both clearly labeled.
 - a. Identify each volume with project name and contents.
 2. Identify each warranty or guarantee or both in manner consistent with names and identification numbers used in Contract Documents.
 3. Provide transmittal letter containing:
 - a. Date
 - b. Project title
 - c. Contractor's name and address
 - d. Title and number of warranties, guarantees, or both.
 - e. Indication of Owner's receipt
 4. Deliver to Owner prior to final payment with copy of transmittal letter indicating Owner's receipt.

END OF SECTION

SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. All documents required by Contract Documents, including but not limited to:
 - 1. Contract Drawings.
 - 2. Project Manual and Specifications.
 - 3. Addenda.
 - 4. Shop Drawings.
 - 5. Product Data.
 - 6. Samples and Mock-ups.
 - 7. Project Information.
 - 8. Change documents.
 - 9. Request for Information responses, directives, clarifications, interpretations, etc.
 - 10. Field test records.
 - 11. Warranties.
- B. Field Documents:
 - 1. Complete set of all documents required for construction.
 - 2. Used for construction of project.
- C. Periodic Update Documents:
 - 1. Complete separate set of all documents required for construction, with exception of samples and mock-ups, used for posting and updating on weekly basis.
 - 2. Do not use for construction of project.
- D. Project Record Documents:
 - 1. Complete set of all documents required for construction, with exception of samples and mock-ups, for updating at end of Project.

1.2 SUBMITTALS

- A. See Section 01 33 00 for Submittal Procedures.
- B. Contract Closeout Information:
 - 1. Copy of transmittal letter to Owner.
 - a. At completion of project, turn over Project Record Documents to Owner with letter of transmittal.
 - b. Submit Record Documents in suitable containers.
 - c. Provide Transmittal Letter containing:
 - 1) Date.
 - 2) Project title.
 - 3) Contractor's name and address.
 - 4) Title and number of each Project Record Document.
 - 5) Certification that Project Record Documents submitted are complete, accurate and reflect actual construction of project.
 - 6) Owner's signature indicating receipt and acceptance of Project Record Documents.
 - 2. Electronic copy of Record Drawing files to Architect.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 POSTING PRIOR TO CONSTRUCTION

- A. After Contract is executed, but prior to start of construction, obtain Contract Drawings and Project Manual/Specifications that will be used for Field Documents and Periodic Update Documents.
- B. Obtain copies of all addenda and post to all above documents.

END OF SECTION

SECTION 01 91 13
GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work described in this section includes the formal and comprehensive commissioning process and responsibilities of the Owner, CxA (Owner selected Commissioning Authority), General Contractor and subcontractors/vendors. These participants shall work together as a Commissioning Team to complete all commissioning requirements:
1. A Commissioning Authority (CxA) will be designated by the Owner to oversee and approve the completion of all commissioning activities. The CxA has the overall responsibility for planning, coordinating, and executing the commissioning process with all of the parties participating in the commissioning process. This includes the Owner, construction manager, facility operator, architect, engineer, general contractor, subcontractors, specialty subcontractors, equipment suppliers, vendors, authorities having jurisdiction and other entities as required.
 2. The General Contractor is responsible for designating a person as the Contractor Commissioning Specialist (CxC). The CxC has the overall responsibility of policing and coordinating all commissioning tasks assigned to the General Contractor and each Subcontractor Commissioning Coordinator (CC). The CxC shall have the authority to make decisions for the General Contractor in regard to the commissioning process. The CxC shall represent the General Contractor as the liaison between all Subcontractor CC's and the CxA. The CxC shall act as the focal point for gathering and coordinating Subcontractor communications, scheduling and document management directly related to the commissioning process.
- B. Commissioning is the process to verify to the Owner that systems, equipment, mechanical, electrical, controls and special systems function together properly to meet performance requirements and design intent, and as described in the Contract Documents. The General Contractor and CxC shall be responsible for executing and performing the commissioning process as outlined in this specification and in references and attachments throughout the Contract Documents. The Contractor shall furnish labor and materials sufficient to meet all requirements of building commissioning under this contract. The commissioning process is not intended to conflict with applicable building codes. Apparent conflicts shall be brought to the attention of the Owner and CxA for resolution.
- C. The General Contractor and CxC shall identify discipline Commissioning Coordinators (CC). This shall include naming a representative coordinator from each of the subcontractor entities. Each CC shall participate as a member of the project Commissioning Team.
1. Each CC shall coordinate their commissioning efforts and the efforts of their vendors with the CxC. This includes providing timely response to issues regarding their discipline/company.
 2. Each CC is responsible for providing scheduling input to the CxC on all activities that effect installation, start-up, TAB, functional performance testing, operator training, warranty, and project closeout.
 3. The CxC shall coordinate the CC commissioning activities and communicate the status of each activity to the CxA and Commissioning Team.
- D. The CxC will work with the General Contractor and commissioning coordinators to establish a Commissioning Schedule. The CxC will provide a draft schedule of primary commissioning events to the CxA and Owner for review no later than 60 days after Notice to Proceed. The draft schedule will be reviewed at the commissioning kickoff meeting, with a final schedule presented to the CxA for review and to the Owner for approval. As construction progresses, detailed schedules are more fully developed by the commissioning team.

- E. Details of the commissioning process and procedures will be incorporated into a final Commissioning Plan. The plan will be coordinated and implemented by the CxA.
- F. Construction phasing requirements that effect the commissioning process will be addressed in the final Commissioning Plan and adhered to by the General Contractor.

1.2 COMMISSIONING STANDARD

- A. The publication listed below forms a part of this specification to the extent that it outlines the procedures that are required to properly commission the facility.

ASHRAE Guideline 0-2005

Commissioning Process Guideline

1.3 SIMILAR TERMS

- A. In some instances, terminology differs between the Contract and the Commissioning Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results. Contract requirements take precedent over the corresponding ACG requirements where differences exist.
- B. References to Functional Performance Tests (FPT) are included in other specification sections that are directly related to the commissioning process. The contractor shall be responsible for coordinating all installation, start-up, testing, and verification requirements with the requirements outlined in this specification. Where these requirements overlap or may otherwise result in a duplication of effort, the contractor shall notify the Owner and CxA, complete with supporting documentation, for review and assessment.

1.4 QUALIFICATIONS OF COMMISSIONING SPECIALIST (CXC)

- A. The CxC shall possess the qualifications of an individual specializing in the commissioning of building systems of similar scope and complexity to those of this project.
- B. The CxC shall have a minimum of 5 years' experience as a project manager or project superintendent responsible for the coordination of mechanical, electrical, and plumbing systems installation, testing, and warranty repair work. The General Contractor shall immediately notify the Contracting Officer if a change of CxC personal is necessary. The General Contractor shall then resubmit qualifications of the replacement CxC for Owner review and approval.
 - 1. The CxC shall have documented experience with working on similar projects that include Commissioning requirements and the presence of an Owner selected CxA.
 - 2. Where a single individual does not have the required experience in commissioning of both mechanical and electrical system, multiple individuals with the necessary qualifications may be submitted for approval as CxC assistants under the direct management of a designated Lead CxC.

1.5 RELATED DOCUMENTS

- A. All provisions of the Contract Documents (drawings/specifications and performance criteria) apply to the work in this section. Conflicting requirements shall be brought to the Owner's attention in writing prior to completion of the bidding phase. Owner will provide clarification in a timely manner.
- B. The following specifications may contain additional installation, testing and acceptance requirements. Interpretation of these specifications by themselves will not provide relief from the requirements stated in all other areas of the contract documents:
 - 1. Division 01 Section 01 9113 GENERAL REQUIREMENTS
 - 2. Division 22 Section 22 0816 COMMISSIONING OF PLUMBING SYSTEMS
 - 3. Division 23 Section 23 0816 COMMISSIONING OF MECHANICAL SYSTEM
 - 4. Division 25 Section 25 0816 COMMISSIONING OF INTEGRATED AUTOMATION

1.6 SUBMITTALS

- A. Submittals with a "CxA" require Commissioning Authority approval while other submittals listed are required for information only. The General Contractor shall review and approve all submittals before they are reviewed by the CxA. Submit the following:
1. Commissioning Schedule; CxA
 - a. Prepared by the General Contractor and CxC. A preliminary commissioning schedule shall be provided by the General Contractor no later than 90 days after Notice to Proceed. The schedule shall include 6 specific milestones for each piece of commissioned equipment, i.e. installation completed, start-up date, point-to-point completed, TAB completed, FPT readiness, and date of operator training. The schedule shall be updated weekly during the commissioning process.
 2. Commissioned Equipment Naming Convention and I.D. Tagging; CxA.
 - a. The Contractor and subcontractors shall develop an integrated equipment naming convention with unique I.D. tag number for each piece of commissioned equipment. The naming convention used on the Bid Documents shall be revised to comply with the Owner's final naming convention for each type of equipment and location. Electronic drawing files used for the bid documents shall be provided to the Contractor, and the Contractor shall update the electronic drawing files with the new I.D. tag numbers and then submit for approval. The approved I.D. numbering scheme shall be used by the Contractor, subcontractors, vendors and suppliers on all submittals and project closeout documentation, including O&M Manuals and documents provided to the Commissioning Authority (CxA). The updated electronic drawing files with I.D. tag numbers shall be approved prior to submitting other equipment/system submittals scheduled for commissioning.
 3. Functional Performance Test Sheets Review Comments; CxA
 - a. Draft Functional Performance Tests (FPTs) will be prepared by CxA. The FPTs will be similar to the complexity illustrated by the sample FPTs included in the Appendix. The CxC and General Contractor shall review the material and return with comments within 30 days. The CxA will update the FPTs with revisions approved by the Owner and integrated testing information included in the approved control system sequence of operation submittals. Draft FPTs will be completed only after all relevant equipment submittals and control sequences have been approved. Final FPTs will be provided to the contractor at least 45 days prior to beginning the functional acceptance tests. Refer to Section 3.1 Systems to be Commissioned for a complete list of all systems and equipment that is included within the commissioning scope.
 4. Final Control System Sequence of Operations;
 - a. The contractor shall provide electronic PDF copies of all final Control System Sequence of Operations. The final control sequence of operation shall reflect all input from contractor, designer, and commissioning provider submittal comments and integration meetings. The contractor shall notify the CxA to acknowledge completion.
 5. Control System Equipment Diagrams;
 - a. The contractor shall provide electronic PDF copies of all final Equipment Wiring Diagrams. These equipment diagrams shall be representative of all control components and devices included in the final sequence of operation.
 6. Equipment Submittals;
 - a. For commissioned systems and components only, provide to Owner and CxA for review and comment simultaneously with timing of Owner's/AE's review of all other project equipment/material submittals. The CxA will provide all comments back to the A/E team in advance of the submittal return date. The A/E team will review and incorporate the CxA submittal comments and/or comment back to the CxA. The CxA will incorporate approved data into PFCs and FPTs.
 7. Testing, Adjusting, Balancing (TAB) Procedures and Reports;
 - a. The contractor shall submit test procedures for any specialty testing considered outside of the normal TAB trade association recommended procedures. Preliminary air/hydraulic

TAB reports shall be supplied directly to the Owner or CxA upon request. Final TAB report shall be submitted no later than 7 days prior to beginning system functional performance tests. TAB backchecks will be performed prior to beginning the system functional tests.

8. Fire Alarm / Smoke Control System Test Plan and Report;
 - a. The contractor shall submit the Fire Alarm and Smoke Control system test plan, including FA/smoke control matrix, no later than 90 days prior to beginning F/A field testing. Final test report shall be submitted to the Owner, CxA, and the designated Fire Protection Engineer for approval.
9. Manufacturer Startup Reports;
 - a. The contractor shall provide electronic PDF copies of all completed Manufacturer Startup Reports.
10. BMCS Point-to-Point Checkout Sheets;
 - a. The contractor shall provide electronic PDF copies of all completed BMCS Point-to-Point checkout sheets.
11. Contractor Commissioning Specialist (CxC); CxA
 - a. Submit CxC's qualifications and supporting documentation no later than 21 days after Notice to Proceed. The documentation shall include similar project complexity, supervisory experience, project experience, dates, employers, and reference names/phone numbers.
12. Test Equipment Calibration Certificates;
 - a. Submit no later than 30 days prior to beginning the pre-functional installation and start-up checks. Updated certificates shall be provided prior to expiration dates. Calibration expiration dates must be after the date of occupancy.

1.7 TRAINING OF OWNER'S OPERATING PERSONNEL; CXA

- A. Submit dates and proposed training agenda for each type of equipment and system no later than 90 days prior to scheduled completion of functional acceptance tests. Training shall include the O&M Manuals for reference, as well as hands-on and classroom instruction manuals. All training sessions shall be professionally recorded video, recorded edited and submitted for approval. A microphone shall be used at all times by the instructor. All questions asked by the audience shall be repeated back by the instructor to ensure clarity on the audio file. Complete training prior to Substantial Completion and commencement of Warranty period.

1.8 ABBREVIATIONS

- A. A/E: Architect/Engineer
- B. BOD: Basis of Design
- C. Cx: Commissioning
- D. CxA: Commissioning Authority (independent commissioning authority designated by the Owner)
- E. CxC: General Contractor commissioning specialist
- F. CC: Commissioning Coordinator(s)
- G. CM: Construction Manager (the Owner's Representative)
- H. FPT: Functional Performance Test
- I. MEP: Mechanical/Electrical/Plumbing
- J. O&M: Operations and Maintenance
- K. OPR: Owners Project Requirements
- L. PM: Project Manager (Company Representative)
- M. Sub: Subcontractor(s)

- N. TAB: Testing, Adjusting, and Balancing
- O. VAV: Variable Air Volume
- P. VFD: Variable Frequency Drive

1.9 DEFINITIONS

- A. Acceptable Performance: A component or system being able to meet specified design parameters under actual load including satisfactory documented completion of all functional performance tests, control system trending and resolution of outstanding issues.
- B. Acceptance Phase: The phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and training occurs.
- C. Architect/Engineer: Architect & Engineer of record
- D. Areas of Conflict: Where commissioning requirements conflict with design provisions or other requirements of the Contract Documents, prompting issuance of a request for clarification.
- E. Basis of Design (BOD): A document prepared by the engineer of record that records concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements (OPR) and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- F. Commissioning: Documented confirmation that building systems function in compliance with criteria set forth in the Contract Documents, OPR and BOD. The process documents all required user training and O&M materials have been properly provided.
- G. Commissioning Authority (CxA): An independent entity designated by the Owner, not associated with the General Contractor. This entity oversees and approves the completion of all General Contractor and CxC commissioning activities.
- H. Commissioning Coordinator (CC): This entity is a representative of the contractor/a subcontractor who is empowered to make timely decisions as they pertain to commissioning, for his/her discipline/company. The CC is responsible for providing scheduling input on all the activities related to his/her Scope-of-Work that effect installation, start-up, TAB, functional performance testing, operator training, warranty, and project closeout.
- I. Commissioning Plan: A document prepared by the CxA and approved by the Owner that outlines the Cx team organization, communication paths, schedule, allocation of resources, matrix of responsibilities, installation/testing requirements, and documentation requirements of the commissioning process.
- J. Commissioning Report: The Commissioning Report is prepared by the CxA and will consist of an executive summary of the process. The Commissioning Report includes inspection reports, start-up reports, TAB verification reports, start-up and functional test reports. The results of failed tests will be included along with a description of the corrective actions taken.
- K. General Contractor Commissioning Specialist (CxC): Hired or employed by the General Contractor, this person or entity coordinates the execution of commissioning activities with all of the parties participating in the commissioning process. This includes the Owner, CxA, construction manager, facility operator, architect, engineer, general contractor, subcontractors, specialty subcontractors, equipment suppliers, vendors, authorities having jurisdiction, and other entities as required.
- L. Contract Documents: The documents binding on parties involved in the construction of this project (drawings, specifications, performance criteria, change orders, amendments, contracts, Cx plan, etc.).
- M. Contractor: The General Contractor and subcontractors/vendors.
- N. Control System: The building energy management and automated control system.
- O. Construction Manager: The Owner's representative.

- P. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the contract documents or OPR.
- Q. Design Intent: A dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the Owner. It is initially the outcome of the programming and conceptual design phases.
- R. Functional Performance Test (FPT): The FPTs are prepared by the CxA, coordinated with the CxC/General Contractor, and approved by the Owner. The tests are used by the CxC/General Contractor to document the full range of checks and tests carried out to establish that all components, sub-systems, systems, and interfaces between systems function in accordance with the Contract Documents. In this context, "function" includes all modes and sequences of control operation, all interlocks and conditional control responses and all specified responses to abnormal emergency conditions. The CxA develops the written functional test procedures form in a sequential format and then coordinates and documents the actual testing which is usually performed by the installing contractor or vendor. Functional performance testing takes place after pre-functional (installation and start-up) tests have been completed and approved by the CxC and Owner.
- S. Issues Log: A list of systems/equipment or procedural deficiencies and/or issues that have been noted. The list is prepared by the CxA and provided to the CxC at regular intervals. It includes the current disposition of each issue and the date of final resolution. Deficiencies include products/material, installation, service, or systems/equipment performance that do not comply with the Contract Documents and/or Commissioning Plan.
- T. O&M Manuals: Manuals used for the training, operations, and maintenance of systems & equipment. Manufacturer's data should be editing such that the O&M materials include information specific to this project.
- U. Owner: Entity with the highest level of responsibility for directing the project.
- V. Owner-Contracted Tests: Tests paid for by the Owner outside the contractor's contract.
- W. Owner's Representative: Construction Manager or other individuals with the authority to make contractual decisions on behalf of the Owner. The Commissioning Plan should be kept up to date by the CxA to include the names/contact information for each of the Owner's representatives.
- X. Owner's Project Requirements (OPR): Non-technical document developed by the Owner, architect, and engineers. It is updated at regular intervals to state the intended concepts, goals, budget, performance, and other criteria to which the completed project must conform. It includes expectations of how the building will be used and operated. This document is the basis for building commissioning. It is used by the engineers to develop their basis of design documentation.
- Y. Project Manager (PM): A staff position for a particular entity with decision making authority.
- Z. Seasonal Performance Tests: Functional performance tests that are deferred until system design conditions can be replicated or simulated.
- AA. Specifications: Part of the contract documents that supplement the design drawings and related performance criteria. Specifications include procedures implied in the Commissioning Plan.
- BB. Start-up: The initial start-up or activation of dynamic equipment.
- CC. Subcontractor: Members of the construction team providing a service or product that are contracted by the General Contractor.
- DD. Training: Organized instruction and hands-on demonstration of operating and maintaining systems and equipment.
- EE. Trending: Monitoring of equipment and sequences using the building control system or data loggers.
- FF. Vendor: Suppliers of equipment or service.

1.10 DUTIES OF CONTRACTOR COMMISSIONING SPECIALIST (CXC)

- A. The primary role of the CxC is to coordinate and police execution of the Commissioning Plan with the General Contractor and each Subcontractor Commissioning Coordinator (CC) through the organization and leadership of the project commissioning team.
- B. The CxC is not responsible for the design concepts, design criteria, code compliance, code inspections, construction scheduling, cost estimating, or construction management.
- C. Obtain copies of all shop drawings, manufacturer's literature, maintenance information or other information as may be needed for systems to be commissioned.
- D. Collect the information needed for development of a complete Commissioning Plan and functional performance test procedures as requested by the CxA.
- E. Obtain all proposed start-up documentation.
- F. Obtain updates to all project documentation to reflect all supplemental instructions, addenda or other revisions to the project construction documents.
- G. Obtain submittals for all systems to be commissioned including control systems, wiring diagrams and narrative sequences of operation, in time for use in preparing the Functional Test Procedures.
- H. Obtain preliminary TAB report, indicating all actual field values recorded, prior to initiation of functional testing.
- I. Obtain complete operation and maintenance information and as-built drawings for verification, organization, and distribution.
- J. Coordinate and assist with the Preliminary and Final Commissioning Plans with the CxA.
- K. As part of Final Commissioning Plan, review the Functional Test Procedures prepared by the CxA with information gathered from Contract Documents and final equipment submittals including narrative sequences of operation, control diagrams and software code for execution with the assistance of Contractor staff as required. Sample documents, located in the Appendix, are examples representing the scope and rigor of the commissioning procedures required, and shall be used as the basis for developing the detailed checklists and functional performance test procedures.
- L. Schedule, direct and witness all 'Pre-Testing' of the FPT scripts prior to final witness and testing by the CxA, as defined in the Commissioning Plan and Functional Test Procedures. All 'Pre-Testing' shall be performed by the Contractor and subcontractors and documented by the Commissioning Specialist.
- M. Attend commissioning scoping meetings. These meetings shall further define the testing requirements and participation of each entity with the CxC and CxA.
- N. Attend regular meetings to facilitate the commissioning process during the installation & startup period, and weekly meetings during the functional testing period. Attend other meetings as required when problems arise.
- O. Provide site observation, FPT 'Pre-Testing' or other project reports in a timely manner.
- P. Document inconsistencies or deficiencies in system operations and system compliance. System deficiencies shall be forwarded to the Owner and CxA and documented in the CxA Issues Log.
- Q. Coordinate the participation of Owner's personnel with equipment, component and systems performance verification and participation in required training.
- R. Coordinate and document training of Owner personnel on commissioning systems and equipment. CxC shall review all training materials prior to actual training sessions.
- S. Provide CxA with Systems Manual materials that will provide operating staff the information needed to understand and optimally operate the commissioned systems.
- T. Coordinate and conduct seasonal/deferred tests. Coordinate activities all participants and report results to the Owner and CxA.

- U. Participate and assist the CxA with a review of the building operation within ten months after substantial completion with building operation, maintenance staff, and occupants.

1.11 DUTIES OF GENERAL CONTRACTOR AND COMMISSIONING COORDINATORS (CC)

- A. Attend commissioning scoping meetings. These meetings shall further define the testing requirements and participation of each entity with the CxC and CxA.
- B. Attend regular meetings to facilitate the commissioning process during the installation and startup period, and weekly meetings during the functional testing period. Attend other meetings as required when problems arise.
- C. Coordinate with the CxC and prepare a Commissioning Schedule. Allow sufficient time before functional performance test dates so that testing, adjusting and balancing activities for each system can be completed. Submit the Commissioning Schedule for Owner and CxA review and approval.
- D. The Commissioning Schedule shall include several important milestones for each piece of commissioned equipment and system; Milestones include installation, start-up, point-to-point checkout, TAB, functional performance test, and operator training. Provide a separate matrix indicating the length and start of warranty period for each commissioned building component, equipment and system.
- E. Attend special meetings intended to clarify the controls sequences of operation and reconcile any differences with the design intent after the first sequence of operations is submitted and reviewed.
- F. Provide equipment data required for development and finalization of the (FPT) procedures.
- G. The General Contractor or relevant Subcontractor shall be responsible for operating and manipulating all commissioned systems and equipment throughout the commissioning phase.
- H. Develop a comprehensive start-up plan for all commissioned systems. The start-up plan shall be developed with the help of the CxC and integrated with the commissioning plan.
- I. The controls contractor shall be responsible for coordinating development of a point-to-point verification plan. The plan shall be developed with the help of the CxC and integrated with the commissioning plan.
- J. The electrical prime contractor shall provide the necessary power to allow mechanical equipment start-up activities to be accomplished according to the approved schedule. Certified personnel shall be provided who are able to conduct specialized testing of electrical power and lighting systems.
- K. The mechanical contractor shall be responsible for installing pressure/temperature test ports (i.e. - Pete's plugs) in all piping systems locations where DDC controls pressure/temperature sensors and transmitters are located.
- L. Use the Functional Performance Tests prepared by the CxA.
- M. Provide skilled technicians familiar with the project for start-up and functional performance testing.
- N. Provide CxA access to building automation system prior to, during, and after functional performance testing for viewing system operation, creating trends, and viewing trends throughout the first year of operation.
- O. Correct deficiencies found during startup and functional performance testing in a timely manner to allow for re-testing activities within the commissioning schedule.
- P. Provide all equipment submittals, equipment start-up forms, field static testing reports (i.e. circuit breaker test reports, megger test reports, torque testing reports, etc.) to the CxC and CxA for review and approval.
- Q. Report TAB deficiencies to the CxC and CxA. The mechanical contractor shall correct the deficiencies in a timely manner so that functional performance tests can be completed on schedule. The cost of belt and sheave changes shall be included in the bid base price.

- R. TAB contractor shall coordinate with the CxC and CxA and provide all set-point value requirements for input into the controls system; including minimum outside air damper positions, return/supply fan VFD speed mapping, pumping loop differential pressure setpoints, duct system static pressure setpoints, air terminal unit flow sensor calibration factors, etc.
- S. Maintain and update as-built drawings each week during construction, including as-builts for the control system.
- T. Set up and maintain system trends for monitoring and troubleshooting purposes to aid in functional testing and project closeout.
- U. Final O&M manuals shall incorporate all equipment/system changes, including changes related to the control system sequence of operations.
- V. Provide operations staff training as required under each individual specification section and for the commissioned equipment and systems specified under this section. Agendas and content of training sessions shall be pre-approved by the CxA and Owner.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide the skilled technicians and all test equipment necessary to complete the start-up and functional performance test commissioning requirements of all commissioned equipment, components, and systems. Submit documentation showing calibration certificates are current for all test equipment.
- B. Provide the skilled technicians and all test equipment necessary to complete the preliminary and functional performance test commissioning requirements. Submit documentation showing calibration certificates are current for all test equipment.
- C. Provide all specialized or proprietary test equipment and software required by equipment/system vendors and manufacturer to complete the testing and commissioning requirements. The equipment shall be provided by the contractor at no additional cost to the Owner and shall become the property of the Owner upon system acceptance. When required, the manufacturer/vendor shall demonstrate use of the test equipment and assist the contractor and CxA in the commissioning process.
- D. All test equipment shall utilize Standard measurements unless otherwise required by the CxC or Owner.

PART 3 - EXECUTION

3.1 SYSTEMS TO BE COMMISSIONED

- A. The systems listed below shall include any subsystems, components, or peripheral devices that form a complete functional system, including any associated controls and control equipment. The systems and equipment identified below will include their own specific pre-functional checklists and functional performance test procedures provided by the CxA.
 - 1. Building Management and Control System
 - a. Control Panels and Controllers
 - b. Wiring and Devices
 - c. Sensors, Indicators, Transmitters and Devices
 - d. Actuators and Control Valves
 - e. Control Dampers and Smoke Dampers
 - f. Power Systems (Emergency Power and UPS)
 - g. Interface with Fire Alarm System
 - h. Interface with 3rd Party Equipment
 - i. I/O Point Schedule
 - j. Sequence of Operation and Programming for all equipment and systems identified.

- k. Software for all modes of operation (normal, unoccupied, emergency shutdown, load shedding, smoke, pandemic, failure, and alarm)
 - l. Equipment alarm points
 - m. Graphic user interface
- 2. Mechanical Systems
 - a. Air and Water flow measuring stations
 - b. Ground Source water circulation pumps and VFD's
 - c. Exhaust and Transfer Fans
 - d. Packaged Ventilation Air Handling Unit system
 - e. Boiler and Heating System Control
 - f. Above Ceiling Ground Source Heat Pump units (Typ of All)
 - g. Mini-split Cooling Units
- 3. Plumbing Systems
 - a. Sump pump.
 - b. Grinder pump.

3.2 WORK PRIOR TO COMMISSIONING

- A. A commissioning plan will be developed and finalized by the CxA, with assistance from the CxC/General Contractor and submitted to the Owner for approval. The CxC and CCs are obligated to assist the CxA in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation, identification of parties responsible for startup activities, and schedule dates for equipment start-up and testing activities.
- B. Complete all phases of work so each system can be started, fully tested, adjusted, balanced, and otherwise commissioned to the satisfaction of the CxA. The contractor has primary start-up responsibilities with obligations to complete systems, including all sub-systems, so they are fully functional. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, change orders, etc.
- C. If during functional testing there are system changes have been made that alter the commissioning process, the CxC shall submit the changes to the CxA for review, who will submit to the Owner for approval.

3.3 MEETINGS

- A. Commissioning Meeting: within 60 days of contract award, the CxA will schedule and conduct a commissioning meeting with the entire commissioning team including representatives of all subcontractors that will be involved in commissioning activities. The purpose of the meeting is to review commissioning requirements, procedures, and documentation.
- B. Other meetings may be scheduled and conducted by the CxA as construction progresses for the purposes of coordination, deficiency resolution, and planning. These meetings shall be independent from the regularly scheduled construction progress meetings and shall be attended by members of the commissioning team as dictated by the CxA or Owner.
- C. The control contractor shall attend a controls coordination meeting with the mechanical engineer, CxA, and owner to review the control submittal and final sequence of operation. This meeting shall take place prior to final approval of the submittal containing sequence of operations.

3.4 NOTIFICATION OF SYSTEM COMPLETION

- A. 30 days prior to the beginning of start-up or test activities for each system, the CxC shall provide a detailed look-ahead schedule. This schedule shall be updated weekly and shall provide information to include date, time, beginning location, and anticipated duration of each start-up or test activity. CxC shall notify the CxA in writing at least 72 hours in advance of any

changes to this schedule. The Owner and CxA shall reserve the right to witness any equipment start-up by the manufacturer's representative. The CxC shall document start-up of all equipment and provide information to the CxA.

- B. When systems are ready for final commissioning verification, CxC shall notify the CxA, in writing, at least 72 hours in advance.

3.5 EQUIPMENT STARTUP

- A. Startup equipment as specified in the Contract Documents. Provide manufacturer representation to start up equipment where specified to do so.
- B. Provide startup reports to the CxA at the completion of startup. Reports shall include at a minimum the equipment tag number per final naming convention, equipment location, model number, serial number, any and all parameters, readings and setpoints such as pressure, flow, voltage, amperage, time delay, relevant to the proper operation of the equipment.

3.6 FUNCTIONAL PERFORMANCE TESTING

- A. A functional test is required for each item of equipment, system, or other assembly specified to be commissioned, unless sampling of multiple identical or near-identical units is allowed by the final test procedures.
- B. Contractor is responsible for execution of required functional tests, after completion of prefunctional checklist, DDC point to point checks/verification and TAB completion.
- C. Contractor is responsible for correction of deficiencies and re-testing at no extra cost to The Owner; if a deficiency is not corrected and re-tested immediately, the commissioning authority will document the deficiency and the contractor's stated intentions regarding correction.
 - 1. Deficiencies are any condition in the installation or function of a component, piece of equipment or system that is not in compliance with the contract documents or does not perform properly.
 - 2. When the deficiency has been corrected, the contractor shall update a copy of the issues log and submit it back to the CxA certifying that the item is ready to be re-tested. The commissioning authority will reschedule the test and the Contractor shall re-test.
 - 3. Identical or Near-Identical Items: If 10 percent, or three, whichever is greater, of identical or near-identical items fail to perform due to material or manufacturing defect, all items will be considered defective; provide a proposal for correction within 2 weeks after notification of defect, including provision for testing sample installations prior to replacement of all items.
 - 4. Contractor shall bear the cost and expense of the Owner and commissioning authority personnel time witnessing re-testing.
 - 5. Contractor shall bear the cost of the Owner and commissioning authority personnel time witnessing re-testing if the test failed due to failure to execute the relevant prefunctional checklist correctly; if the test failed for reasons that would not have been identified in the prefunctional checklist process, contractor shall bear the cost of the second and subsequent re-tests.
- D. Functional Test Procedures:
 - 1. Some test procedures are included in the contract documents; where functional test procedures are not included in the contract documents, test procedures will be determined by the commissioning authority with input by and coordination with contractor.
 - 2. Examples of Functional Testing:
 - a. Test the dynamic function and operation of equipment and systems (rather than just components) using manual (direct observation) or monitoring methods under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint).
 - b. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc.

- c. Systems are run through all the HVAC control system's sequences of operation and components are verified to be responding as the sequence's state.
 - d. Traditional air or water test and balancing (TAB) is not Functional Testing; spot checking of TAB by demonstration to the Commissioning Authority is Functional Testing.
- E. Deferred Functional Tests: Some tests may need to be performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions; performance of these tests remains the contractor's responsibility regardless of timing.
- F. Provide skilled technicians to execute starting of equipment and to execute the Functional Tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments, and problem-solving.
- G. Provide all necessary materials and system modifications required to produce the flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test condition.
- H. Manual Testing: Use hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- I. Simulating Conditions: Artificially create the necessary condition for the purpose of testing the response of a system; for example, apply hot air to a space sensor using a hair dryer to see the response in a VAV box.
- J. Simulating Signals: Disconnect the sensor and use a signal generator to send an amperage, resistance, or pressure to the transducer and control system to simulate the sensor value.
- K. Over-Writing Values: Change the sensor value known to the control system in the control system to see the response of the system; for example, change the outside air temperature value from 50°F to 75°F to verify economizer operation.
- L. Indirect Indicators: Remote indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100 percent closed, are considered indirect indicators.
- M. Monitoring: Record parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of the relevant control systems; where monitoring of specific points is called for in Functional Test Procedures:
 - 1. All points that are monitored by the relevant control system shall be trended by Contractor; at the Commissioning Authority's request, Contractor shall trend up to 20 percent more points than specified at no extra charge.
 - 2. Parameters should be monitored at no fewer than 5 minute intervals. Up to 1 minute monitoring of trends may be requested by the CxA.
 - 3. At the option of the Commissioning Authority, some control system monitoring may be replaced with data logger monitoring.
 - 4. Provide electronic copies of monitored data in columnar format with time down left column and at least 5 columns of point values on same page.
 - 5. Graphical output is desirable and is required for all output if the system can produce it.
 - 6. Monitoring may be used to augment manual testing.

3.7 DOCUMENTATION

- A. Verification of performance will take place after formal notice from the CC that the following steps have been completed:
 - 1. FPT scripts have been 'pre-tested' and the system and/or equipment is deemed ready for final witnessing and testing by the CxA.

- B. Performance demonstration shall be done by the systems and equipment trade representatives and shall be coordinated by the CxC and witnessed by the CxA.
- C. Verification will include demonstration of performance listed in the FPT sheets prepared by the CxA.
- D. The witnessed performance data shall be added to the FPT sheets at the time of verification.
- E. The Contractor shall notify the CxA and Owner as soon as possible of any issues identified during construction that may affect the commissioning process or final system performance.

3.8 WORK TO RESOLVE DEFICIENCIES

- A. Items such as excessive noise, building thermal/air leakage, improper adjustments, misapplied equipment, and deficient performance of equipment under varying loads will result in additional work being required to complete commissioning of the systems. Whereas all CCs will have input and the opportunity to discuss the work and resolution of problems with the CxC, the Owner and CxA will have final authority for accepting the work plan for achieving acceptable performance of systems and equipment.
- B. Corrective work shall be completed by the General Contractor in a timely fashion to permit the on time completion of the commissioning process per the approved commissioning schedule. When requested by the Owner or CxA, the GC or relevant Subcontractor shall provide a manufacturer's representative at no additional cost to the Owner.
- C. Experimentation to render system performance will be permitted:
 - 1. If the CxC deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the CxC will notify the Owner and CxA indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities.
 - 2. If deadlines pass without resolution of the problem, the CxA and Owner reserve the right to obtain supplementary services and/or equipment to resolve the problem. This process shall not change the General Contractor's warranty obligations for the effected system and/or equipment.
 - 3. Costs incurred to solve the problem in an expeditious manner will be the General Contractor's responsibility.

3.9 RETESTING AND RECOMMISSIONING

- A. Any fault with material/equipment, integrated tests, or in any part of the installation revealed by commissioning tests shall be investigated, replaced, or repaired by the General Contractor.
- B. Commissioning tests shall be repeated at the Contractor's expense until no fault appears and until the repeated test results are approved by the CxA and Owner.
- C. The Contractor will be assessed the actual cost to the Owner for the CxA to witness the 2nd, 3rd and any additional re-testing of a particular piece of equipment or system. Such costs will be deducted from the contract amount due to the Contractor.

3.10 CURRENT FACILITIES REQUIREMENTS AND OPERATION AND MAINTENANCE PLAN

- A. The General Contractor shall assist the CxA by providing documentation for the manual as listed below.
- B. Final assembly of the manual will be the CxA responsibility.
- C. The following information will be required to be provided by the contractor to the CxA in assembling the final manual:
 - 1. Final as built drawings for MEP and building automation.
 - 2. As-built sequence of operation.
 - 3. All control setpoints and any necessary seasonal change requirements.
 - 4. Building occupancy schedule
 - 5. Equipment run time schedules.

6. Preventive maintenance plan
- D. The Designer of record shall assist the CxA by providing the following for the manual.
 1. Minimum outside air requirements

END OF SECTION



DIVISION 02

EXISTING CONDITIONS



SECTION 02 56 19

GAS CONTAINMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This specification section outlines the requirements for the construction of gas containment systems. The work includes furnishing and installing the necessary materials and equipment to construct the gas containment system. The project site contains contaminated soils, reference Section 02 24 00 Environmental Assessment.
- B. The work consists of, but is not limited to, the following:
 - 1. Surface preparation and substrate treatment
 - 2. Construction of the containment structure
 - 3. Installation of gas detection and alarm systems
 - 4. Installation of sub-slab ventilation systems
 - a. Vent riser installation of stub ups
- C. Related sections:
 - 1. Section 01 33 00 - Submittal Procedures
 - 2. Section 01 45 00 - Quality Control
 - 3. Section 01 74 19 - Construction Waste Management and Disposal
 - 4. Section 02 24 00 – Environmental Assessment
 - 5. Section 02 32 00 – Geotechnical Investigation
 - 6. Section 02 41 00 - Demolition
 - 7. Section 02 56 13 - Waste Containment
 - 8. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

1.2 ACTION SUBMITTALS

- A. Shop drawings for the gas containment system, including all necessary details and dimensions. Project-specific drawings showing transitions from flat vent system to circular pipe.
- B. Product data for all materials used in the gas containment system.
- C. Manufacturer's installation instructions for all equipment and materials.
- D. Testing plan for quality control smoke testing of the below-slab membrane.
- E. Test reports for all materials and equipment used in the gas containment system.
- F. Safety data sheets for all chemicals used in the construction of the gas containment system.

1.3 INFORMATIONAL SUBMITTALS

- A. Applicator Certification: Submit written confirmation that the applicator is currently approved by the membrane manufacturer.
- B. Operation and maintenance manuals for all equipment used in the gas containment system.
- C. Record drawings showing the final as-built configuration of the gas containment system.
- D. Warranty documents for all equipment and materials used in the gas containment system.

1.4 STORAGE AND HANDLING

- A. All materials and equipment used in the gas containment system shall be stored in a secure and weatherproof location.

- B. Materials and equipment shall be handled and transported in accordance with the manufacturer's instructions.
- C. All chemicals used in the construction of the gas containment system shall be stored in accordance with applicable safety regulations.

1.5 QUALITY ASSURANCE

- A. All work shall conform to the requirements of applicable codes, standards, and regulations.
- B. All materials and equipment shall be new and free from defects.
- C. Applicator Qualifications: The system applicator shall be an manufacturer authorized/certified applicator who is trained to perform work in accordance with the manufacturer's standards and policies.
- D. Manufacturer Qualification: Obtain vapor intrusion barrier materials and system components from a single manufacturer source. Manufacturer must have 20 years experience in the manufacture of vapor intrusion barrier systems.
- E. Third Party Inspection: Independent inspection of the composite system installation. Testing to include:
 - 1. Smoke testing for continuity of the installed vapor intrusion barrier. Test observation is to include seams, penetrations, and transition points.
 - a. The Applicator is to repair/remediate installation until verification of membrane continuity with no breaches is observed.
 - 2. Notify third-party testing agency and other appropriate parties one week in advance of the dates and times when membrane will be ready for testing.
- F. All equipment and materials shall be installed in accordance with the manufacturer's instructions.
- G. All work shall be inspected and tested in accordance with industry standards and regulations.
- H. All work shall be performed in a manner that minimizes disruption to other ongoing construction activities.

1.6 WARRANTY

- A. Special Warranty: Submit a written warranty signed by vapor intrusion barrier manufacturer agreeing to replace system materials that do not conform to manufacturer's published specifications or are deemed to be defective. Warranty does not include failure of vapor intrusion barrier due to failure of soil substrate prepared and treated according to requirements or formation of new joints and cracks in the concrete that exceed 1/8 inch (3.175 mm) in width.
 - 1. Warranty Period: 1 years after date of substantial completion. Longer warranty periods are available upon request.
 - 2. Coverage: Manufacturer will guarantee that the material provided is free of defects for the warranty period.
- B. All equipment and materials used in the gas containment system shall be covered by the manufacturer's standard warranty.
- C. The Applicator shall provide a one-year warranty for all workmanship and installation.

1.7 PERFORMANCE REQUIREMENTS

- A. Provide a vapor intrusion barrier system that prevents the passage of methane gas, and contaminant vapors including chlorinated solvents and petroleum hydrocarbons, and complies with the physical requirements as demonstrated by testing performed by an independent testing agency. Provide venting material that collects contaminant vapors and directs them to discharge points as specified in the Drawings and complies with the physical requirements set forth by the manufacturer.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete: ASTM C94/C94M, 4,000 psi minimum compressive strength at 28 days.
- B. Reinforcing steel: ASTM A615/A615M, Grade 60.
- C. Ventilation system: ASHRAE 62.1, Minimum Ventilation Rates in Breathing Zones and Work Zones for Indoor Air Quality.
- D. Gas detection and alarm system: UL 2075, Gas and Vapor Detectors and Sensors.

2.2 MANUFACTURERS

- A. Vapor Intrusion Barrier System: Basis of Design: EPRO Services, Inc. (EPRO), P.O. Box 347; Derby, KS 67037; Tel: (800) 882-1896; www.eproinc.com
 - 1. Basis of Design Membrane System: Geo-Seal 60 (58 mils)
 - a. Accessories as required for complete installation including, but not limited to: Geo-Seal FILM 11, Geo-Seal CORE (30 mils), Geo-Seal BOND
 - 2. Basis of Design System @ Elevator Pit: Geo-Seal 100 (100 mils)
 - a. Accessories as required for complete installation including, but not limited to: Geo-Seal FILM 11, Geo-Seal CORE (60 mils), Geo-Seal BOND
 - 3. Basis of Design Venting System: Vapor-Vent
 - a. Accessories as required for complete installation including, but not limited to: Vapor Vent Fittings, e.tape reinforcement tape
- B. Gas detection and alarm system:
 - 1. Honeywell Analytics
 - 2. MSA

2.3 MATERIALS

- A. Vapor Intrusion Barrier System Materials:

- 1. Vapor Intrusion Barrier
 - a. Basis of Design: GEO SEAL 60
 - 1) 59 mil total thickness consisting of 30 mil polymer modified asphaltic membrane sandwiched between two layers of HDPE geo-composite membranes: 11 mil HDPE base layer, 18 mil HDPE top layer

PROPERTIES	TEST METHOD	VALUE
Tensile Strength	ASTM D412	527.7 psi
Elongation	ASTM D412	45%
Adhesion to Concrete	ASTM D903	8 lbf/in
Puncture Resistance	ASTM D1709	310 lbf
Water Vapor Transmission	ASTM E96	0.020 perms
PCE Diffusion Rate	Geokinetics	1.16 x 10 ⁻¹⁷ m ² /sec
Benzene Diffusion Rate	Geokinetics	2.31 x 10 ⁻¹⁸ m ² /sec
Vapor Barrier Classification	ASTM E1745	A, B, & C

- 2. Auxiliary materials:
 - a. General: All accessory products shall be provided by the specified vapor intrusion barrier manufacturer. Auxiliary products used in lieu of, or in addition to, the

manufacturer products must be approved in writing by the manufacturer prior to installation.

- b. Reinforcement Fabric: Manufacturer's polyester fabric, Reinforcement Fabric available in 6 inch, 12 inch, and 40 inch widths. Basis of Design: Geo-Seal
- c. Basis of Design Detailing Material: Geo-Seal CORE Detail, a roller applied, water based, high viscosity, polymer modified asphaltic material.
- d. Backer Rod: Closed cell polyethylene foam
- e. Termination Bar: e.term hd, or approved alternate

B. Vapor Collection System Materials:

- 1. Basis of Design: Vapor-Vent: Vapor-Vent features a lightweight three-dimensional, highly flexible polypropylene core and a non-woven geotextile filter fabric. The filter fabric is bonded to the dimples of the polypropylene core to prevent clogging within the vent.

PROPERTIES	TEST METHOD	VALUE
	DIMPLED CORE	
Core Material		Polypropylene
Color		Black
Compressive strength	ASTM D 1621	9,500 PSF (455 kN/m ²)
Thickness	ASTM - 1777	1 in.
Flow rate	ASTM D 4716	30 gpm./ft. of width
	FILTER FABRIC	
CBR puncture	ASTM D 6241	250 lbs.
Grab tensile strength	ASTM D 4632	100 lbs
AOS	ASTM D 4751	70 U.S. sieve
Permittivity	ASTM D 4491	2.0 sec -1
Flow rate	ASTM D 4491	140 gpm./ft ²
UV resistance	ASTM D 4355	70% (500 hrs.)
Dimensions: 165' x 12" x 1"		
Weight: 65 pounds		

2. AUXILIARY MATERIALS

- a. General: All accessory products shall be provided by the specified vapor intrusion barrier manufacturer. Auxiliary products used in lieu of, or in addition to, the manufactures products must be approved in writing by the manufacturer prior to installation.
- b. Basis of Design Ventilation System Fittings: Transition low profile venting to Vapor-Vent End Out in order to properly transition to specified round pipe.
- c. Reinforcement Tape: e.tape should be used when securing Vapor-Vent to fittings and at transition joints

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The contractor shall examine the site to verify existing conditions and dimensions.
- B. The contractor shall verify that all utilities have been properly disconnected and capped off prior to the start of work.

3.2 PREPARATION

- A. The contractor shall prepare the site by excavating and grading as necessary to achieve the required dimensions and elevations.
- B. The contractor shall install any required drainage systems prior to the start of construction.

3.3 IDENTIFY LOW PROFILE VENT LAYOUT

- A. A. Identify and mark the layout of the low-profile vent material according to the vapor mitigation plans.

3.4 LOW PROFILE VENT INSTALATION

- A. General: Install low-profile vent system over substrate material as designated on drawings. The flat base of the inner core shall be placed up, facing the installer. Seams shall be overlapped in accordance with the manufacturer's recommendations.
- B. Intersection: At areas where low profile vent intersects, cut and fold back fabric to expose the dimpled core. Arrange the strips so that the top strip interconnects into the bottom strip in an interlocking fashion. Unfold fabric to cover the core and use manufacturer's recommended tape and sealant to seal the connection to prevent sand or gravel from entering the core.
- C. Footings and Grade Beams: When crossing low-profile over footings or grade beams, a solid pipe sleeve may be required to keep the vapor collection system continuous. The solid pipe sleeve will be placed on top of, or through, the desired transition area. Once the solid pipe sleeve is in place, attach a low-profile vent system end fitting on either side of the solid pipe and seal the low-profile vent to the low-profile end fitting. Consult with low-profile vent system manufacturer and structural engineer for appropriate use and placement of the solid pipe sleeve.
- D. Vent Risers: Place vent risers per the vapor mitigation plans. Connect the vent riser to low-profile vent system end fitting and seal with manufacturer's recommended tape and sealant. An additional reducer may be required to transition the 4" diameter end fitting to the specified diameter vent riser.

3.5 PLACEMENT OF OVERBURDON

- A. If placing overburden over the vapor collection system take care to prevent damage to the venting material.
- B. Heavy equipment shall not be driven over the low-profile pipe.
- C. Do not penetrate the vapor collection system once it is installed.

3.6 SURFACE PREPARATION

- A. A. The general contractor shall engage the certified vapor intrusion barrier contractor and certified inspector to ensure surfaces are prepared in accordance with manufacturer's instructions.
- B. Examine all substrates, areas, and conditions under which the composite membrane system will be installed, the applicator and inspector must be present. Do not proceed with installation until unsatisfactory conditions have been corrected and surface preparation requirements have been met. If conditions exist that are not addressed in this section, notify inspector and contact the manufacturer for additional clarification.
- C. Soil and Sand Substrates: Native soil and sand substrates shall be uniformly compacted to meet structural and building code requirements. All surfaces shall be free from protrusions and debris that may compromise the membrane system. Free-standing water must be removed prior to application.
- D. Aggregate Substrates: Aggregate substrates shall be compacted to meet structural and building code requirements and then rolled flat to provide a uniform substrate. ¾ inch minus aggregate with no more than one fractured face is recommended, but other aggregates substrates may be approved by the manufacturer provided they do not create sharp angular protrusions that may compromise the vapor intrusion system.

- E. Working Slab: Mud slab, rat slab, or other concrete working slab shall have a uniform plane with a light broom or light trowel finish.
- F. Concrete Surfaces: Clean and prepare concrete surface to manufacturer's recommendations. In general, only apply the polymer-modified asphaltic membrane material to dry, clean and uniform concrete substrates with a light trowel, light broom, or equivalent finish.
- G. Cast-in-Place or Shotcrete Walls: Application to green concrete is acceptable provided the substrate is prepared in accordance with manufacturers specifications and published instructions.
 - 1. Provide clean, dust-free, and dry substrate for vapor intrusion barrier application.
 - 2. Surfaces shall be power washed to remove grease, oil, form release agents, or any other penetrating contaminants from the concrete.
 - 3. Remove all fins, ridges, and other protrusions.
 - 4. Fill honeycomb, aggregate pockets, tie holes, and other voids with hydraulic cement, or rapid-set grout.

3.7 VAPOR INTRUSION BARRIER INSTALLATION

- A. General: The underslab vapor intrusion system shall be installed under strict accordance with the manufacturer's guideline.

3.8 BASE COURSE – BASIS OF DESIGN: GEO-SEAL FILM 11

- A. Whenever possible roll out 11 mil HDPE membrane in the same direction over the substrate. When multiple pours will occur, extend the 11 mil HDPE membrane a minimum of 2 feet past the pour joint.
- B. Overlap 11 mil HDPE membrane a minimum of 6 inches.
- C. At the seam overlap, peel back the top layer of 11 mil HDPE membrane and apply 60 mils into the overlapping seam, making certain to apply 30 mils of polymer-modified asphaltic membrane material to both the top of the bottom sheet and the bottom of the top sheet. Embed the top sheet into the bottom sheet.
- D. Visually verify there are no gaps/fish-mouths in seams.

3.9 TERMINATION SEQUENCE

- A. System Termination: The termination process is appropriate for terminating the membrane onto exterior footings, pile caps, interior footings and grade beams. When terminating the membrane to stem walls or vertical surfaces the same process should be used.
 - 1. Concrete surfaces that are not a light trowel, light broom or equivalent finish, will need to be repaired.
 - 2. Terminations on horizontal and vertical surfaces should extend 6" onto the termination surface. Job specific conditions may prevent a 6" termination. In these conditions exist, contact manufacturer for recommendations.
 - 3. Apply 60 mils of polymer-modified asphaltic membrane to the terminating surface and then embed the 11 mil HDPE membrane layer by pressing it firmly into the previously applied polymer-modified asphaltic membrane layer.
 - 4. Apply 30 mils of polymer-modified asphaltic membrane to the 11 mil HDPE membrane layer.
- B. Apply the 18 mil HDPE membrane layer and apply a final 30 mil seal of the polymer-modified asphaltic membrane layer over the edge of the termination. For further clarification, refer to the termination detail provided by manufacturer.

3.10 SEALING OF PENETRATIONS

- A. Sealing of Standard Pipe Penetrations: Prepare membrane penetrations so they are free of any
- B. material that will inhibit a direct bond to the penetration surface: foam, insulation, protective coatings, etc.

1. Trim 11 mil HDPE membrane to within 1/8 inch of the penetration.
2. Apply polymer-modified asphaltic membrane 3 inches horizontally and 3 inches vertically around the base of the penetration.
3. Embed manufacturer's recommended reinforcement fabric 3 inches horizontally and 3 inches vertically around the base of the penetration.
4. Apply a second layer of polymer-modified asphaltic membrane to reinforcement fabric until the reinforcement fabric is fully saturated. Secure reinforcement fabric to penetration with a cable tie. For further clarification, refer to the termination detail provided by the manufacturer.

3.11 POLYMER MODIFIED ASPHALT MEMBRANE – BASIS OF DESIGN: GEO-SEAL CORE

- A. Mask off adjoining surfaces where unwanted polymer-modified asphalt membrane may be exposed on finished surfaces or impact other construction trades.
- B. Commence application of polymer-modified asphalt when ambient air temperatures are within manufacturer recommendations.
- C. Surfaces that will receive the membrane must be clean and free from standing moisture.
- D. Apply one application of polymer-modified asphaltic membrane in accordance to manufacturer's instructions in order to obtain a seamless membrane with a minimum dry film thickness of 30 mils (1.5 mm).
- E. Apply polymer-modified asphaltic membrane in and around penetrations and cavities to ensure the formation of monolithic seal around all penetrations.
- F. Apply polymer-modified asphaltic membrane to prepared wall terminations and vertical surfaces to heights indicated according to manufacturer's recommendations and details.
- G. Verify polymer-modified asphaltic membrane thickness of every 1000 ft² (93 m²).

3.12 GEOCOMPOSITE PROTECTION COURSE – BASIS OF DESIGN: GEO-SEAL BOND

- A. Sweep off any water that has collected on the surface of the polymer-modified asphaltic membrane layer, prior to the placement of the 18 mil HDPE membrane layer. Install 18 mil HDPE membrane protection course perpendicular to the direction of the 18 mil HDPE membrane.
- B. Overlap 18 mil HDPE membrane seams a minimum of 6 inches. Secure the seams of 18 mil HDPE membrane by applying 30 mils of polymer-modified asphaltic membrane in-between the seam overlap OR by applying a 30 mil layer of polymer-modified asphaltic membrane on top of the seam overlap, completely covering the seam overlap.
- C. To expedite the construction process, the 18 mil HDPE membrane layer can be placed over the polymer-modified asphaltic membrane immediately after the spray application is complete, provided the polymer-modified asphaltic membrane mil thickness has been verified and smoke tested.
- D. Do not penetrate the membrane system once it has been applied. If the vapor intrusion barrier is penetrated, immediately contact the applicator.

3.13 CONSTRUCTION

- A. The ventilation system shall be installed in accordance with industry standards and the manufacturer's instructions.
- B. The gas detection and alarm system shall be installed in accordance with industry standards and the manufacturer's instructions.

3.14 FIELD QUALITY CONTROL AND REPAIRS

- A. Underslab:
 1. Inspect damaged area to determine which system components have been damaged.

2. If the 11 mil HDPE membrane sheet has not been compromised, patch only the areas that have been damaged by re-installing the damaged materials. The patch should extend 6 inches beyond the damaged area in all directions.
 3. If the 11 mil HDPE membrane sheet has been breached but no additional system components have been installed, install a patch below and above the base sheet that extends 6 inches beyond the damaged area. Area shall be sealed using the specified method for sealing the base sheet.
 4. If the damaged area has breached the base sheet and additional components have been installed over the 11 mil HDPE membrane sheet, the area will require removal of the overlying components to expose the 11 mil HDPE membrane sheet.
 5. If the damage is less than 3 inches, the base sheet will need to be opened up to create a minimum 4-inch diameter circle to allow access
 6. Place a minimum 8-inch diameter coupon under the base sheet and seal using the specified method for seaming the base sheet. If heat welding the seam, probe the seam to ensure a uniform seal.
 7. Apply a reinforcement detail of 30 mil polymer-modified asphaltic membrane and reinforcement fabric 6 inches beyond the edge of the repair area.
 8. Apply the remaining layers as specified.
 9. Refer to manufacturer's detail for further repair clarification.
- B. The contractor shall test all materials and equipment prior to use to ensure they meet the required specifications.
 - C. The contractor shall test the containment system for leaks prior to commissioning.
 - D. The contractor shall commission the containment system and ensure that all equipment and systems are functioning properly.

3.15 TESTING AND COMMISSIONING

- A. Third Party Inspection: Independent inspection of the composite system installation. Testing to include:
 1. Smoke generator: Capable of producing 3000 CFM of non-toxic fog with a high-volume, low-pressure blower.
 2. Smoke testing for continuity of the installed vapor intrusion barrier. Test observation is to include seams, penetrations, and transition points.
 - a. Record as part of the report, the date, time temperature, humidity, barometric pressure, wind speed/direction, and cloud cover. Include names of the parties involved in testing, number of leaks identified, and distribution of leaks identified (i.e. tears, seam leaks, boot leaks, penetration seal leaks, etc.)
 - b. Assemble and connect the smoke testing hose to the planned testing port within the base sheet. Activate the smoke generator system and pump smoke under the membrane. Monitor membrane for lifting.
 - c. Maintain operation of the smoke generator for a minimum of 15 continuous minutes. Thoroughly inspect the entire membrane surface for leakage.
 - d. Use solvent-free fluorescent orange paint to mark any leak locations. Also, mark leak locations on a floor plan.
 3. The Applicator is to repair/remediate installation until verification of membrane continuity with no breaches is observed.
 - a. When no further testing is required, the Applicator shall repair and seal the testing port.
- B. Thickness Verification: Use a digital mil reading caliper to measure the thickness of coupon samples. To measure coupon samples correctly, the thickness of the systems 11 mil HDPE membrane layer must be measured and calibrated in the field when verifying coupon sample thicknesses. Mark coupon sample area for repair.

3.16 CLEANING

- A. The contractor shall clean the work area and remove any debris generated during construction.
- B. The contractor shall dispose of all construction waste in accordance with industry standards and the manufacturer's instructions.

3.17 CLOSEOUT

- A. The contractor shall provide operation and maintenance manuals for all equipment used in the containment system.
- B. The contractor shall provide record drawings showing the final as-built configuration of the containment system.
- C. The contractor shall provide warranty documents for all equipment and materials used in the containment system.
- D. The contractor shall provide any required training to the owner or operator of the containment system.

END OF SECTION



DIVISION 03

CONCRETE



01SECTION 03 08 13
CONCRETE TESTING AND EVALUATION - OWNER

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Concrete Testing and Evaluation - Owner, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in Field.
 - 2. ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 3. ASTM E329 Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
- B. American Concrete Institute (ACI):
 - 1. ACI 318 Building Code Requirements for Structural Concrete and Commentary.
- C. Testing Agency:
 - 1. Acceptable to Architect.
 - 2. Recent evidence of inspection by Cement and Concrete Reference Laboratory of National Institute of Standards and Technology, with cited deficiencies corrected.
 - 3. Meet requirements of ASTM E329.
 - 4. Agency and its representatives are not authorized to revoke, alter, relax, enlarge, or release requirements, nor approve or accept portion of Contract Documents.

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Project Information:
 - 1. Testing Agency qualifications.
 - 2. Production sample test reports, when required:
 - a. Include same data as that required for mix designs.
 - 3. Reports of Contractor option tests.
 - 4. Test reports on in-place testing if such testing is performed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DESCRIPTION

- A. Test concrete materials and inspect operations as work progresses.
- B. Failure to detect defective work or material shall not prevent later rejection when such defect is discovered nor shall it obligate Architect for final acceptance.
- C. Payment for Testing:
 - 1. Pay for testing services required in paragraph Article 3.2, following.

2. Routine testing of concrete furnished to job site for compliance with Contract Documents will be performed by Owner's testing agency at Owner's expense.
 - a. Test for compressive strength, slump, air content, temperature, and unit weight.
 - b. Perform tests every 75 cubic yards or fraction thereof, for each mixture design placed in one day.
 - c. Obtain composite samples in accordance with ASTM C172.
 - 1) Obtain each sample from a different batch of concrete on a random basis.
 - 2) Select test batch at random before commencement of concrete placement.
 - d. Mold and cure sufficient specimens from each sample in accordance with ASTM C31 and report deviations from requirements, if any.
 - e. Coordinate number of specimens with test specification requirements and construction operations.
 - f. Test specimens in accordance with ASTM C39.

3.2 RESPONSIBILITIES AND DUTIES OF CONTRACTOR

- A. Provide testing services performed by Testing Agency for qualification of proposed materials and establishment of mix designs.
- B. Submit concrete materials and concrete mix designs.
 1. Include results of testing performed to qualify materials and establish mix designs.
- C. Place no concrete until Contractor has received approval.
- D. Use of testing service shall not relieve Contractor of responsibility to furnish materials and construction in compliance with Contract Documents.
- E. Testing and Inspection:
 1. Furnish labor to assist Owner's Testing Agency in obtaining and handling samples or other materials at site.
 2. Advise Owner's Testing Agency in advance of operations.
 3. Provide and maintain facilities for storage and curing of concrete compressive strength test specimens on site for first 24 hours or until strength is achieved as required by ASTM C31.
- F. Pay for following additional testing services performed by Owner's testing agency when:
 1. When changes in materials or proportions are requested by Contractor Additional testing and inspection.
 2. When specimens fail to meet specification requirements, by test or inspection.
 3. Testing services needed or required by Contractor.
 - a. Field-cured test specimens as needed for control of stripped, reshored, unshored, post-tensioned concrete work.

3.3 EVALUATION AND ACCEPTANCE OF COMPRESSIVE STRENGTH TEST RESULTS

- A. Evaluate test results for standard molded and cured test cylinders separately for each concrete mix design.
 1. Evaluate each mix design for strength and uniformity by a minimum of five tests.
- B. Strength level of concrete shall be considered acceptable when average of three consecutive strength test sets equal or exceed specified strength (f'_c) and no individual strength test result is less than specified strength (f'_c) by more than 500 psi.

3.4 TESTING CONCRETE IN PLACE

- A. Test concrete in place when compressive strength tests indicate potential strength deficiency to evaluate actual strength.
 1. Pay for concrete tests and engineering time and analysis required to evaluate in-place concrete strength as result of deficient cylinder strength tests.

- B. Testing by rebound hammer, ultrasonic, or other non-destructive device.
 - 1. Tests shall be used to determine relative strengths at various locations in structure to determine areas to be cored.
 - 2. Calibrated and correlated tests with other test data shall be used as basis for acceptance or rejection.
- C. Core Tests:
 - 1. Obtain and test largest practical diameter cores, 2 inches minimum, in accordance with ASTM C42.
 - a. Test dry if concrete in structure will be dry under service conditions,
 - 1) Air dry cores at 60 deg F to 80 deg F, relative humidity less than 60 percent for 7 days before test.
 - b. Test cores after moisture conditioning if concrete in structure is more than superficially wet under service conditions.
 - 2. Take three cores from area of concrete or member considered deficient in strength.
 - a. Location as selected by Architect.
 - b. Replace cores damaged prior or during removal from structure prior to testing.
 - 3. Concrete core test shall be considered acceptable if average strength of cores is equal to at least 85 percent of, with no single core less than 75 percent of specified strength (f'c).
 - 4. Fill core holes with low slump patching compound per Section 03 35 00.

3.5 ACCEPTANCE OR REJECTION OF CAST-IN-PLACE CONCRETE

- A. General:
 - 1. Completed concrete work which conforms to requirements of Contract Documents will be accepted without qualification.
 - 2. Concrete work which fails to conform to one or more requirements of Contract Documents shall be rejected and will not be accepted until repaired and proven adequate by concrete testing.
 - 3. Contractor pays costs incurred in providing remedial work necessary to change rejected work to accepted work.
 - 4. Remedial work includes, but is not necessarily limited to, applicable repairs, replacement, reinforcement, engineering, and testing.
 - 5. Repair or replacement of concrete in an approved manner and in conformance with Contract Documents constitutes acceptance.
- B. Dimensional Tolerances:
 - 1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to confirmation of safety by structural analysis or load test.
 - a. When deficiencies are confirmed, replace or reinforce structure as directed.
 - 2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances will be rejected if strength or finish of structure is not acceptable, or function is adversely affected.
 - a. If removal of excess material is permitted, repair of surfaces constitutes acceptance.
 - b. If removal of excess material is not permitted, replacement of surfaces constitute acceptance.
 - 3. Concrete members cast in wrong location will be rejected if: strength or finish is not acceptable, function is adversely affected, and /or interference is encountered with other construction.
 - 4. Inaccurately formed concrete surfaces exceeding tolerances and exposed to view will be rejected.
- C. Finish:

1. Architectural concrete with surface exceeding limitations will be rejected.
 2. Concrete exposed to view with defects which adversely affect appearance of specified finish may be repaired only by approved methods.
 3. Slabs:
 - a. Finished slabs exceeding tolerance limits specified in Section 03 35 00 will be rejected if finish is not acceptable and function is adversely affected.
 - 1) If rejected, repair of finished surfaces or replacement of slab in an approved manner and in conformance with Contract Documents will constitute acceptance.
 - b. Repair may involve removing high spots by grinding, filling low spots with patching compound, or remedial measures as permitted.
 4. Formed surfaces:
 - a. Concrete exposed to view with defects which adversely affect appearance of specified finish will be rejected.
 - 1) Repair surface defects in conformance with Section 03 35 00.
 5. Concrete not exposed to view is not subject to rejection for defective finish.
- D. Strength of Structure:
1. Concrete in place which control strength of structure will be rejected if it fails to comply with requirements of Contract Documents, including but not necessarily limited to:
 - a. Deficient concrete strength based on compressive strength tests.
 - b. Reinforcing steel size, quantity, strength, position, or arrangement at variance with requirements on reinforcement.
 - c. Concrete which differs from required dimensions or location.
 - d. Curing less than that specified.
 - e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
 - f. Mechanical injury, construction fires, accidents, or premature removal of formwork.
 - g. Substandard workmanship.
 2. When strength of structure is considered potentially deficient, it will not be accepted until one of following is completed and submitted to Architect for approval prior to action by Contractor.
 - a. Confirmation of safety of structure by structural analysis.
 - b. Core tests shall be performed only when safety of structure is not confirmed by structural analysis.
 - c. Confirmation of safety of structure by load tests performed and evaluated in accordance with ACI 318.
 - d. Replacement of structure deficient in strength.
 - e. Reinforce structure with supplement supports as directed by Architect and approved by Owner.

END OF SECTION

SECTION 03 11 00

CONCRETE FORMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Concrete Formwork, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 DESCRIPTION

- A. Definitions:
 - 1. Formwork: Total system of support for freshly placed concrete including mold or sheathing which contacts concrete as well as supporting members, hardware, and necessary bracing.
 - 2. Exposed construction: Exposed to view.
 - 3. Exposed to view: Concrete surfaces seen by the public from eye level from any walking surface in a public location after completion of building.
 - 4. Public location: Building areas accessible to public and employees not responsible for maintenance. Storerooms, unfinished space, and large mechanical rooms are considered public locations. Equipment closets, elevator and mechanical penthouses are not public space.
- B. Use forms, wherever necessary, to confine concrete and shape it to required dimensions. Use forms of sufficient strength to withstand pressure resulting from placement and vibration of concrete, with sufficient rigidity to maintain specified tolerances.
- C. See concrete finish requirements in Section 03 35 00.
- D. Use earth side forms for spread footings and unfinished grade beams where earth can be shaped to a straight and true surface. Do not use earth cuts as forms for other vertical surfaces unless permitted.

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.

1.4 QUALITY ASSURANCE

- A. Design, engineering, and construction of formwork are responsibility of Contractor.
 - 1. Design, engineer, and construct formwork for applicable gravity and lateral loads and pressures as well as other design considerations or applicable requirements of legal local building code.
 - 2. Develop shoring and re-shoring pattern and sequence so as not to exceed safe structural capacity of supporting structural systems. Confer with Architect, if there is any question, regarding the capacity of the structural system.
- B. Design formwork, prepare drawings, and construct formwork in accordance with ACI 347, Guide to Formwork for Concrete.
- C. Layout and measurement of concrete forms and embedment's, required for work, performed by a licensed surveyor employed by the contractor.

PART 2 - MATERIALS

2.1 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Form accessories, partially or wholly embedded in concrete, such as ties and hangers: Shall be of a commercially manufactured type. Do not use non-fabricated wire. Use form ties constructed so ends or end fasteners can be removed without causing appreciable spalling of concrete faces. After ends or end fasteners of form ties have been removed, embedded portion of ties shall terminate not less than 2 diameters or twice minimum dimension of tie from formed faces of concrete to be permanently exposed to view, but in no case less than 3/4 inches. When formed face of concrete is not to be permanently exposed to view, form ties may be cut off flush with formed surfaces. Use ties with 3/4 inches diameter cones on both ends for water retaining structures.

2.2 FABRICATION OF FORMS

- A. Make forms sufficiently tight to prevent loss of cement fines. Place chamfer strips in outside corners of forms to produce 45-degree beveled corners on permanently exposed surfaces. Interior corners on such surfaces and edges of formed joints will not require beveling.
- B. To maintain specified finish tolerances, camber formwork to compensate for anticipated formwork deflections prior to hardening of concrete.
- C. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up settlement during concrete placing operation. Securely brace forms against lateral deflection.
- D. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.
- E. At construction joints, contact surface of form sheathing for flush surfaces exposed to view shall overlap hardened concrete in previous placement minimum 1 inch. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
- F. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.
- G. Fasten wedges (used for final adjustment of forms prior to concrete placement) in position after final check.
- H. Anchor formwork to shores or other supporting surfaces or members so upward or lateral movement of any part of formwork system is prevented during concrete placement.
- I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

2.3 TOLERANCES

- A. Construct formwork so concrete surfaces will conform to tolerance limits listed: Tolerances non-cumulative. Most restrictive tolerance governs. Tolerance limits noted are maximum deviations (plus or minus) on each side of intended line.
 - 1. Deviation from plumb:
 - a. In lines and surfaces of columns, piers, walls, and in arises:
 - 1) In any length: 1 in 500 but not less than 1/8 inches.
 - 2) In any story: 3/8 inches.
 - 3) Maximum for entire length: 3/4 inches.
 - b. For exposed corner columns, control-joint grooves, and other conspicuous vertical lines:
 - 1) In any length: 1 in 1000 but not less than 1/8 inches.
 - 2) In any story: 3/16 inches.

- 3) Maximum for entire length: 1/2 inches.
2. Deviation from level or from grades specified:
 - a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores:
 - 1) In any length: 1 in 750 but not less than 1/8 inches.
 - 2) In any bay: 3/8 inches.
 - 3) Maximum for entire length: 1/2 inches.
3. Deviations from true plane of concrete surface exposed to view caused by bulging of form facing material between supports:
 - a. 3/16 inches or 1/300 of span between supports whichever is smaller.
4. Deviation from established position in plan of linear building lines, columns, walls:
 - a. In any length: 1 in 500, but not less than 1/8 inches.
 - b. In any bay: 1/2 inches.
 - c. Maximum for entire length: 3/4 inches.
5. Deviation in sizes and location of sleeves, floor openings, and wall openings: 1/4 inches.
6. Deviation in cross-sectional dimensions of columns and beams and in thickness of slabs and walls:
 - a. Minus: 1/4 inches.
 - b. Plus: 1/2 inches.
7. Footings:
 - a. Deviations in dimensions in plan:
 - 1) Minus: 1/2 inches.
 - 2) Plus: 2 inches.
 - b. Misplacement or eccentricity:
 - 1) 2 percent of footing width in direction of misplacement but not more than 2 inches.
 - c. Thickness:
 - 1) Decrease in specified thickness: 5 percent.
 - 2) Increase in specified thickness: No limit (except that which may interfere with other construction).
8. Deviation in steps:
 - a. In flight of stairs:
 - 1) Rise: 1/8 inches.
 - 2) Tread: 1/4 inches.
 - b. In consecutive steps:
 - 1) Rise: 1/16 inches.
 - 2) Tread: 1/8 inches.
 - c. Deviation from level for any step or landing: 1 inch 1000 but not more than 1/8 inches.
- B. Formwork Classifications:
 1. Concrete formwork shall meet the following classification requirements:
 - a. Concrete noted as "Architectural Exposed Concrete: Class A."
 - b. Concrete exposed to view or to receive membrane waterproofing: Class B.
 - c. Footings: Class D.
 - d. All other concrete: Class C.
- C. Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items, except where specifically noted otherwise.

- D. Establish and maintain in undisturbed condition and until final completion of project, sufficient control points and benchmarks to be used for reference purposes to check tolerances.
- E. Regardless of tolerances listed allow no portion of building to extend beyond property line of project.

PART 3 - EXECUTION

3.1 PREPARATION OF FORM SURFACES

- A. Clean form surfaces and embedded materials of mortar, grout and foreign material before concrete is placed.
- B. Before placing of reinforcing steel or concrete, treat surfaces of forms as follows:
 - 1. Unless otherwise noted, cover surfaces of forms with non-staining, biodegradable, form release agent to prevent absorption of moisture and prevent bond with concrete.
 - 2. Form release agent VOC content no greater than 250 g/L.
 - a. Bio-Nox by Nox-Crete Products Group, or equal.
 - 3. Do not allow excess release agent to collect in forms or contact hardened concrete against which fresh concrete is placed.
 - 4. Factory applied non-absorptive liner may be used.

3.2 REMOVAL OF FORMS

- A. When repair of surface defects or finishing is required at early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations.
- B. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging. Perform needed repairs or treatment required on such sloping surfaces at once, followed by specified curing.
- C. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.
- D. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.
- E. When shores and other vertical supports are arranged so non-load-carrying form-facing material may be removed without loosening or disturbing shores and supports, facing material may be removed at earlier age as permitted.

3.3 REMOVAL STRENGTH

- A. When removal of formwork or re-shoring is based on concrete reaching specified strength, concrete shall be presumed to have reached this strength when either of following conditions has been met.
 - 1. When test cylinders, field cured along with concrete they represent, have reached specified strength.
 - 2. When concrete has been cured as specified for same length of time as age at test date of laboratory-cured cylinders which reached specified strength. Determine length of time concrete has been cured in structure by cumulative number of days or fractions thereof, not necessarily consecutive, during which temperature of air in contact with concrete is above 50 deg F and concrete has been damp or sealed from evaporation and loss of moisture.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Concrete Reinforcing, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM A36 Standard Specification for Carbon Structural Steel.
 - 2. ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 3. ASTM A663 Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
 - 4. ASTM A706 Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - 5. ASTM A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- B. American Concrete Institute (ACI):
 - 1. ACI 315 Details and Detailing Concrete Reinforcement.
- C. American National Standards Institute (ANSI) /American Welding Society (AWS):
 - 1. ANSI/AWS-D1.4 Structural Welding Code- Reinforcing Steel.

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Shop drawings indicating size, number, dimensions and locations of reinforcing steel and accessories, in sufficient detail to permit installation of reinforcing without reference to Contract drawings.
 - a. Details of concrete reinforcement and accessories not indicated on Contract Documents shall be in accordance with ACI 315.
- C. Project Information:
 - 1. Certification that reinforcing to be welded conforms to ASTM A706.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Epoxy Adhesive for Anchoring Reinforcing:
 - 1. Base:
 - a. HIT System by Hilti.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. General Reinforcing:
 - 1. Conform to ASTM A615, Grade-60.
- B. Welded Reinforcing:
 - 1. Conform to ASTM A706.
- C. Welded Wire Reinforcement:
 - 1. Smooth wire flat sheets.
 - 2. Conforming to ASTM A1064 and to wire size and spacing as indicated on Drawings.
- D. Smooth Dowel Bars for Construction Joints:
 - 1. Conform to ASTM A663 or ASTM A675, Grade-60.
 - 2. Where indicated, provide a metal dowel cap at one end of dowel to permit longitudinal movement of dowel within concrete section.
 - 3. Provide for movement which equals joint width plus 1/2 inches.
 - 4. Unless otherwise indicated, use 5/8 inches diameter dowels spaced 18 inches on center.
- E. Slab on Grade Plate Dowels:
 - 1. ASTM A36 steel.
 - 2. May be used as an equal substitute for smooth dowel bars at construction joints.
 - 3. Diamond Dowel System, by PNA Construction Technologies, size 1/4 inches x 4-1/2 inches dowels or equal.
 - 4. Locate plate dowels per smooth dowel bar requirements.
 - 5. Do not shear plates.
 - 6. Remove burrs at edges of plates.
- F. Epoxy Anchored Reinforcing:
 - 1. Install reinforcing anchored in concrete with epoxy adhesive, in accordance with epoxy manufacturer's instructions.

2.3 FABRICATION

- A. Bars for Concrete Reinforcement:
 - 1. Sheared length: Plus or minus 1 inch.
 - 2. Depth of truss bars: Plus 0, minus 1/2 inches.
 - 3. Overall dimensions of stirrups, ties, and spirals: Plus or minus 1/2 inches.
 - 4. Other bends: Plus or minus 1 inch.
- B. Bars with End Bearing Splice Couplers:
 - 1. Terminate bar ends in flat surfaces within 1-1/2 degrees of right angle to axis of bars.
 - 2. Fit within 3 degrees of full bearing after assembly.

PART 3 - EXECUTION

3.1 WELDING

- A. Perform welding of reinforcing steel in conformance with AWS-D1.4.
- B. Use E70 electrodes.
- C. Each welder shall place an approved identifying mark near each completed weld.
- D. Cut out welds determined to be defective.
 - 1. Weld and retest at Contractor's expense.

3.2 PLACING REINFORCEMENT

- A. Provide minimum concrete covering for reinforcement as follows:
 - 1. Concrete deposited against earth: 3 inches.
 - 2. Formed surfaces exposed to weather or in contact with earth:
 - a. 2 inches for reinforcing bars No.6 or larger.
 - b. 1-1/2 inches for reinforcing bars less than No.6.
 - 3. Interior surfaces:
 - a. 1-1/2 inches for beams, girders, and columns.
 - b. 3/4 inches for slabs, walls and joists with No.11 bars or smaller.
- B. Place bars to following tolerances:
 - 1. Clear distance to formed surfaces: Plus or minus 1/4 inches.
 - 2. Minimum spacing between bars: Minus 1/4 inches.
 - 3. Top bars in slabs and beams:
 - a. Members 8 inches deep or less: Plus or minus 1/4 inches.
 - b. Members between 8 and 24 inches deep: Plus/minus 1/2 inches.
 - c. Members more than 2 feet deep: Plus or minus 1 inch.
 - 4. Crosswise of members: Spaced evenly within 2 inches.
 - 5. Lengthwise of members: Plus or minus 2 inches.
- C. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
 - 1. If moved more than one bar diameter, or enough to exceed above tolerances, resulting arrangement of bars subject to approval.
- D. Assure that reinforcement, at time concrete is placed, is free of materials that may adversely affect or reduce bond.
 - 1. Reinforcement with rust, mill scale or a combination of both is acceptable provided dimensions and weights, including heights of deformations, of a cleaned sample is not less than required by ASTM.
- E. Support reinforcement and fasten together to prevent displacement by construction loads or placing of concrete beyond tolerances indicated.
 - 1. On ground, provide supporting concrete blocks or other approved method.
 - 2. Over formwork, use concrete, metal, plastic or other approved bar chairs and spacers.
 - 3. Where concrete surface will be exposed to weather in finished structure, furnish accessories within 1/2 inches of concrete surface of non-corrosive material or protect against corrosion.
- F. Overlap welded wire reinforcement not less than spacing of cross wires plus 2 inches.
 - 1. Unless shown otherwise, support welded wire reinforcement by methods of Paragraph E, above.
- G. Offset vertical bars in columns at least one bar diameter at lapped splices to ensure proper placement, furnish templates for column vertical bars and dowels.
- H. Splices not specifically indicated shall be subject to approval.
- I. Unless permitted by Architect, do not bend reinforcement after embedding in hardened concrete.
- J. Unless permitted by Architect, do not tack weld reinforcing.

END OF SECTION

SECTION 03 31 00
CONCRETE MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Concrete Materials and Proportioning, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM C33 Standard Specification for Concrete Aggregates
 - 2. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - 3. ASTM C94 Standard Specification for Ready-Mixed Concrete
 - 4. ASTM C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
 - 5. ASTM C143 Standard Test Method for Slump of Hydraulic-Cement Concrete
 - 6. ASTM C150 Standard Specification for Portland Cement
 - 7. ASTM C157 Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
 - 8. ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - 9. ASTM C192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
 - 10. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - 11. ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete
 - 12. ASTM C311 Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
 - 13. ASTM C496 Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
 - 14. ASTM C567 Standard Test Method for Determining Density of Structural Lightweight Concrete
 - 15. ASTM C595 Standard Specification for Blended Hydraulic Cements
 - 16. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
 - 17. ASTM C989 Standard Specification for Slag Cement for Use in Concrete and Mortars
 - 18. ASTM C1602 Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
- B. American Concrete Institute (ACI):
 - 1. Comply with applicable provisions of following ACI publications, latest edition, except as otherwise indicated.
 - 2. ACI 301 Specifications for Structural Concrete for Buildings.
- C. Concrete Mixture Proportioning:
 - 1. Employ and pay for testing agency acceptable to Architect and Owner to perform materials evaluation, testing and design of concrete mixes.

2. Certificates, signed by material producer and Contractor, may be submitted in lieu of material testing when approved by Architect.
- D. Concrete Testing:
1. Specified in Section 03 08 13.
 2. Contractor to assist with related communication and temporary storage of test cylinders at jobsite.
- E. Preinstallation Conference:
1. See Section 01 31 19.
 2. Minimum thirty-five (35) days prior to start of concrete construction schedule, conduct meeting to discuss approved mix designs and required methods and procedures to achieve required concrete construction.
 3. Send a Pre-Installation Conference agenda to attendees twenty (20) days prior to scheduled date of the conference.
 4. Invite responsible representatives, in addition to those listed in Section 01 31 19, including but not limited to following:
 - a. Ready-mix concrete producer.
 - b. Admixture manufacturer.
 - c. Concrete pumping equipment manufacturer
 - d. Laboratory responsible for the concrete design mix.
 - e. Owners Testing Agency responsible for field quality control.
 5. Record minutes of the meeting and distribute to attendees within five (5) days of conference.
 - a. Include statement by concrete contractor indicating proposed mix design, and placing, finishing, and curing procedures produce concrete quality required by specifications.

1.3 SUBMITTALS

- A. Product Data:
1. Concrete Mix Designs:
 - a. Submit each Mix Design individually.
 - b. Do not combine multiple mix designs into a single submittal.
 - c. Submit following data for each concrete mix proposed:
 - 1) Intended use.
 - 2) Proportions of materials.
 - 3) Slump.
 - 4) Air content.
 - 5) 7-day and 28-day compression test results of trial mixes or those used for standard deviation analysis of an established mix.
 - a) Test records for use in standard deviation analysis must have been made within 24 months of the date of the submittal and represent a time span of production of not less than 45 days.
 - d. Submit source and certification or proof of quality (and compatibility of admixtures) for each of the constituents of the proposed concrete mixes. Compatibility of admixture must be certified.
 - 1) Cement.
 - 2) Aggregate.
 - 3) Water.
 - 4) Admixtures:
 - a) Air Entraining Admixture.

- b) High-Range Water Reducer.
- c) Fly Ash.
- e. Submit concrete mix designs using the mix design submittal form included at the end of this specification:

PART 2 - PRODUCTS

2.1 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Normal Weight Concrete:

- 1. Concrete for which density is not a controlled attribute.
- 2. Materials used in production must be of same quality, properties and proportion as indicated in approved concrete mix design as approved by Architect.

B. Under-slab Vapor Retarder:

- 1. Specified in Section 03 31 10.

C. Cement:

- 1. Portland cement conforming to ASTM C150 or blended cements conforming to ASTM C595.
- 2. Color: Natural gray.

D. Aggregates:

- 1. General:
 - a. Regard fine and coarse aggregates as separate ingredients.
 - b. Each size of coarse aggregate, as well as combination of sizes when two or more are used, shall conform to grading requirements of applicable ASTM specifications.
- 2. Normal Weight Concrete:
 - a. ASTM C33, also aggregate shall be obtained from a source approved by the State Highway Department for use in concrete for State bridges.

E. Potable Water:

- 1. Conforming to ASTM C1602.

F. Admixtures:

- 1. Use only when specifically required or permitted by Contract Documents, otherwise must be approved by Architect.
- 2. Trial mixes and tests shall be prepared with job materials, including admixture, to demonstrate that there will be no subsequent reduction in strength or durability of hardened concrete.
- 3. Provide admixtures certified by manufacture to be compatible with other admixtures. Calcium chloride, thiocyanates, and admixtures containing more than 0.05 percent chloride ions are not permitted.
- 4. Air-entraining Admixtures: ASTM C260.
- 5. Mid-Range Water Reducer: ASTM C494, Type A.
- 6. High-Range Water Reducer:
 - a. ASTM C494, Type F or G. Subject to complying with these specifications, the following manufacturers of High Range Water Reducing Admixtures are approved:
 - 1) Daracem or Adva Series by GCP Applied Technologies.
 - 2) MasterRheobuild 1000, MasterGlenium Series or PS 1466 by Master Builders Solutions.
 - 3) Eucon 37, Eucon SPJ or Plastol Series by Euclid Chemical.

- 4) PSP-N, PSP-N2, PSP-R, and PSP-L by Procrete Industries.
- b. Other manufacturers desiring approval comply with Section 00 26 00.
7. Water-reducing, Retarding, and Accelerating Admixtures: ASTM C494.
8. Non-Chloride, Non-Corrosive Accelerating Admixture:
 - a. ASTM C494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products include:
 - 1) Euclid Chemical Co; Accelguard 80, 90 or NCA.
 - 2) Master Builders Solutions; Masterset AC 534.
 - 3) GCP Applied Technologies; Daraset.
 - b. Other manufacturers desiring approval comply with Section 00 26 00.
9. Viscosity Modifying Admixture (VMA):
 - a. Specialty admixture to reduce bleed and segregation in concrete.
 - 1) Euclid Chemical Company; Viscrol.
 - 2) Boral Materials Technologies; Boral SL.
 - 3) Master Builders Solutions; MasterMatrix VMA Series
 - b. Other manufacturers desiring approval comply with Section 00 26 00.
10. Supplementary Cementitious Materials:
 - a. Fly ash - ASTM C618, Class C or Class F.
 - 1) Samples shall be obtained, prepared, and tested in accordance with ASTM C311.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

2.2 PROPORTIONING CONCRETE MIXES

- A. General:
 1. Contractor and concrete supplier are responsible to provide concrete, in-place, which satisfies requirements listed in following table.
 2. Contractor and concrete supplier are responsible to adjust the concrete mixes, as needed, to:
 - a. Correct for non-conformance.
 - b. Correct for a variation in the quality of a constituent.
 - c. Compensate for extreme conditions in the field.
- B. Establish concrete material proportions by any of the proportioning methods described in AC1-301 guidelines.
- C. Instructions for use of Table:
 1. Provide concrete mixes with properties indicated in locations identified in Use column.
 2. 28-day Strength:
 - a. Installed concrete must meet or exceed the minimum 28-day compressive strength indicated.
 - b. Laboratory mix design strengths must exceed this strength by the appropriate amount per AC1-301.
 - c. Determine strength in accordance with ASTM C192 and ASTM C39.
 3. Dry Unit Weight:
 - a. If no value is listed, assume normal weight.
 - b. Dry unit weight of light weight mixes shall be maximum air dry unit weight permitted.
 - c. Correlate fresh weight with air dry weight of same mix to use as basis of acceptance on job site. Test in accordance with ASTM C567 and ASTM C138.

- d. Dry unit weight for concrete for Radiation Shielding shall be minimum air dry unit weight permitted. Use heavy aggregate if necessary.
- 4. Maximum Aggregate Size:
 - a. Maximum size of coarse aggregate determined in accordance with:
 - 1) ASTM C33 for normal weight concrete.
 - b. Some mixes are designated 3/4 inches or 1 inch, permitting contractor option.
- 5. Air Content:
 - a. Required percentage of entrained and entrapped air as measured by ASTM C231, ASTM C173, or ASTM C138, as appropriate.
 - b. Tolerance of air content as delivered is +/- 1-1/2 percent for normal weight and +/- 2 percent for lightweight concrete.
 - c. When left blank, the required air content is not specified. All concrete exposed to freezing and thawing shall have air content between 4.5 percent and 7.5 percent. All interior slabs and all slabs to receive dry shake shall have a maximum air content of 3 percent.
- 6. Water Reducer:
 - a. Mid-Range Water Reducer or High Range Water Reducer shall be provided as necessary to achieve slump indicated.
 - b. Contractor, as option, may elect to use Water Reducers to improve workability or permit pumping.
- 7. Maximum W/C Ratio:
 - a. Maximum allowed ratio of pounds of water to pounds of cementitious material used in the concrete mix.
- 8. Slump:
 - a. Mixes without Water Reducers:
 - 1) Slump tolerance: Up to 1 inch above maximum indicated is allowed, provided the average of 5 consecutive batches does not exceed the indicated amount by more than 1/2 inch.
 - b. Mixes with Water Reducers:
 - 1) Slump indicated is after dosing.
 - 2) Slump tolerance after dosing: +1-1/2 inches and -1 inch is permitted for each batch.
 - c. Determine slump in accordance with ASTM C143.
 - d. Where slump is not specified, provide concrete with slump in accordance with approved mix designs.
- 9. Cement:
 - a. Type: Provide cement type indicated.
 - b. As option, the contractor/supplier may use Fly Ash or Ground Blast Furnace Slag for partial replacement of cement.
 - 1) For each unit of cement that is removed, replace with two units of Class F Fly Ash or one unit of Class C Fly Ash.
 - 2) For each unit of cement that is removed, replace with one unit of Ground Blast Furnace Slag.
 - 3) Maximum amount of cement replaced shall not exceed that specified in table 4.2.2.7.b.2 of ACI 301
 - 4) W/C ratio shall be based on total cementitious material content.
- D. Admixtures:
 - 1. Use admixtures in accordance with manufacturer's instructions.
 - 2. Use only approved admixtures.

PART 3 - EXECUTION

3.1 STORAGE OF MATERIALS

- A. Store cement in weather tight buildings, bins, or silos which will exclude moisture and contaminants.
- B. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
 - 1. Perform tests for determining conformance to requirements for cleanliness and grading on samples secured from aggregates at point of batching.
 - 2. Do not use frozen or partially frozen aggregates.
- C. Allow sand to drain until it has reached relatively uniform moisture content before use.
- D. Store admixtures in manner to avoid contamination, evaporation, or damage.
 - 1. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure uniform distribution of ingredients.
 - 2. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics.

3.2 MIXING AND DELIVERY

- A. Batch, mix and transport concrete in accordance with ASTM C94.
- B. Batch and mix admixtures in accordance with manufacturer's instructions.
- C. Water added to concrete at the job site:
 - 1. Water additions at job site shall be limited to comply with W/C Ratio requirements.
 - 2. Do not allow water to be added to the mix unless the amount allowed is clearly indicated on the truck delivery ticket.
- D. Following addition of High Range Water Reducer, mix for a minimum of 70 revolutions or 5 minutes to assure a consistent mixture.
- E. Reduction of required average strength:
 - 1. During construction, and after sufficient data becomes available, laboratory strength of mixes may be reduced in accordance with Section 3.11 of AC1-301, subject to approval by the Architect.

END OF SECTION

SECTION 03 31 10
CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Concrete Mixing, Placing, Jointing and Curing as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM C94 Standard Specification for Ready-mixed Concrete.
 - 2. ASTM C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
 - 3. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete.
 - 4. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - 5. ASTM D1751 Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
 - 6. ASTM D1752 Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - 7. ASTM E1643 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.
 - 8. ASTM E1745 Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
- B. American Concrete Institute (ACI):
 - 1. ACI 302.1R Guide for Concrete Floor and Slab Construction.
 - 2. ACI 305.1 Hot Weather Concreting.
 - 3. ACI 306.1 Cold Weather Concreting.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Placement plans: Indicate proposed locations of construction joints and placement sequence.
 - 2. Screeding and finishing plan.
- B. Product Data:
 - 1. Vapor Retarder.
- C. Project Information:
 - 1. Joint filler technical data.
 - 2. Strippable Curing compound technical data.
 - a. Interior slabs:
 - 1) Include floor covering manufacturer's written approval for use.
 - 2) Include procedures to be used for removing compound.
 - 3. Waterstop technical data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Evaporation Retarder:
 - 1. Base:
 - a. Euclid Chemical Company; Eucobar.
 - 2. Optional:
 - a. Master Builders Solutions; MasterKure ER50.
- B. Strippable Curing Compound:
 - 1. Base:
 - a. Kurez DR VOX or Kurez W VOX by Euclid Chemical Company
 - b. L&M Cure R by L&M Construction Chemicals
 - c. Clear Resin Cure J11W by Dayton Superior
 - d. 1150 Clear by WR Meadows
 - e. SpecRez by SpecChem, LLC
- C. Curing Sheet Material:
 - 1. Base
 - a. Hydrazure M5 by PNA Construction Technologies, Inc.
 - 2. Optional:
 - a. Transguard 4000 by Reef Industries, Incorporated
- D. Vapor Retarders: As noted.
- E. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Concrete Materials and Proportioning: See Section 03 31 00.
- B. Premolded Expansion Joint Filler: Type required, conforming to ASTM D1751 or ASTM D1752.
- C. Evaporation Retarder
 - 1. Waterborne, monomolecular film forming, manufactured for application to fresh concrete designed to inhibit the loss of moisture before and during the finishing process.
- C. Curing Sheet Material:
 - 1. Provide where concrete is scheduled to be stained per section 09 67 75.
 - 2. Moisture-Retaining Cover Conforming to ASTM C171: Naturally colored, non-woven polypropylene fabric with a 4-mil non-perforated reflective (white) polyethylene coating.
 - 3. Fabric shall exhibit low permeability and high moisture retention.
- D. Strippable Curing Compound:
 - 1. Conform to ASTM C309 with VOC no greater than 350 g/l.
 - 2. Where used on slabs receiving subsequent applied finishes, compound must be removed completely after curing.
 - 3. Install in accordance with manufacturer's recommendation and supervision.
- E. Granular Fill: See Section 31 23 00.
- F. Underslab Vapor Retarder and Gas Barrier:
 - 1. Meet ASTM E1745 Class A, B and C.

2. Maximum water vapor Permeance, ASTM E154: 0.0098 Perm.
3. Minimum tensile strength, ASTM E154: 58 feet-LB/IN.
4. Minimum puncture resistance, ASTM D1709: 2600 Grams.
5. Radon diffusion coefficient, K124/02/95: 0.0040 Grains/HR-SF.
6. Methane Permeance, ASTM D1434: Less than 0.32 Gas Transmission Rate (GTR) ml/m².D.ATM.
7. Base Product:
 - a. VaporBlock Plus 20 by Raven Engineered Films.
8. Optional Product:
 - a. VaporBlock 20Plus by Americover.
9. Tape as recommended by vapor retarder manufacturer.
10. Other manufacturers desiring approval comply with requirements of Section 00 26 00.

PART 3 - EXECUTION

3.1 MIXING AND PRODUCTION OF CONCRETE

- A. Batch, mix and transport ready-mixed concrete in accordance with ASTM C94.
 1. Plant equipment and facilities shall conform to Check List for Certification of Ready Mixed Concrete Production Facilities of National Ready Mixed Concrete Association.
- B. Site batched and mixed concrete will be permitted only after ability to control quality has been demonstrated to satisfaction of Architect.

3.2 MIXING - CONTROL OF ADMIXTURES

- A. Incorporate admixtures in accordance with Manufacturers' recommendations.
- B. Verify compatibility with manufacturers when more than one admixture is used.

3.3 MIXING - TEMPERING AND CONTROL OF MIXING WATER

- A. Mix concrete only in quantities for immediate use. Discard concrete which has set.
- B. When concrete arrives at project with slump below that suitable for placing, water may be added only if neither maximum permissible water-cement ratio nor maximum slump is exceeded.
 1. Incorporate water by additional mixing equal to at least half of total mixing required.
 2. Do not add water after discharge commences.

3.4 MIXING - WEATHER CONDITIONS

- A. Cold Weather:
 1. Comply with ACI 306.
 2. In cold weather, temperature of concrete when delivered at site shall conform to following limitations:
 3. For sections with least dimension greater than 36 inches, comply with table 3.1 of ACI 306R.

Minimum Concrete Temperature Required at Time of Pour		
Air Temperature at time of pour	For sections with least dimension less than 12 inches	For sections with least dimension 12 inches to 36 inches
Above 30 degrees F	60 degrees F	55 degrees F
0 to 30 degrees F	65 degrees F	60 degrees F
Below 0 degrees F	70 degrees F	65 degrees F

Minimum Concrete Temperature Required within 24 Hours of Pour		
Air Temp within 24 Hours of pour	For sections with least dimension less than 12 inches	For sections with least dimension 12 inches or greater
Below 32	60 degrees F	50 degrees F

4. If water or aggregate is heated above 100 degrees F, combine water with aggregate in mixer before cement is added.
 - a. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 100 degrees F.
 - b. Final temperature of combined mix shall not exceed 90 degrees F or be high enough to cause flash set or loss of slump or workability.
- B. Hot Weather:
1. Comply with ACI 305 when high temperature, low slump, flash set, or cold joints are encountered.
 2. Cool ingredients before mixing or add flake ice or well-crushed ice of a size that will melt completely during mixing for all or part of mixing water. Account for water contribution by ice when calculating the quantity if mixing water and insure that specified W/C ratio is not exceeded.

3.5 PREPARATION BEFORE PLACING

- A. Equipment:
1. Remove hardened concrete and foreign material from inner surfaces of conveying equipment.
 2. Provide spare vibrator on job site during concrete placing operations.
 3. In cold weather, have protective blankets ready and heaters operational and in-place before placing concrete.
- B. Forms:
1. Complete formwork: Remove frost, snow, ice, water, and foreign material; secure reinforcement in place, position expansion joint material, anchors, and other embedded items, and have entire preparation inspected prior to concrete placement.
 2. In hot weather when temperature of reinforcing or forms is greater than 120 degrees F spray forms and reinforcement with water just prior to placing concrete.
- C. Screeds and Screenshot Rails:
1. Develop a screed system to accurately strike off fresh concrete to the surfaces and elevations defined on drawings.
 2. Anticipate deflection of formwork and support systems.
 - a. Provide and place extra concrete as necessary to produce finish surfaces with specified tolerances at designated elevations and contours at no additional cost to the Owner.
 3. When form work is cambered whether shored or un-shored and screeding is performed perpendicular (i.e., up and over) to crown of camber set screed rails to follow camber and provide a slab of uniform thickness.
 - a. When screeding parallel with the camber, set one screed at midspan along crown of camber and one along girder or support.
 - b. Two passes of the screed are necessary to cover one full bay.
 4. Other screeding methods may be used provided deflection of un-shored formwork is taken into consideration.
 5. On un-shored steel framing systems, accurately strike off concrete using a laser to produce a level surface after steel supporting system has deflected due to dead weight of fresh

concrete. Anticipate steel framing deflection to be 0 inch at columns, and up to 1 1/2 inches at mid-point of bays, with an approximately parabolic profile.

6. Slab thickness on cambered steel shall not be less than that indicated on plan.
 7. If not required in documents and subjected to approval of Architect, Contractor as option may camber formwork.
 8. Concrete shall be struck off with a vibrating screed.
 9. Use of a wet screed system will not be permitted unless:
 - a. Concrete is struck with a pneumatically vibrated floater screed.
 - b. A highway straight edge is used to true the surface perpendicular to direction of screeding.
 - c. A satisfactory finish is produced on a trial slab.
 10. Submit a screeding and finishing plan for approval.
 - a. A representative trial slab pour shall be provided to demonstrate that the specified tolerances and a satisfactory surface can be provided by the proposed method of screeding and finishing.
- D. Subgrade for Slabs on Grade:
1. Subgrade shall be well drained and of adequate and uniform load bearing nature.
 - a. Keep in-place density of subgrade soils at least to minimum indicated.
 2. Keep subgrade free of frost before concrete placing begins.
 - a. If temperature inside a building where concrete is to be placed is below freezing, raise temperature and maintain above 50 degrees F long enough to remove frost from subgrade and reinforcing.
 3. Keep subgrade moist at time of concreting.
 - a. If necessary, dampen with water in advance of concreting.
 - b. Allow no free water standing on subgrade nor muddy or soft spots when concrete is placed.

3.6 UNDER-SLAB VAPOR RETARDER

- A. Place continuous vapor retarder over granular fill.
1. See Section 31 23 00.
 2. Installation as recommended by manufacturer.
- B. Comply with ASTM E1643 Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
1. Lap vapor retarder at ends and edges of sheets and seal with vapor retarder tape.
 2. Extend to extremities of area.
 3. Turn up at perimeter walls to form bond breaker and tape in place.
 4. Terminate at top of foundation or grade beam for slabs on grade.
 5. Detail sleeved or drilled penetrations as recommended by manufacturer.
 - a. Coordinate detailing at penetrations with subcontractors responsible for penetrations.
- C. Protect vapor retarder. Repair punctures, tears and other damage using vapor retarder tape.
- D. Trim excess material after slab is placed.
- E. Inspect and approve vapor retarder installation prior to concrete placement.
1. See Section 01 45 23.

3.7 PROTECTION

- A. Unless adequate protection is provided and approval is obtained, do not place concrete when temperature is below freezing or during rain, sleet, or snow.

- B. Do not allow rainwater to increase mixing water nor to damage surface finish.
- C. Concrete damaged by rain or weather and judged defective by Architect shall be removed and replaced by Contractor at no additional cost to Owner or corrected by procedures listed in Section 03 08 13.

3.8 CONVEYING

- A. Handle concrete from mixer to place of final deposit as rapidly as practicable by methods which prevent segregation or loss of ingredients and assure that quality is maintained.
- B. Use equipment conforming to ASTM C94.
- C. Use horizontal belt conveyors or mount at a slope which will not cause excessive segregation or loss of ingredients.
 - 1. Protect concrete against undue drying or rise in temperature.
 - 2. Handle to prevent segregation.
 - 3. Do not allow mortar to adhere to belt.
 - 4. Discharge long runs into a hopper or through a baffle.
- D. Use metal or metal-lined chutes with slope between 1 vertical and 2-3 horizontal.
 - 1. Chutes more than 20 feet long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
- E. Pumping or pneumatic conveying equipment shall be of suitable kind with adequate pumping capacity.
 - 1. Control pneumatic placement so that segregation is not apparent in discharged concrete.
 - 2. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 2 inches.
 - 3. Do not convey concrete through pipe made of aluminum or aluminum alloy.

3.9 DEPOSITING IN FORMS

- A. Work Includes:
 - 1. Deposit concrete continuously or in layers of such thickness that no concrete is deposited on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within section.
 - 2. Place at such a rate that concrete which is being integrated with fresh concrete is still plastic.
 - 3. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
 - 4. Remove temporary spreaders in forms when concrete placing has reached an elevation rendering their service unnecessary.
 - 5. Temporary spreaders may remain embedded in concrete only if made of metal or concrete and if prior approval has been obtained.
- B. Do not start placing concrete in supported elements until concrete previously placed in columns and walls is no longer plastic and has been in place at least two hours.
- C. Deposit concrete as nearly as practicable in its final position to avoid segregation due to re-handling or flowing.
 - 1. Do not subject concrete to procedure which will cause segregation.
 - 2. Concrete shall not drop more than 6 feet unless approved by the Architect. For greater heights, provide special mix design, chute, spout, tremie, or other approved method.
- D. Concrete buckets shall be equipped with rubber discharge tubes.
 - 1. Tube size shall be effective in directing flow of concrete directly downward between reinforcing.

2. Unless it can be demonstrated, no segregation will occur with greater distances, maximum free fall distance of concrete below flexible tube is limited to 4 feet.

E. Consolidation:

1. Consolidate concrete by vibration, so that concrete is thoroughly worked around reinforcement, around embedded items and into corners of forms eliminating air or stone pockets which may cause honeycombing, pitting, or planes of weakness.
2. Use internal vibrators having a minimum frequency of 8000 vibrations per minute to consolidate concrete effectively.
3. Do not use vibrators to transport concrete within forms.
4. Insert vibrators and withdraw at points approximately 18 inches apart.
5. At each insertion allow duration sufficient to consolidate concrete but not sufficient to cause segregation; generally, from 5 to 15 sec.
6. Where concrete is to have an as-cast finish, bring a full surface of mortar against form by vibration process, spading, or both to work coarse aggregate back from formed surface.

3.10 SLAB PLACEMENT

A. Coordinate mixing and placing with finishing.

1. Do not place concrete on subgrade or forms more rapidly than it can be spread, straight edged, and darried or bull floated.
2. Perform these operations before bleed water has an opportunity to collect on surface.

B. Plan size of finishing crews to achieve good surfaces and avoid cold joints caused by temperature and atmospheric conditions.

1. If construction joints become necessary, construct as required under joints and embedded items.

C. Consolidation:

1. Thoroughly consolidate concrete in slabs.
2. Use internal vibration in beams and girders of framed slabs and along bulkheads of slabs on grade.
3. Obtain consolidation of slabs with vibrating screeds, roller pipe screeds, internal vibrators, or other approved means.

3.11 JOINTS AND EMBEDDED ITEMS

A. Construction Joints - Other than Slab on Grade:

1. Locate joints not indicated to least impair strength of structure.
 - a. Place joints in locations approved by Architect.
2. In general, locate near middle of spans of slabs, beams, and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice width of beam.
 - a. Locate joints in walls and columns at underside of floors, slabs, beams, or girders and at tops of footings or floor slabs.
 - b. Place beams, girders, brackets, column capitals, haunches, and drop panels at same time as slabs.
 - c. Make joints perpendicular to main reinforcement.
3. Continue reinforcement across joints.
4. Clean surface of concrete at joints thoroughly and remove laitance.
 - a. Prior to placing adjoining concrete, dampen, but do not saturate, hardened concrete of construction joints.

B. Joints – Slabs on Grade:

1. Construction joints:
 - a. Place keyed dowelled or diamond plate construction joints as indicated on plans and at locations where a slab placement is terminated or interrupted.
 - b. Size of placements and sequence of slab placement is Contractor's option, except construction joints shall be located at a control joint location.
 - c. Construction joints act as control joints.
 2. Control joints:
 - a. Provide contraction (control) joints as indicated.
 - b. If not shown, provide along column centerlines.
 - c. Where column centerline spacing or spacing between column centerlines and walls exceeds 20 feet, provide an intermediate joint at intervals not exceeding 20 feet.
 - d. Locate joints to produce panels that are as square as possible with length not exceeding 1.5 times width.
 - e. Also provide joints where change in slab width occurs, such as at block-outs, pits, etc.
 - f. If saw cut joints are required or permitted, time cutting properly with set of concrete by one of the following methods:
 - 1) A conventional saw, cutting as soon as possible after final finishing when cutting action will not tear, ravel, abrade, or otherwise damage surface and before concrete develops random contraction cracks. Cut to a depth of 1/4 slab thickness or 1/3 slab thickness if steel-fiber or structural synthetic macro fiber reinforcement is used.
 - 2) An early entry saw beginning immediately after final finishing when cutting action will not tear, ravel, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
 - a) Remove debris in path of cut and under skid plate before cutting. Skid plate must remain flat on surface.
 - b) Use early entry saw blades and skid plates.
 - c) Install early entry joint protector at sawcut intersection prior to cross-cutting.
 - d) Remove dry powder without disturbing finish.
 - e) Avoid traffic across saw cut until sufficient strength is gained to protect joint edges.
 3. Complete before shrinkage stresses become sufficient to produce cracking.
 4. Isolation joints:
 - a. Provide isolation joints around columns, and between slab on grade and walls.
 - b. Also provide isolation joints around equipment or machinery isolation pads, pits, pipes, etc., unless detailed otherwise.
- C. Expansion Joints:
1. Do not permit reinforcement or other embedded metal items bonded to concrete, except dowels in floors bonded on only one side of joints, to extend continuously through expansion joint.
 2. Locate expansion joints as indicated.
- D. Acoustic Isolation Joint:
1. Do not permit any reinforcing or other bonded items to extend through joint.
 2. Remove forming material and clean joint thoroughly prior to cover installation. Locate as indicated.
- E. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to placement of concrete.
1. Give Contractors whose work is related to concrete or supported by it ample notice and opportunity to introduce and/or furnish embedded items before concrete placement.

2. Position expansion joint material, waterstops, and other embedded items accurately and support against displacement.
3. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete.

3.12 SLAB FINISHING

- A. See Section 03 35 00.

3.13 CURING AND PROTECTION

- A. Work Includes:

1. Beginning immediately after placement, protect concrete from premature drying, hot or cold temperatures, and mechanical injury, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration and hardening of concrete.
2. Materials and methods of curing subject to approval.

- B. Preservation of Moisture:

1. Preserve moisture in slab before and during finishing until slab is ready for application of final curing.
2. When conditions warrant, apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pound/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions one or more times after placing, screeding, and bull floating or darbying concrete, but before float finishing.

- C. Final curing:

1. Interior slabs:
 - a. Application of sheet curing materials.
 - b. Application of strippable curing compound.
 - 1) Submit written approval from floor covering manufacturer prior to use.
 - 2) Apply in accord with recommendations of manufacturer immediately after water sheen, which may develop after finishing, has disappeared.
 - 3) Apply continuous film at manufacturer's specified rate.
 - 4) Completely remove prior to application of floor covering material.
2. Other concrete surfaces not in contact with forms apply one of following procedures immediately after completion of placement and finishing:
 - a. Ponding or continuous sprinkling.
 - b. Application of absorptive mats or fabric kept continuously wet.
 - c. Application of sand kept continuously wet.
 - d. Continuous application of mist spray, not exceeding 150 degrees F.
 - e. Application of sheet curing materials.
 - f. Application of other moisture-retaining covering as approved.
 - g. Application of strippable curing compound.
 - 1) Apply in accordance with recommendations of manufacturer immediately after water sheen has disappeared.
 - 2) Apply continuous film at manufacturer's specified rate.
 - 3) Remove after curing where cured surface is against which additional concrete or other material is to be bonded, unless it is proven that curing compound will not prevent bond.
3. Minimize moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by sun by keeping forms wet until they can be safely removed.
 - a. After form removal cure concrete until end of time prescribed.

4. Continue curing in accordance with ACI 301 and ACI 302. Seven days for most concrete.
 - a. If tests made of cylinders, kept adjacent to structure, and cured by same methods, indicate average compressive strength has reached 70% of specified strength, (f'c), moisture retention methods may be terminated.
 - b. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is one day old, provided concrete is not permitted to become surface dry during transition.
- D. Temperature, Wind and Humidity:
1. Cold weather:
 - a. When mean daily outdoor temperature is less than 40 degrees F maintain temperature of concrete between 50 and 70 degrees F for required curing period.
 - b. Make provisions for heating, covering, insulating, or housing concrete work adequately to maintain required temperature without injury.
 - c. Do not use combustion heaters during first 24 hours unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
 2. Hot weather:
 - a. Make provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light-colored material.
 - b. Take such protective measures as quickly as concrete hardening and finishing operations will allow.
 3. Rate of temperature change:
 - a. Keep changes in temperature of air immediately adjacent to concrete during and immediately following curing period as uniform as possible.
 - b. Do not exceed 5 degrees F in any 1 hour or 50 degrees F in any 24-hour period.
- E. Protection from Mechanical Injury:
1. During curing period, protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
 2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
 3. Do not load self-supporting structures in such a way as to overstress concrete.
- F. Protection of Slabs on Grade from Frost:
1. Interior slabs exposed to freezing temperatures shall be adequately protected so that frost does not develop in supporting subgrade.

END OF SECTION

SECTION 03 35 00
CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Concrete Finishing and Repair of Surface Defects, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. ASTM E1155 Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers
 - 2. ACI 302.1R Guide for Concrete Floor and Slab Construction
- B. Floor Finish Tolerances:
 - 1. Follow F-Number System as defined in ASTM E1155.
 - a. Floor Flatness F-Number: F_F defines maximum floor curvature allowed over 24 inches computed on basis of successive 12 inches elevation differentials.
 - b. Floor Levelness F-Number: F_L defines relative conformity of floor surface to a horizontal plane measured over a 10 feet distance.
 - c. Above number pair to be stated in form: F_F/F_L .
 - d. Specified Overall Value (SOV) is enumerated and is based on composite of measured values in a placement.
 - e. Minimum Local Value (MLV) describes flatness or levelness below which repair or replacement is required. MLV is based on individual placement and applies to minimum local area not crossing construction or control joints.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Chemical Hardener:
 - 1. Base:
 - a. Master Builders Solutions.
 - 2. Optional:
 - a. SpecChem, LLC
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Bonding Agent:
 - 1. Approximately 1 part Portland cement to 1 part fine sand passing a No.30 mesh sieve.
 - 2. Mix to consistency of thick cream.
- B. Patching Compound:
 - 1. Same materials and approximately same proportions as used for concrete, except omit coarse aggregate.
 - 2. Shall consist of not more than 1 part Portland cement to 2-1/2 parts sand by loose volume.

3. For exposed concrete, part of Portland cement shall be white to produce a color matching color of surrounding concrete, as determined by a trial patch.
 4. Add no more water than necessary for handling and placing.
 5. Mix compound in advance and allow to stand with frequent manipulation, without addition of water, until it has reached stiffest consistency that will permit placing.
- C. Grout Mix:
1. Cleaned rubbed finish:
 - a. Mix 1 part Portland cement and 1-1/2 parts fine sand with sufficient water to produce a grout with a consistency of thick paint.
 2. Cork floated rubbed finish:
 - a. Mix 1 part Portland cement and 1 part fine sand with sufficient water to produce a stiff grout.
- D. Proprietary Materials:
1. Contractor's option: Proprietary compounds for adhesion, patching, or finishing may be used in lieu of or in addition to foregoing grouts.
 2. Use such compounds in accordance with manufacturer's recommendations.

PART 3 - EXECUTION

3.1 FINISHING

- A. After removal of forms, repair and give surfaces of concrete finishes indicated.
1. Top surface of slabs not included.
- B. Unspecified finish: If finish is not designated, use following finishes as applicable:
1. Unpainted concrete surfaces not exposed to public view: Rough form finish.
 2. Unpainted concrete surfaces exposed to public view: Smooth form finish.
 3. Concrete surfaces to receive paint: Grout cleaned rubbed finish.
 4. Unformed surfaces (except slabs): As indicated.
 5. Concrete surfaces to be waterproofed in Section 07 13 26 : Smooth form finish.

3.2 REPAIR OF SURFACE DEFECTS

- A. Repair surface defects immediately after form removal.
- B. Remove honeycombed and other defective concrete down to sound concrete.
- C. Chip if necessary to make edges perpendicular to surface or slightly undercut.
- D. No feather edges will be permitted.
- E. Dampen area to be patched and an area at least 6 inches wide surrounding it to prevent absorption of water from patching compound.
- F. After surface water has evaporated from area to be patched, brush bonding agent into surface.
- G. When bonding agent begins to lose water sheen, apply patching compound.
- H. Thoroughly consolidate compound into place and strike off so as to leave patch slightly higher than surrounding surface.
- I. To permit initial shrinkage, leave undisturbed for at least 1 hour before final finish. Keep patched area damp for 7 days.
- J. Do not use metal tools in finishing a patch which will be exposed.
- K. Tie holes:
1. Unless stainless steel, non-corrosive, or acceptably coated ties are used, tie holes shall be filled.

2. Clean and thoroughly dampen tie holes; fill solid with patching compound.

3.3 AS-CAST FINISHES

A. Rough Form Finish:

1. No selected form facing materials are specified for rough form finish surfaces.
2. Concrete surfaces shall conform to tolerances in 03 11 00 Concrete Formwork.
3. Patch defects and tie holes.
4. Chip or rub off fins exceeding 1/4 inches in height.
5. Leave surfaces with texture imparted by forms.

B. Smooth Form Finish:

1. Use form facing material to produce a smooth, hard, uniform texture on concrete.
2. Arrange facing material orderly and symmetrical, with number of seams kept to practical minimum.
3. Support by studs or other backing capable of preventing excessive deflection.
4. Do not use material with raised grain, patches, or other defects which will impair texture of concrete surface.
5. Patch tie holes and defects.
6. Remove fins completely.
7. When surface textures are impaired and form joints misaligned by more than 1/8 inches grind bush hammer, or otherwise correct affected concrete.
8. Slurry grout areas evidencing minor mortar leakage to match adjacent concrete.
9. Repair major mortar leakage as a defective area.

C. Unformed Surface Finish:

1. Strike smooth tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
2. Float to a texture reasonably consistent with that of formed surfaces.
3. Continue final treatment on formed surfaces uniformly across unformed surfaces.
4. Not intended for slabs.

3.4 RUBBED FINISHES

A. General:

1. Form and repair concrete surfaces to receive rubbed finishes, in accordance with requirements for smooth form finish.
2. Remove forms and perform necessary patching as soon after placement as possible without jeopardizing structure.

B. Smooth:

1. Produce smooth rubbed finish on newly hardened concrete no later than day following form removal.
2. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced.
3. Use no cement grout other than cement paste drawn from concrete itself by rubbing process.

C. Grout Cleaned:

1. Undertake no cleaning operations until contiguous surfaces are completed and accessible.
2. Wet surface of concrete sufficiently to prevent absorption of water from grout and apply grout uniformly.

3. Immediately after applying grout, scrub surface vigorously with a cork float or stone to coat surface and fill air bubbles and holes.
4. While grout is still plastic, remove excess grout by working surface with a rubber float, sack, or other means.
5. After surface whitens from drying, rub vigorously with clean burlap.
6. Keep finish damp for at least 36 hours after final rubbing.

D. Cork Floated:

1. Remove forms at an early stage, within 2 to 3 days of placement where possible.
2. Remove ties.
3. Remove burrs and fins.
4. Dampen wall surface.
5. Apply grout with firm rubber float or with trowel, filling surface voids.
6. Compress grout into voids.
7. If grout surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with a fog sprayer.
8. Produce final texture with a cork float using a swirling motion.

3.5 SLAB FINISHING

A. General:

1. Place slabs to finish tolerances specified.
2. Slab finish: Use following finishes at building locations noted.
 - a. Scratched finish: Surfaces intended to receive bonded applied cementitious applications, such as setting beds, grout, etc.
 - b. Floated finish (magnesium):
 - 1) Surfaces intended to receive roofing, waterproofing membranes, or sand bed terrazzo.
 - 2) Surfaces of ramps, docks, stairs in which no other covering is specified.
 - c. Troweled finish:
 - 1) Floors intended as walking surfaces or to receive floor coverings.
 - 2) Roof surfaces intended to receive protected membrane roofing system.
 - d. Non-slip finish (interior and exterior): Ramps, docks, stairs specifically noted on drawings.

B. Finishing tolerances:

1. For shored construction, measurements for conformance with finishing tolerances shall be made as soon as slab can tolerate foot traffic, and before shores are removed.
2. The F_L levelness tolerance is not applicable to unshored form work such as cast in place topping on prestressed tees, slabs on unshored steel and metal deck, or unshored, post-tensioned slabs on steel beams.
3. Horizontal finishes will be accepted provided:
 - a. Applicable specification requirements are satisfied.
 - b. Water does not pond in areas sloped to drain.
 - c. Floor finish tolerances F_F / F_L conforms to that specified for particular finish and Minimum Local Values are not less than 75 percent of the floor finish tolerance specified.
4. Accumulated deviation from intended true plane of finished surface does not exceed 1 inch.
5. Accuracy of floor finish does not adversely affect installation and operation of movable equipment, floor supported items or items fitted to floor.

C. Finishes:

1. Scratched finish:
 - a. After concrete has been placed, consolidated, struck off, and leveled to a F_F15/ F_L13 tolerance, roughen surface with stiff brushes or rakes before final set.
2. Floated finish:
 - a. After concrete has been placed, consolidated, struck off, and leveled, do not work further until ready for floating.
 - b. Using a magnesium float, begin floating when water sheen has disappeared, and surface has stiffened sufficiently to permit operation.
 - c. During or after first floating, check planeness of entire surface with a 10 foot straightedge applied at not less than two different angles.
 - d. Cut down high spots and fill low spots during this procedure to produce a surface within F_F20/ F_L15 tolerance throughout.
 - e. Refloat slab immediately to a uniform sandy texture.
3. Troweled finish:
 - a. Sequence:
 - 1) Float finish.
 - 2) Power trowel
 - 3) Hand trowel
 - b. First troweling after power floating shall produce a smooth surface which is relatively free of defects, but which may still indicate some trowel marks.
 - c. Final trowel when a ringing sound is produced as trowel is moved over surface.
 - d. Thoroughly consolidate surface by hand troweling.
 - e. Leave finished surface essentially free of trowel marks, uniform in texture and appearance and plane to F_F25/ F_L20 tolerance.
 - f. On surfaces intended to receive floor coverings, grind off defects which would indicate through floor covering.
 - g. On surfaces intended to receive waterproofing membranes grind off defects that might tear or otherwise damage membrane.
4. Broom or belt finish:
 - a. Immediately after concrete has received float finish, give it a coarse scored texture by drawing a broom or burlap belt across surface transverse to slope or traffic flow.
5. Non-slip slab finish:
 - a. Aggregate: Crushed, ceramic bonded aluminum oxide particles. Apply at 25 pound per 100 square feet.
 - b. Blend aggregate with Portland cement in proportions recommended by manufacturer of aggregate.
 - c. Give surface a float finish.
 - d. Apply approximately two-thirds of blended material for required coverage to surface by a method that ensures even coverage without segregation.
 - 1) Begin floating immediately.
 - e. After material has been embedded by floating, apply remainder of blended material to surface at right angles to previous application.
 - f. Make second application heavier in areas not sufficiently covered by first application. Follow with second floating immediately.
 - g. After selected material has been embedded by two floatings, complete operation with a broomed finish.

END OF SECTION

SECTION 03 35 43
POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Polished Concrete Floor, as indicated, in accordance with provisions of Contract Documents.
- B. Related Requirements: Include, but are not necessarily limited to:
 - 1. Section 03 35 00 – Concrete Finishing.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Experienced in specified requirements and methods for Work of this section.
 - 2. Provide letter from concrete finish manufacturer stating installer is an approved applicator of special concrete finishes and is familiar with procedures and installation requirements required by manufacturer.
- B. ASTM International (ASTM):
 - 1. ANSI 137,1
- C. ASTM International (ASTM):
 - 1. ASTM C779 Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces
 - 2. ASTM C805 Standard Test Method for Rebound Number of Hardened Concrete
 - 3. ASTM D4039 Standard Test Method for Reflection Haze of High-Gloss Surfaces
 - 4. ASTM D5767 Standard Test Method for Instrumental Measurement of Distinctness-of-Image (DOI) Gloss of Coated Surfaces
- D. American Concrete Institute (ACI):
 - 1. ACI 302 1R-89 Guide for Concrete Floor and Slab Construction.
- E. American Society of Concrete Contractors (ASCC):
 - 1. Concrete Polishing Council Aggregate Exposure Chart.
 - 2. Concrete Polishing Council Polished Concrete Appearance Chart.
- F. Protection:
 - 1. Do not place steel on slabs to avoid rust staining.
 - 2. Do not allow acids and acidic detergents to come in contact with slab.
 - 3. Do not use pipe cutting machines on floor slab.
 - 4. Diaper hydraulic powered equipment to avoid staining of concrete.
 - 5. Do not park vehicles on inside slab.
 - a. If necessary to complete Work, place impervious drop cloths under vehicles.
- G. Mock-up:
 - 1. Apply mock-up of each finish, to demonstrate typical joints, surface finish, color variation, and standard of workmanship.
 - a. Construct mock-ups approximately 50 square feet in location indicated or as directed by Architect.
 - b. Obtain Architect approval of mock-up before starting construction.

- c. If mock-ups do not meet requirements, demolish and remove from site and cast additional mock-up until approved.
- d. Maintain mock-up during construction in undisturbed condition as standard for judging completed work.
- e. Approved mock-ups may become part of completed work if undisturbed at time of substantial completion.

1.3 SUBMITTALS

A. Product Data:

- 1. Manufacturer's specifications and test data, describing specified product.
- 2. Recommended installation procedures.
- 3. Concrete finish technical data sheet including descriptive data, curing time, and application requirements.

B. Samples:

- 1. Color and finish.

C. Project Information:

- 1. Certified test reports, prepared by an independent testing laboratory, confirming compliance with specified performance criteria.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Polished Concrete Floor:

- 1. Base:
 - a. Advanced Floor Products.
- 2. Optional:
 - a. Laticrete
 - b. Prosoco.
 - c. LM Scofield.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIAL: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Reactive Stabilizer:

- 1. Base Product: Retro Plate 99 by Advanced Floor Products.
- 2. Silicate concrete hardener.
- 3. Nonflammable.
- 4. Water based.
- 5. Abrasion: 400% increase in resistance.
- 6. Hardness: 21% increase in impact strength.
- 7. Exposure: Class B as defined by the Concrete Polishing Council Aggregate Exposure Chart.
- 8. Floor finish: Level 2 as defined by the Concrete Polishing Council Polished Concrete Appearance Chart.
- 9. Image Clarity: 10 to 39 percent.
- 10. Dynamic coefficient of friction: Greater than 0.42 per ANSI 137.1.

B. Neutralizing Agent:

1. Trisodium phosphate.
- C. Water:
 1. Potable.
- D. Sealer:
 1. Base Product: RetroPel by Advanced Floor Products.
 2. Oil and water repellent.
 3. Does not affect floor appearance.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Finish slabs to surface requirements specified in Section 03 35 00 Concrete Finishing.
- B. Comply with manufacturers written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting topping performance.
- C. Close areas to traffic during floor application and after application, for time period recommended in writing by manufacturer.
- D. Examine substrate, with installer present, for conditions affecting performance of finish.
 1. Correct conditions detrimental to Work.
 2. Do not proceed until unsatisfactory conditions are corrected.
 3. Verify base slab meet finish and surface profile requirements in Division 3.
- E. Prior to application, verify floor surfaces are free of construction laitance.

3.2 APPLICATION

- A. Apply in accord with manufacturer's instructions.
- B. Start floor finish applications in presence of manufacturer's technical representative.
- C. Sealing, Hardening and Polishing of Concrete Surface:
 1. Concrete must be in place a minimum of 45 days or as directed by the manufacturer before application can begin.
 2. Apply a minimum of 10 days prior to installation of fixed equipment, furniture, or accessories.
 3. Follow procedures recommended by product manufacturer and to match approved mock-up.
 4. Polish to required sheen level.

3.3 CLEAN UP

- A. Keep work area clean and free of debris.
- B. Repair damages to surface caused by cleaning operations.
- C. Remove spatter from adjoining surfaces.
- D. Dispose of materials in accordance with local regulations.

3.4 PROTECTION

- A. Protect finished work until fully cured.

END OF SECTION



DIVISION 05

METALS



SECTION 05 12 10

STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Structural Steel, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Structural steel work covered herein shall be fabrication and erection of steel framing and bracing members including connections and steel material either supporting or connected to steel members shown on structural plans and not specified in other sections.
- B. Quality standards latest edition of following standards plus any corresponding published revisions at time of bidding shall be applicable standard. The Local Building Code shall govern if conflicting.
 - 1. Local Building Code.
 - 2. American Institute of Steel Construction (AISC):
 - a. ANSI/AISC 360 "Specification for Structural Steel Buildings" (referred to herein as the AISC Specification).
 - b. Code of Standard Practice for Steel Buildings and Bridges (referred to as AISC Code of Standard Practice).
 - c. Quality Certification Program.
 - 3. American Welding Society:
 - a. Structural Welding Code - Steel ANSI/AWS-D1.1 (referred to herein as the AWS Code). AWS Code shall govern techniques and quality of welding and testing procedures. Statements contained in the AWS Code requiring information to Bidders and/or Contract Documents to define nondestructive testing or statements defining responsibilities and obligations for services and payment shall be disregarded.
 - 4. Research Council on Structural Connections: "Specifications for Structural Joints Using High Strength Bolts" (referred to herein as RCSC Specification).
 - 5. Steel Structures Painting Council (SSPC): Steel Structures Painting Manual Vol. 2, "System and Specifications", referred to herein as SSPC Specification.
- C. Fabricator Qualifications:
 - 1. Certified by AISC Quality Certification Program for Structural Steel Fabricators and is designated as AISC Certified Fabricator (BU), Standard for Steel Building Structures.
 - 2. Fabricators not certified shall have minimum 10 years experience and shall employ an approved testing agency to inspect fabrication work performed off site. The testing agency shall furnish weekly inspection reports and a final report to the Building Official and the Architect certifying the work was performed in accordance with the specifications and approved shop drawings. The testing agency will inspect shop welding in accordance with Section 6 of the AWS code. The testing agency will also perform the following inspections:
 - a. Test 10 percent of fillet welds with liquid dye penetrant.
 - b. Test 100 percent of full penetration welds and partial penetration welds with ultrasonic, radiographic, or magnetic particle testing.
 - c. Inspect high strength bolting in accordance with section 6 of specification for structural joints.
 - d. Inspect stud welding in accordance with AWS code.

- e. Check 10 percent of members fabricated to verify they meet the dimensional tolerances specified in Section 05 12 10, Part 1.2, I.
- 3. Fabricators not certified shall have minimum ten years' experience and shall employ an approved testing agency to inspect fabrication work performed off site.
- 4. Testing agency shall furnish weekly inspection reports and a final report to Building Official and Architect certifying work was performed in accordance with specifications and approved shop drawings.
- D. Erector Qualifications:
 - 1. Minimum 10 years' experience in erection of structural steel.
 - 2. Certified as Certified Steel Erector by AISC quality Certification Program.
 - 3. Certification by other equivalent programs subject to approval of the Structural Engineer.
- E. Source Quality Control:
 - 1. Provide access and facilities for testing agency during shop and field inspections.
- F. Testing and Inspection: Testing, (except testing to qualify welders and as needed for Contractor's own quality control), will be performed at no cost to Contractor by a Testing/Inspection Agency employed by Owner. Owner's Testing/Inspection Agency may use nondestructive testing methods in addition to visual inspection to verify weld quality. Repair rejected welds as directed by Testing/ Inspection Agency at no additional cost to Owner.
- G. Provide testing and inspection agency with sufficient notification and access so that inspection and testing can be accomplished.
- H. Previous acceptance of material or finished members by testing and inspection agency or Architect shall not prevent its rejection at later date if it does not comply with specifications.
- I. Tolerances:
 - 1. Rolling: ASTM A6.
 - 2. Fabrication and Erection tolerances: AISC Code of Standard Practice.
- J. Complete final detailing of connections where details provided do not adequately reflect conditions.
 - 1. Connection arrangement and detail shall be consistent with details provided on Contract Documents.
 - 2. When applicable, use tables provided in AISC for selection. Arrangements shall match the type and strength of connection detail provided.
 - 3. Identify in submittal connections that do not conform to details provided in contract documents.
 - 4. Final arrangement and details of connections subject to review and approval of Structural Engineer Of Record.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Source and certification of quality for high-strength bolts, nuts, and washers.
 - 2. Technical data on base plate grout.
- B. Shop Drawings:
 - 1. Indicate details including cuts, copes, connections, holes, and welds. Indicate shop and field welds using AWS symbols. Indicate connections where high strength bolts are required.
 - 2. Headed stud placement drawings.
- C. Project Information:

1. Fabricator's AISC Certification or name of independent testing agency for use by non-certified fabricator along with proof that fabricator has 10 years' experience in fabrication of structural steel for buildings.
 2. Inspection reports and certification of shop fabrication by independent testing laboratory for non-certified fabricator.
 3. Steel erector's AISC Certification or proof that steel erector has 10 years' experience in erection of structural steel.
 4. Connection design calculations signed and sealed by Specialty Structural Engineer.
 5. Welding Procedure Specification (WPS) for shop and field welds.
- D. Contract Closeout information:
1. Certificate by fabricator that steel was fabricated in accordance with the approved contract documents.
 2. Certificate by erector that steel was erected in accordance with the approved erection plans and specifications.

PART 2 - PRODUCTS

2.1 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Steel, Structural W-Shapes and Tee's:
 1. ASTM A992 (50 ksi yield point).
- B. Steel, Structural Angles and Channels:
 1. ASTM A36.
- C. Steel plate
 1. ASTM A572 (50 ksi yield point)
- D. Pipe, Round:
 1. ASTM A53, Grade-B.
- E. Tubing, Round, Square, or Rectangular:
 1. ASTM A500, Grade-C. (50 ksi yield point for square or rectangular; 46 ksi yield point for round)
- F. Bolts, Nuts, and Washers, High Strength.
 1. Conform to RCSC Specification.
 2. Twist off style, conform to ASTM F3125 Grade F1852 (A325TC) and Grade F2280 (A490TC).
 - a. Approved bolts:
 - 1) Tension control bolt by LeJeune Bolt Company, Burnsville, MN.
 - 2) Tru-Tension Fasteners by Nucor Fastener a Division of Nucor Corporation, St. Joe, Indiana.
 - 3) Lohr Fasteners by Lohr Structural Fasteners, Humble, TX.
- G. Bolts, Nuts and Washers, Standard Strength:
 1. Bolts: ASTM A307, Type A.
 2. Nuts: ASTM A563.
 3. Washers plain: ANSI/ASME-B18.22.1.
- H. Anchor Rods, Standard Strength:
 1. Bolts or rod for threading: ASTM A36 or ASTM F1554-36 ksi.

2. Nuts and washers:
 - a. Nuts: ASTM A563.
 - b. Washers plain: ANSI/ASME-B18.22.1.
3. Thread tolerance: ANSI/ASME-B18.1, Class 2A.
- I. Welding Electrodes:
 1. Shielded metal-arc: AWS A5.1 or AWS A5.5, E70XX.
 2. Submerged-arc: AWS A5.17 or A5.23, F7X-EXXX.
 3. Gas metal-arc: AWS A5.18, ER70S-X.
 4. Flux cored-arc: AWS A5.20, E70T-X (except 2, 3, 10, GS).
- J. Headed Studs and Deformed Bar Anchors:
 1. Headed studs (HS)
 - a. Fabricated from cold drawn bar stock conforming to ASTM A 108, grades 1010 through 1020.
 - b. AWS D1.1 type B.
 - c. Minimum yield strength: 51 ksi.
 - d. Minimum tensile strength: 65 ksi over 3/8 inches diameter.
 - e. Minimum tensile strength: 55 ksi 3/8 inches diameter and under.
 2. Deformed bar anchors (DBA): Straight, unless otherwise indicated.
 - a. ASTM A1064.
 - b. Minimum yield strength: 70 ksi.
 - c. Minimum tensile strength: 80 ksi.
- K. Grout: Pourable.
 1. Base: L&M Construction Chemicals, Duragrout.
 2. Minimum Strength : 4000 psi at 7 days and 8000 psi at 28 days.
- L. Expansion Anchors:
 1. Expansion anchors shall be a single-end expansion shield anchor which complies with the descriptive part of Federal Specification FF-S325, Group II, Type 4, Class 1 for concrete expansion anchors. Anchors shall be Hilti Kwik Bolt TZ Expansion anchor by Hilti Fastening Systems (ICC Report No. ESR-1917) or equal.
- M. Adhesive Anchors:
 1. Threaded rods, bolts, etc., indicated as adhesive anchors into concrete or solid masonry:
 - a. HIT HY-200 adhesive by Hilti Fastening Systems or equal.
 - b. Unless indicated otherwise, adhesive anchor bolt shall conform to HAS - E Standard ISO Class 5.8 by Hilti or equal. Do not field cut rods without engineer's approval.

2.2 FABRICATION

- A. General:
 1. Fabricate and assemble material in shop to greatest extent possible.
 2. Use ASTM F1852 bolts, twist-off type, unless otherwise indicated.
 3. One sided or other types of eccentric connections not indicated, will not be permitted without prior approval.
 4. Bevels for field welds may be flame cut provided such cutting is done automatically. Leave free of burrs and slag.
 5. At HSS canopy members repair any surface defects.
 6. Accurately mill bearing ends of columns.
 7. Cut, drill, or punch holes at right angles to surface of metal.

- a. Do not make or enlarge holes by burning.
 - b. Make holes clean cut, without torn or ragged edges.
 - c. Remove outside burrs resulting from drilling or reaming operations with tool making 1/16 inches 1.6 mm bevel.
 - d. Provide holes in members to permit connection of work of other trades.
8. Make splices only as indicated.
9. Headed stud type shear connectors (H.S.) and deformed bar anchors (D.B.A.), on Drawings: Automatically end welded in accordance with AWS Code.
- a. When headed stud type shear connectors are to be either shop or field applied, clean top surface of beam flanges in shop to remove oil, scale, rust, dirt, and other materials injurious to satisfactory welding.
 - b. Fillet welding of headed studs and deformed anchors is not allowed without prior approval.
 - c. Do not weld studs when temperature is below 0 deg F -18 deg C or surface is wet with rain or snow.
 - d. After welding, remove ceramic ferrules and maintain clean and free from substances which would interfere with function as anchor or bond of deformed anchor bars.
 - e. Quality control: Weld minimum of 2 studs at start of each production period to determine proper generator, control unit, and stud welder settings.
 - 1) These studs shall be capable of being bent 45 degrees from vertical without weld failure. These studs shall not be included as a part of the required construction.
 - 2) All production studs shall be sounded by a sharp blow with a hammer.
 - 3) If, after welding, a stud does not ring when struck by a hammer or visual inspection reveals that sound weld or full 360 degree fillet has not been obtained for a particular stud, that stud shall be struck with hammer and bent approximately 15 degrees off perpendicular to nearest end of beam.
 - 4) Studs meeting this test shall be considered acceptable and shall be left in this position.
 - 5) Studs bent beyond 15 degrees shall be considered ineffective and replaced.
 - 6) Studs failing under this test shall be replaced.

B. Welding:

- 1. Welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work shall comply with AWS Code, and requirements indicated.
- 2. Test and qualify welding operators and tackers in compliance with AWS Code for position and type of welding to which they will be assigned.
 - a. Conduct tests in presence of approved testing agency.
 - b. Certification within last 12 months from a welding inspector will be acceptable provided samples of welder's work are satisfactory.
 - c. At discretion of testing agency, shop personnel continuously employed at welding process for which they have been qualified may be accepted from older qualification tests.
- 3. Qualify joint welding procedures or test in accordance with AWS qualification procedures.
- 4. Before start of welding work, meet with testing agency and welders to review and verify procedures.
- 5. Comply with AWS Code to minimize shrinkage and distortion stress.
- 6. Use back-up plates in accordance with AWS Code, extending minimum of 1 inch 25 mm either side of joint. Make flange welds before making web welds.
- 7. For manual shielded metal-arc welding: Comply with Article 4.6 of AWS Code.
- 8. Low hydrogen electrodes: Dry and store electrodes in compliance with AWS Code.

9. Do not perform welding when ambient temperature is lower than 0 deg F -18 deg C, or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.
10. Before starting welding:
 - a. Carefully plumb and align members.
 - b. Fully tighten bolts.
 - c. Assembly and surface preparation shall comply with AWS Code.
 - d. Preheat base metal to temperature stated in AWS Code.
 - 1) When no preheat temperature is given and base metal is below 32 deg F 0 deg C, preheat base metal to at least 70 deg F 21 deg C.
 - 2) Preheating shall bring surface of base metal within distance from point of welding equal to thickness of thicker part being welded or 3 inches 75 mm, whichever is greater, to specified preheat temperature.
 - 3) Maintain temperature during welding.
 - e. Each welder is to provide identifying mark at welds worked on.

2.3 SURFACE PREPARATION AND SHOP-APPLIED COATINGS

- A. Surfaces Not to be Coated:
 1. Do not coat following surfaces:
 - a. Surfaces to be fireproofed with spray-on material.
 - b. Machined surfaces, surfaces adjacent to field welds, contact surfaces of bolt connections where connection is specified as slip critical, and top of top flanges of beams.
 - c. Other members for which no coating is specified.
 2. Clean thoroughly before shipping; remove loose mill scale, rust, dirt, oil, and grease.
- B. Hot Dip Galvanized (HDG) Members:
 1. Galvanize following members:
 - a. Members set in, or in contact with, exterior surface material, including:
 - 1) Brick ledge angles.
 - 2) Embedded items in exterior surfaces.
 - b. Exterior exposed structure not indicated to be otherwise shop finished.
 - c. Other members indicated.
 2. Clean thoroughly before galvanizing.
 3. Galvanize in accordance with ASTM A123.
- C. Surfaces coated with Coal Tar Epoxy:
 1. Base Product: "46H-413 High-Build Tneme-Tar" by Tnemec.
 2. Apply coal tar epoxy to following surfaces:
 - a. Steel in contact with soil and not galvanized.
 3. Clean in accordance with SSPC-SP10, Near White Blast Cleaning.
 4. Apply in accordance with paint manufacturer's instructions.
 - a. 2 mils, dry film thickness.
 5. Finish Paint (applied in field): Specified in Section 09 91 23.
- D. Exterior Surfaces to be Shop Primed for Finish Paint:
 1. Primer: As recommended by finish (top) coat manufacturer for substrate.
 2. Finish Paint (applied in field): Specified in Section 09 91 13.
- E. Interior Surfaces to be Shop Primed for Finish Paint:

1. As recommended by top coat manufacturer for substrate.
2. Finish Paint (applied in field): Specified in Section 09 91 23.

PART 3 - EXECUTION

3.1 ERECTION

A. Safety:

1. Contractor is solely responsible for safety. Construction means and methods and sequencing of work is the prerogative of the Contractor.

B. Capacity of Partially Complete Construction:

1. Consider that full structural capacity of many structural members is not realized until structural assembly is complete; that is, until slabs, decks and the permanent lateral resisting system is installed. Partially complete structural members shall not be loaded out of sequence without an investigation.
2. Temporary lateral bracing for the partially complete structure will be required, until all elements of the permanent lateral resisting system are complete.

C. Temporary Bracing:

1. Provide adequate temporary bracing for stability and to resist loads to which the partially complete structure may be subjected including but not limited to, environmental conditions, construction activities and operation of equipment.
2. If not obvious from the drawings, confer with Engineer to identify structural elements requiring completion before structure's permanent lateral resisting system is effective.
 - a. Design of temporary bracing system must consider sequence and schedule of placement of such elements and effects of loads imposed on structural steel frame by partially or completely installed work of other trades.
 - b. Do not remove temporary bracing until the permanent lateral resisting system is effective.

D. General:

1. Set base and bearing plates accurately and grout immediately as indicated.
 - a. Use metal wedges, shims or setting nuts as required.
 - b. Pack grout solidly between plate and bearing surface.
2. Clean bearing and contact surfaces before assembly.

E. Install A325SC bolts with washers. Install and tighten in accordance with the RCSC Specifications or in accordance with manufacturer's instructions when twist-off bolts are used.

F. Use same requirements for field welding as for shop welding.

G. At Canopy members, remove piece marks after erection.

H. Do not use gas cutting to correct fabrication errors on major members.

1. Gas cutting on minor members may be permitted when members are not loaded, only after approval by Engineer.

I. Tighten and leave in place erection bolts used in welded construction.

J. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1:20 with a plane normal to bolt axis.

K. After installation, touch up damaged or abraded areas of primed steel using same materials used for shop priming.

1. Clean field welds, bolted connections, and abraded areas before touching up.

L. After installation, repair galvanized surfaces damaged or abraded using zinc rich paint in accordance with ASTM A780.

1. Surfaces to be repaired with paint containing zinc dust shall be clean, dry, and free of oil, grease, preexisting paint, corrosion, and rust.
2. Surfaces to be repaired shall be blast cleaned to the requirements of SPC SP10 (near white). Where circumstances do not allow blast or power tool cleaning to be used, then hand tools may be used. Cleaning shall meet the requirements of SSPC SP2 (removal of loose rust, mill scale, or paint to the degree specified by hand chipping, scraping, sanding, and wire brushing)
3. If areas /surfaces to be repaired include welds, remove weld flux residue and weld spatter by blasting, chipping, grinding, or power scaling.
4. Spray or brush apply the paints containing zinc dust to the prepared surfaces/areas. Apply the paint in accordance with the manufacturer's recommendations in a single application employing multiple passes to achieve a dry film thickness equal to the original zinc coating thickness.

END OF SECTION

SECTION 05 36 00
COMPOSITE METAL DECKING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Composite Metal Form Deck, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. American Iron and Steel Institute (AISI):
 - 1. Specification for Design of Cold-Formed Steel Structural Members.
- B. American Welding Society (AWS):
 - 1. ANSI/AWS D1.3 Structural Welding Code – Sheet Steel.
- C. Steel Deck Institute (SDI):
 - 1. Floor Deck Manual.
- D. Qualify welding processes and welding operators in accordance with AWS qualification procedures.
- E. Minimum Thickness:
 - 1. Where gage of metal is indicated, provide following minimum uncoated steel thickness, unless following performance requirements require greater thickness.

Gage	Minimum Thickness
18	0.045 inches

- F. Performance Requirements:
 - 1. Provide form deck to act as bottom form for cast-in-place concrete slabs and which will become positive slab reinforcement through mechanical anchorage after concrete hardens.
 - 2. Provide deck thickness such that maximum deck stress shall not exceed 0.6 its yield strength under combined weights of wet concrete (including weight of additional concrete due to structural deflection), deck, and construction live loading of either 20 psf uniform load or 150 pound concentrated load on a 1 foot wide section of deck.
 - 3. Provide deck with adequate thickness to limit maximum deflection relative to supporting structural members to 1/180 of clear span or 3/4 inches whichever is smaller, caused by combined weights of wet concrete and deck.
 - 4. Gage of deck furnished shall not be less than that indicated on the drawings.
 - 5. Configuration, physical and chemical properties, and composite superimposed load carrying capacity of deck units furnished shall conform to manufacturer's catalog current at time bids are received.
 - 6. Provide accessories (pour stops, column closures, end closures, cover plates, and girder fillers) as needed to prevent concrete leakage.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's load tables for deck to be furnished on this project.
- B. Shop Drawings:

1. Complete layout indicating types of deck panels, anchorage, supplementary framing, cut openings, accessories, deck thicknesses.
 2. Indicate areas requiring shoring on the shop drawings.
- C. Project Information:
1. Manufacturers analysis of unshored span limits.
 2. Shoring design and documentation prepared by a Licensed Structural Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Manufacturers and Designations:
1. Composite metal form deck, 3 inches:
 - a. Base:
 - 1) ASC Steel Deck; Type 3W.
 - 2) Canam United Steel Deck; Type 3 inches Lok Floor.
 - 3) CSM Metal Deck; Composite Floor Deck.
 - 4) New Millennium Building Systems; Composite Floor-Dek 3.
 - 5) Verco Manufacturing; Type W3 Formlok.
 - 6) Vulcraft; Type 3VLI.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Composite Metal Form Deck:
1. Cold formed from steel sheets, conforming to ASTM A653, Structural Quality, Grade-40 with G60 coating.
- B. Accessories:
1. Sheet steel closures, cover plates and other sheet steel accessories: Use same material and coating as for deck.

2.3 FABRICATION

- A. Extend deck over three or more spans with butted end laps.
- B. Form closures and cover plates to configuration required to form concrete and/or to prevent concrete leakage.
- C. Locate end laps and accessories to maintain capacity of field applied studs for composite beams.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which deck units are to be installed for conditions detrimental to proper and timely completion of work.
- B. Correct unsatisfactory conditions.

3.2 INSTALLATION

- A. General:
1. Do not overload supporting members.

2. Unless specifically noted otherwise, provide composite metal form deck for concrete slabs supported directly or indirectly by structural steel frame.
 3. Install deck units and accessories in accordance with final shop drawings and as specified herein.
 4. Do not start placing units before supporting members are completely installed.
 5. Bear deck units on supporting members minimum of 2 inches. Butt units tightly together at centerline of support. Place abutting units in accurate and close alignment for entire length of run.
 6. Neatly cut and fit deck units and accessories around columns, walls, and other objects projecting through or adjacent to deck. Install closures and cover plates as required to prevent concrete leakage.
 7. Install shoring where indicated on shop drawings.
- B. Openings:
1. Deliver deck to job site intact when openings in deck are indicated on drawings to be installed after concrete fill is cured. Openings installed in this manner shall be paid for by trade requiring opening.
 2. Where openings in floor are framed, deliver deck to job site cut to proper length.
- C. Fastening – Welded Connectors:
1. For welding deck to supports, employ only welders, qualified under AWS qualification procedures, and experienced in welding light gauge metal.
 2. Minimum deck fastening requirements:
 - a. At end of each unit and at intermediate supports: Puddle welds at 12 inches on center with not less than two welds per support.
 - b. At exterior beam parallel to deck span: Puddle welds or 1-1/4 inches seam welds at 24 inches on center.
 - c. At male-female side laps, 1-1/2 inches long seam welds or button punching at 24 inches on center.
 - d. At lapped side laps, 1-1/2 inches long seam welds at 24 inches on center.
 - e. Sheet metal closures, cover plates: Self-drilling screws or tack welds at 24 inches on center.
 3. Verify that minimum deck fastening requirements are adequate for safely supporting material and construction loads placed on deck from time of deck placement to time of concrete placement. Additional fastening required to accomplish this shall be provided and paid for by Contractor.
 4. Puddle welds shall have effective fusion diameter not less than 5/8 inches. Weld metal shall penetrate layers of deck material at end laps and be thoroughly fused to supporting members.

END OF SECTION

SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Cold-Formed Metal Framing in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM A1003 Standard Specification for Steel Sheet, Carbon, Metallic- and – Nonmetallic-Coated for Cold-Formed Framing Members.
 - 2. ASTM C1007 Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
- B. American Iron and Steel Institute (AISI):
 - 1. AISI S200 Series North American Standards for Cold-Formed Steel Framing.
- C. Provide Cold-Formed Metal Framing engineered to support dead, live, and lateral (wind or seismic) loads indicated.
 - 1. Comply with Section 01 71 21, Specialty Engineering Requirements.
 - 2. Include headers and reinforcing members around openings.
 - 3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.
 - 4. Design cold-formed metal framing to accommodate building drift.

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Complete building elevations defining framing member sizes, locations, and connection details.
 - a. Show openings, edges and support conditions field verified and coordinated with respect to location, physical requirements of items to be installed in or on exterior wall system.
- C. Project Information:
 - 1. Structural calculations for Cold Formed Metal Framing indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
 - a. Submit concurrent with Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Cold-Formed Metal Framing:
 - 1. Base:
 - a. ClarkDietrich Building Systems

2. Optional:
 - a. Telling Industries
 - b. California Expanded Metal Products Co.
 - c. Custom Stud Inc.
 - d. Marino\WARE
 - e. MBA Metal Framing
 - f. MRI Steel Framing LLC
 - g. The Steel Network
- B. Galvanizing Repair Coating:
 1. Base:
 - a. Tnemec
 2. Optional:
 - a. ZRC Worldwide
 - b. Sherwin Williams
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Design Cold-Formed Metal Framing to satisfy requirements of applicable building codes as locally amended, but not less than loads shown in contract documents.
 1. Design Exterior Soffits similarly.
 2. Include anticipated dead and live with lateral, wind or seismic, loads where details indicate cladding, soffits or equipment weights are carried by stud wall system.
- B. Limit lateral deflection of stud wall system due to wind or seismic as follows:

Maximum Allowable Deflection	
Exterior Finish Material	Deflection Limit
Marble, Granite, and other Stone Veneers	L/720
Brick and Concrete Masonry Veneers	L/600
Portland Cement Plaster (Stucco)	L/360
Manufactured Stone Veneer, Adhered Stone Veneer, Thin Brick, Tile, and similar Mortar-Set finishes.	L/360
Metal Panels, Curtain Walls, and other flexible wall finishes.	L/240

- C. Select stud gauge and spacing as required for strength and to limit deflection due to applied loads.
 1. Utilize properties of metal stud only.
 2. Do not include contributions provided by wallboard or sheathing.
 3. Design connections such that anticipated structural movements will not adversely affect system or cladding supported by system.
 - a. Allow for vertical beam deflections of span/600.
 - b. Allow for lateral interstory drift of story height/400.
 4. Design framing system to resist gravity loads and wind uplift at soffits.

2.3 MATERIALS

- A. Exterior Studs:

1. 33 ksi 227 MPA steel studs, runner channels and track, bracing, and accessories.
 - a. Revise thickness and minimum requirements if 50 ksi 345 MPa steel is used.
2. Coatings:
 - a. G60 Z180 galvanized.
 - b. A60 ZF180, AZ50 AZ150, or GF30 ZGF90 EQ coatings.
3. Stud depth:
 - a. As indicated on Drawings.
4. Span:
 - a. As indicated on Drawings.
5. Stud spacing:
 - a. Use closer spacing as needed to satisfy load deflection criteria.
 - b. 12 inches 300 mm OC minimum.
 - c. 16 inches 400 mm OC maximum.
6. Stud, runner, and track thickness:
 - a. Minimum: 43 mils (18 GA) 1.09 mm.
 - b. Increase member thickness where needed to satisfy loading and deflection criteria.
7. Deep-leg runner flange:
 - a. Minimum: 2 inches 50 mm.
8. Headers:
 - a. C-shapes used to form header beams.
 - b. Web depths and stiffened flanges as required.
 - c. Thickness: As determined by engineering calculations for specific opening.
9. Runner fasteners:
 - a. Power driven fasteners.
 - b. Minimum 190 pound 86 kg shear and bearing.
- B. Galvanizing Repair Coating:
 1. Tnemec Series 94-H20 Hydro-Zinc.
 2. ZRC Worldwide, Galvilite 221.
 3. Sherwin Williams Zinc Clad III HS 100.
- C. Gypsum Sheathing:
 1. See Section 06 16 43.
- D. Exterior Joint Sealants:
 1. See Section 07 92 13.
- E. Metal Backing:
 1. See Section 09 22 16.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrate for suitability to accept work.
- B. Start of work constitutes acceptance of substrate and responsibility for performance.

3.2 ERECTION

- A. Studs and Runners:
 1. Align outside deep leg runner track accurately according to exterior wall layout.

2. Fasten 12 inches 300 mm OC, or as needed to satisfy design criteria.
3. Position studs vertically in inside deep leg runners at required spacing.
4. Install minimum of two (2) studs each side of openings; use more if required to meet loadings.
5. Anchorage:
 - a. Top:
 - 1) Allow 3/4 inches 19 mm clearance between top of inside deep leg runner and outside deep leg runner.
 - 2) Do not fasten inside deep leg runner to outside deep leg runner.
 - 3) Fasten studs to inside deep leg runner.
 - b. Bottom:
 - 1) Anchor each stud at bottom to runners with two, 3/8 inches 9.5 mm minimum, type S-12 pan head screws.
6. Where stud design is outside edge of floor slab, provide galvanized connectors designed for loading requirements and allow individual floor movement without affecting integrity of stud system.
7. Shop weld assemblies as required to meet design requirements.
8. Touch-up burned off or abraded galvanizing with galvanizing repair coating.
- B. Openings:
 1. Install header, jamb, and sill framing system per approved engineering documents.
- C. Coordinate installation of wall blocking used to support wall-supported items with installation of Cold-Formed Metal Framing.

3.3 PROTECTION

- A. Protect erected wall and openings with temporary covers until finish, roofing, flashing, and windows are installed.

END OF SECTION

SECTION 05 45 23
EQUIPMENT SUPPORT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Equipment Support System, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Provide Equipment Support System engineered to support dead, live, lateral, and seismic loads indicated.
 - 1. Comply with Section 01 71 21, Specialty Engineering Requirements.
 - 2. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.
- B. Manufacturer Qualifications:
 - 1. Service office within 500 mile radius of project, functioning with full time personnel for minimum of 5 years.
 - 2. Maintain quality assurance program.
 - 3. Submit mill test reports for material.
- C. Installer Qualifications:
 - 1. Trained and certified by manufacturer with minimum 10 years' experience installing products comparable to those specified in this section.

1.3 REFERENCES

- A. American Iron and Steel Institute (AISI):
 - 1. AISI S200 Series North American Standards for Cold-Formed Steel Framing
- B. American Institute of Steel Construction (AISC):
 - 1. Steel Construction Manual
- C. American National Standards Institute (ANSI)/American Welding Society (AWS):
 - 1. ANSI/AWS C1.1M/C1.1 Recommended Practices for Resistance Welding
 - 2. ANSI/AWS D1.3/D1.3M Structural Welding Code - Steel
- D. ASTM:
 - 1. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - 2. ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 - 3. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate plan layout, typical elevations, anchoring methods.
- B. Product Data:

1. Manufacturers' product data sheets, details and installation instructions for Equipment Support System, properties of sections, components, and accessories.
- C. Project Information:
 1. Address of nearest stocking dealer.
 2. Equipment manufacturer's design load data.
 3. Structural calculations for equipment support system indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
 - a. Submit concurrent with Shop Drawings.
 4. Manufacturer Certification of Installer Qualifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Equipment Support System:
 1. Base:
 - a. Unistrut by Atkore
 2. Optional:
 - a. Eaton B-Line
 - b. Hilti Modular Support Systems
 - c. Thomas and Betts Superstrut
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Dedicated Equipment Supports:
 1. Provide support framing for each identified piece of ceiling mounted equipment.
 2. Coordinate with location of other utilities and building structure to minimize conflicts.
- B. Ceiling Anchorage:
 1. Attach to structure by means of embedded concrete inserts or by direct attachment to structural framing.
 2. Position expansion anchor with bolt loaded in shear when used to anchor metal framing to support structure.
 - a. Expansion anchors in tension are not permitted without Architect's approval.
- C. Design Load:
 1. Design Dedicated Equipment Supports based on actual dead loads and dynamic loads provided by equipment manufacturers.
 2. Equipment load is maximum encountered by positioning of equipment at extent of maximum travel load configuration.

2.3 MATERIALS

- A. Equipment Support System:
 1. Parallel metal channels flush with ceilings which allow attachment of equipment at any point without drilling or welding.
 2. Locate channels perpendicular to equipment tracks, at 26 to 28 inches.
 3. Provide supports; attach to building structure indicated.
 4. Arrange framing members above ceiling to avoid conflict with ductwork, lighting fixtures and other equipment.

5. Provide bracing to resist lateral design load.
 6. Provide removable flush cover strips painted white, for channels.
 7. Do not support any part of ceiling system on equipment support system.
- B. Framing Members:
1. Formed steel sheet, ASTM A1011, Grade-33 or ASTM A653/A653M, Grade-A.
 2. Finish:
 - a. Framing members and fittings: Corrosion resistant epoxy paint.
 - b. Color: Green
 - c. Hardware: Electrogalvanized, ASTM B633 Type-3-SC1
- C. Fittings and Fasteners:
1. Provide fittings, fasteners, clamps, and miscellaneous items to provide a complete and secure installation.
 2. Electrogalvanized.
- D. Bracing:
1. Provide bracing to resist lateral design load.
- E. Channel covers:
1. Provide channel covers at exposed surfaces after radiology equipment and supports are installed.
 2. Provide end cap at exposed channel ends.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Field measure to assure support system installation without interference with structural framing, mechanical systems, plumbing, or other obstructions.
- B. Report conflicts and proposed modification to installation to Architect before proceeding.
- C. Install equipment support structure in accordance with approved shop drawings.
- D. Install under supervision of manufacturer.
- E. Erection Tolerance:
1. Equipment support channels: Horizontal within 1/32 inches in 2 feet, and within 1/16 inches in 18 feet.
 2. Multiple equipment support channels: Horizontal in plane to each other within 1/32 inches.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Miscellaneous Metal Fabrications, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.
 - 1. Includes:
 - a. Misc steel,
 - b. Framing at trash enclosure
 - c. Framing generator enclosure.
 - d. Excavation for post bases.
 - e. Concrete foundation for posts and center drop for gates.
 - f. Manual gates and related hardware.

1.2 REFERENCES

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application
 - b. ASTM A36 Standard Specification for Carbon Structural Steel
 - c. ASTM A47 Standard Specification for Ferritic Malleable Iron Castings
 - d. ASTM A48 Standard Specification for Gray Iron Castings
 - e. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - f. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - g. ASTM A148 Standard Specification for Steel Castings, High Strength, for Structural Purposes
 - h. ASTM A197 Standard Specification for Cupola Malleable Iron
 - i. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 psi Tensile Strength
 - j. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
 - k. ASTM A354 Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
 - l. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
 - m. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - n. ASTM A668 Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
 - o. ASTM A992 Standard Specification for Structural Steel Shapes
 - 2. American Society of Mechanical Engineers (ASME):
 - a. ANSI/ASME-A17.1 Handbook on Safety Code for Elevators and Escalators
 - 3. American Institute of Steel Construction (AISC)
 - a. Steel Construction Manual

4. American Iron and Steel Institute (AISI):
 - a. Specification for the Design of Cold-Formed Steel Structural Members.
5. American Welding Society (AWS):
 - a. ANSI/AWS C1.1M/C1.1 Recommended Practices for Resistance Welding
 - b. ANSI/AWS D1.1 Structural Welding Code - Steel.
 - c. ANSI/AWS D1.3 Structural Welding Code - Sheet Steel.
6. National Association of Architectural Metals Manufacturers (NAAMM):
 - a. Class 1, Architectural, per NAAMM AMP-555, Code of Standard Practice for the Architectural Industry.

1.3 SUBMITTALS

- A. Product Data:
 1. For each type of material and accessory.
- B. Shop Drawings:
 1. Plans and elevations showing members and connections.
 2. Anchors and accessory items.
- C. Project Information:
 1. Structural calculations for Miscellaneous Metals Fabrications indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
 - a. Submit concurrent with Shop Drawings.

1.4 QUALITY ASSURANCE

- A. Provide Miscellaneous Metals Fabrications engineered to support dead, live, and lateral (wind or seismic) loads where indicated or required by code.
 1. Comply with Section 01 71 21 Specialty Engineering Requirements.
 2. Include headers and reinforcing members around openings.
 3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Materials Listed:
 1. Base: As noted.
- B. Galvanizing Repair Paint:
 1. Base:
 - a. Tnemec.
 2. Optional:
 - a. ZRC Worldwide.
 - b. Sherwin-Williams.
- C. Shop Primer:
 1. Base:
 - a. As recommended by finish coat manufacturer for substrate.
 2. Optional:
 - a. Sherwin-Williams.

- b. Tnemec.
- D. Coal Tar Epoxy: At trash/generator enclosure, where steel is to be embedded within footing.
 - 1. Base:
 - a. Tnemec.
 - 2. Optional:
 - a. ICI Dulux Paint Centers.
- E. Non-shrink Grout:
 - 1. Base:
 - a. Dayton Superior Corporation.
 - 2. Optional:
 - a. Sauereisen.
 - b. CGM Building Products.
- F. Decorative Bollard Covers:
 - 1. Base:
 - a. Innoplast.
- G. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Structural Steel:
 - 1. Structural W and T shapes: ASTM A992, 50 ksi yield point.
 - 2. Other steel shapes and plate: ASTM A36.
 - 3. Pipe: ASTM A53 Grade B.
 - 4. Tubing: ASTM A500, Grade B, 46 ksi minimum.
- B. Cast Steel:
 - 1. ASTM A27, Grade-65-35; and ASTM A148, Grade-80-50.
- C. Steel Forgings:
 - 1. ASTM A668.
- D. Bolts:
 - 1. ASTM A307, ASTM A325, ASTM A354.
- E. Filler Metal:
 - 1. AWS Standards.
- F. Cast Iron:
 - 1. ASTM A48, Class 30, minimum 30,000 psi 206.8 MPa tensile strength.
- G. Malleable Iron:
 - 1. ASTM A47 and ASTM A197.
- H. Aluminum:
 - 1. ASTM B308 for particular alloy in standard shapes and extrusions.
 - 2. ASTM B26 for castings.
- I. Anchorage Devices:
 - 1. Standard manufactured items.
 - 2. Lead expansion shields for machine screws and bolts 1/4 inch 6 mm and smaller: Head out embedded nut type.

3. For machine screws and bolts larger than 1/4 inch 6 mm: Manufacturers' standard.
 4. Bolt anchor expansion shields for lag bolts: Zinc alloy, long shield anchors.
 5. Bolt anchor expansion shields for bolts: Closed end bottom bearing type.
 6. Anchor to embed or set device in setting compound or epoxy grout where shown.
- J. Fasteners:
1. Galvanized or stainless where built into exterior walls.
 2. Select fasteners for type, grade and class required.
 3. Bolts and Nuts: Regular hexagon head ASTM A307, Grade A.
 4. Lag Bolts: Square or octagonal head type.
 5. Machine Screws: Zinc-Nickel plated steel.
 6. Wood Screws: Flat head carbon steel.
 7. Plain Washers: Round carbon steel.
 8. Lock Washers: Helical spring carbon steel.
- K. Non-shrink Grout:
1. Compressive strength: 9000 psi 62 MPa at 7 days.
 2. Base Product: 1107 Advantage Grout by Dayton Superior.
- L. Abrasive Warning Tape:
1. Self-adhering, tape with slip resistant mineral surface
 2. Color: Safety Yellow
 3. Width: 2 inches 50 mm, except where noted otherwise
 4. Tape Type 2:
 - a. Base Product: Safety-Walk 530 Conformable by 3M
 - b. Backing: Aluminum foil
 - c. Thickness: 0.035 inches 0.9 mm
 - d. Use Type 2 at top and bottom rungs of ladders.
 - e. Use at stair nosing at top and bottom of each flight.

2.3 FABRICATION

- A. Form to shapes indicated with straight lines, sharp angles, and smooth curves.
- B. Shop-fabricate in as large assemblies as practicable.
- C. Anchorage Accessories:
 1. Items required securing wood to metal, wood to masonry, metals to masonry or concrete, metal to metal or metal to other items.
- D. Drill or punch holes with smooth edges for temporary field connections and attachment of work by other trades.
 1. Conceal fastenings where practicable.
- E. Make permanent shop and field connections with continuous fillet type welds.
 1. Grind exposed welds smooth.
- F. Supply items required to complete construction and installation.
- G. Meet requirements specified under Structural Steel for fabricating items of structural nature or use.

2.4 FINISHES

- A. Items not to receive coatings:
 1. Surfaces scheduled to be fireproofed with spray-on material.

2. Machined surfaces.
 3. Surfaces adjacent to field welds.
 4. Contact surfaces of bolt connections at slip connections.
 5. Top flanges of beams to receive shear connectors.
 6. Items for which no coating or field finish is specified.
- B. Shop Primer for Interior Non-wet Items:
1. Primer: Coordinate with field applied finish systems specified in Section 09 91 23.
 2. Apply primer for interior finish paint to following surfaces not receiving other coating:
 - a. Surfaces exposed on interior.
 3. Clean thoroughly before priming; remove mill scale, rust, dirt, oil, and grease in accordance with SSPC-SP3.
 4. Apply in accordance with paint manufacturer's instructions.
 - a. Apply minimum 0.002 inch 0.05 mm, dry film thickness.
- C. Hot-dip Galvanized (HDG) Coating for Exterior Items:
1. Galvanize (HDG) the following items:
 - a. Items to be installed on site, roof or other areas that are outside of building enclosure walls. This shall include items attached to exterior walls of building.
 - b. Items to be installed in wet or humid (greater than 70 percent RH) areas of building.
 - c. Partial listing of items to receive HDG:
 - 1) Masonry lintels, ledge angles and shelf angles.
 - 2) Pipe Bollards.
 - 3) Exterior Ladders, Stairs, and railings.
 - 4) Exterior gratings and substructure.
 - 5) Exterior equipment supports.
 - 6) Similar items which are exposed to weather or built-in to Exterior walls.
 - 7) Other items indicated.
 2. Clean thoroughly before galvanizing.
 3. Galvanize in accordance with ASTM A123.
- D. Galvanizing Repair Coating:
1. Tnemec Series 94-H20 Hydro-Zinc.
 2. ZRC Worldwide, Galvilite 221.
 3. Sherwin Williams Zinc Clad III HS 100.
- E. Surfaces Coated with Coal Tar Epoxy:
1. Base Product: 46H-413 High-Build Theme-Tar by Tnemec.
 2. Apply coal tar epoxy to following surfaces:
 - a. Steel in contact with soil and not galvanized.
 3. Clean in accordance with SSPC-SP10, Near White Blast Cleaning.
 4. Apply in accordance with paint manufacturer's instructions.
 - a. Apply minimum of 14 to 20 mils 0.36 to 0.5 mm, dry film thickness.
- F. Shop-primer Coating for Exterior Items:
1. Primer: Tnemec, Series 94- H20 Hydro-Zinc.
 2. Primer: Sherwin-Williams Pro-Cryl Universal Acrylic Primer, B66-310 Series.
 3. Primer: Coordinate with finish systems specified in Section 09 91 13.
 4. Apply primer for exterior finish paint to following surfaces:

- a. Steel exposed permanently to weather and not galvanized.
 - 5. Clean in accordance with SSPC-SP6, Commercial Blast Cleaning.
 - 6. Apply in accordance with paint manufacturer's instructions.
 - a. Apply minimum 0.0025-inch 0.06 mm, dry film thickness.
 - 7. Finish Paint (applied in field): Specified in Section 09 91 13.
- G. Finish Painting:
- 1. Exterior: See Section 09 91 13.
 - 2. Interior: See Section 09 91 23.

2.5 METAL FABRICATIONS

A. Ladders:

- 1. Design to comply with following regulations:
 - a. ANSI A14.3.
 - b. OSHA 29 1910.23.
- 2. Coordinate details with Owner provided fall arrest system where desired or required.
- 3. Material:
 - a. Exterior Ladders: Galvanized steel, painted by Section 09 91 13.
 - b. Interior Ladders: Shop-primed steel, painted by Section 09 91 23.
- 4. Side rail members: Minimum 1/2 by 2 inches 13 by 25 mm.
 - a. Rail clip: Minimum 5/16 by 2 inches 8 mm by 25 mm, length as necessary.
- 5. Rungs: Minimum 3/4 inch 19 mm round or square bars.
 - a. Punch rungs through side rails and weld.
- 6. Size to support concentrated moving load of 200 pounds 90.7 kg.
- 7. Minimum clearance from centerline of rung to wall or obstruction: 7 inches 180 mm.
- 8. Minimum ladder width: 16 inches 400 mm between side rails.
- 9. Rung spacing: 12 inches 300 mm O.C.
- 10. Apply abrasive warning tape Type 2 to top and bottom rung of ladders.
- 11. Ladder Safety Device:
 - a. OSHA compliant fall protection system.
 - 1) Provided by Owner on ladders over 20 feet 6 m high.
 - 2) OSHA compliant fall arrest system attached to ladder.
 - a) Base Product: DBI SALA 61180 Lad-Saf Cable Vertical Safety 2-User System, galvanized Steel, by 3M.
 - b) Coordinate cable length with ladder height.
 - c) Harness and other accessories provided by Owner.
- 12. Elevator pit ladders:
 - a. Comply with general items above, except as amended by following:
 - b. Extend from bottom of pit to 4 feet 1.2 m above floor level.
 - c. Rungs: Minimum 3/4 inches 19 mm round or square bars.
 - d. Rung clearance: 4-1/2 inches 115 mm clear from face of rung to face of pit wall.
 - e. Maximum projection from wall: 8 inches 200 mm or as directed by locally adopted codes and elevator running clearances.
 - f. Comply with ANSI/ASME-A17.1.
 - g. Coordinate final dimensions and locations with Elevator contractor.

B. Metal Gratings:

- 1. Complying with NAAMM Metal Bar Grating Manual.

2. Material and thickness (except were otherwise indicated):
 - a. Galvanized steel, nominal 1-1/2 inches 38 mm thick.
 3. Load capacity: Support minimum uniform load of 100 psf 5 kPa.
 4. Provide hold down clips.
 5. Furnish with frames and support items of comparable material and finish.
- C. Steel Support Angles, Support Frames, and Loose Lintel Steel Members:
1. ASTM A36 steel, sizes and configurations as indicated.
 2. Items to be hot dip galvanized:
 - a. Items to be permanently exposed to weather, high humidity, or wet conditions.
 - b. Items set into exterior walls.
 3. Shop prime interior items not required to be galvanized.
- D. Miscellaneous Equipment Supports:
1. ASTM A36 steel, Sizes and configurations as indicated.
 2. Examples of items included:
 - a. Supports for Folding Partitions, Operable Walls, Coiling Doors, and Grilles.
 - b. Supports for ICU Doors.
 - c. Support of Medical Equipment including Surgical Lights, Power Columns. And other items indicated.
 - d. Ceiling hung toilet partitions.
 - e. Other miscellaneous support items as indicated.
 3. Items to be hot dipped galvanized:
 - a. Items to be permanently exposed to weather, high-humidity, or wet conditions.
 - b. Items set into exterior walls.
 4. Shop Prime interior items in non-wet areas.
- E. Bollards:
1. Provide where indicated.
 2. Supply items required to complete construction and installation.
 3. Minimum Workmanship Standards (unless noted otherwise): Class 1, Architectural, per NAAMM AMP-555, Code of Standard Practice for the Architectural Industry.
 4. Utility Bollards Type UB-1:
 - a. 6 inch 150 mm nominal diameter extra strength, HDG (galvanized), steel pipe or round structural tube.
 - b. Length: Unless otherwise indicated; minimum 42 inch 1050 mm projection above ground and 36 inch embedment into concrete.
 - c. Fabricate with welded on anchors.
 - d. Fill bollard with 3000 psi 20.7 MPa concrete with rounded top.
 - e. Field paint by Division 09. Color as selected by Architect.
 5. Steel Bollards with Decorative Cover Type DB-1:
 - a. Assembly including a concrete filled steel pipe with a decorative cover sleeve.
 - b. Steel pipe bollard:
 - 1) 6 inch 150 mm nominal diameter extra strength, hot dip galvanized steel pipe or round structural tube.
 - 2) Length: Unless otherwise indicated; minimum 42 inch 1050 mm projection above ground and 36 inch 900 mm embedment into concrete.
 - 3) Fabricate with welded on anchors.
 - 4) Fill with 3000 psi 20.7 MPa concrete, flush at top.

F. Steel Fence:

1. Steel member Shapes and Sizes: As indicated on Drawings.
 - a. Top Caps: At all vertical posts, fully cap and enclose the opening, continuous weld full perimeter of end cap.
2. Steel members fabricated to dimensions and configurations indicated on Drawings.
 - a. Weld connections.
3. Shop-fabricate to maximum extent possible for ease of site installation.
4. Galvanic Protection:
5. For items located on exterior or wet areas.
 - a. Weld connections prior to application of hot-dip galvanization.
 - b. Hot dip galvanized, fabricated units in accordance with ASTM A123.
6. Field Painted
 - a. Prepare and Paint in field by Division 09.
7. Post Footings: Concrete footing to diameter and depth shown on Drawings.
 - a. At all posts and at center drop rod location.
 - b. Concrete: Type specified in Div 03.
8. Gates:
 - a. Fabricate gates to permit 180-degree swing.
 - b. Gates Construction: ASTM F900 with welded corners. Use of corner fittings is not permitted.
 - c. Gate Hardware:
 - 1) 180 degree gate hinges
 - 2) Center gate stop and drop rod.
 - 3) Mechanical keepers.
 - 4) Padlock hasp.
 - a) Padlock by Owner.
 - 5) Gate Pull:
 - a) Base Product: BF105-RKW by Rockwood
 - b) Mounting type 1HD
 - c) Finish: Powder Coat, black.
 - 6) Casters at base of gate, swing side.
9. Sheet metal backing as noted on Drawings:
 - a. PVDF coated sheet metal, 14 GA.
 - b. Install cold-formed metal framing at 16 IN o.c. within steel framing openings, where steel backing is to be installed.
 - c. Field paint steel and cold-formed metal framing prior to the installation of slats of sheet metal backing. See exterior painting spec: epoxy at exterior atmospheric exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrate to accept installation.
- B. Installation constitutes acceptance of responsibility for performance.
- C. Verify wall backing has been installed for wall-mounted items specified in this Section.
 1. See Section 09 22 16.

3.2 INSTALLATION

- A. General:

1. Set work level, true to line, plumb.
 2. Weld field connections and grind smooth.
 3. Conceal fastenings where practical.
 4. Secure metal to wood with lag screws of adequate size with appropriate washers.
 5. Secure metal to concrete with embedded anchors, setting compounds, caulking and sleeves, or setting grout.
 - a. Use expansion bolts, toggle bolts, or screws for light duty service.
 6. Meet structural requirements for erecting items of structural nature.
 7. Do not field splice fabricated items unless size requires splicing.
 8. Weld splices.
 9. Provide fabricated items complete with attachment devices as required to install.
- B. Galvanic Repair:
1. After galvanized units have been erected and anchored apply galvanizing repair paint in accordance with manufacturer's recommendations.
 2. Surface preparation: Remove contaminates in accordance with SSPC SP-1.
- C. Bollards:
1. Direct buried:
 - a. Hole Depth: 6 inches 150 mm deeper than embedment length specified for bollard.
 - b. Hole Diameter: 24 inch 600 mm diameter for 6 inch 150 mm diameter bollard.
 - c. Set bollards plumb and to the exposure height indicated.
 2. Surface bolted and other means of attachment: Install as detailed.
 3. Fill annular space with concrete fill having a compressive strength of at least 3000 psi 20.7 MPa.
 4. Paint or cover with decorative sleeves as scheduled.
- D. Fencing:
1. Excavate holes for posts to diameter and spacing indicated on Drawings without disturbing underlying materials.
 2. Set intermediate, terminal, gate, and posts plumb, in concrete footings with top of footing 6 inches 150 mm below finish grade. Cast floor of enclosure at grade, over top of footing. Slope floor uniformly toward outside edges, with crown at center.
 3. Center and align posts. Place concrete around posts and vibrate or tamp for consolidation. Verify vertical and top alignment of posts and make necessary corrections.
 4. Allow footings to cure minimum 7 days before installing fabric and other materials attached to posts.
 5. Post Footing Depth Below Finish Grade: ASTM F567, 5 feet 6 inches.
 6. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.
 7. Install center and bottom brace rail on corner gate leaves.
 8. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

3.3 TOUCH-UP AND REPAIR

- A. Verify installations are neat and flush in appearance, and that there are no burrs, projections, or defects on exposed surfaces that might snag fingers or clothing. Correct deficiencies.
- B. Touch-up damage to powder coat finishes in manner satisfactory to Architect.
- C. Galvanic Repair:

1. After galvanized units have been erected and anchored apply galvanizing repair paint in accordance with manufacturer's recommendations.
2. Surface Preparation: Remove contaminants in accordance with SSPC SP-1.

END OF SECTION

SECTION 05 51 00
METAL STAIRS AND RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Steel Stairs and Railings, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application
 - 2. ASTM A36 Standard Specification for Carbon Structural Steel
 - 3. ASTM A47 Standard Specification for Ferritic Malleable Iron Castings
 - 4. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - 5. ASTM A148 Standard Specification for Steel Castings, High Strength, for Structural Purposes
 - 6. ASTM A276 Standard Specification for Stainless Steel Bars and Shapes
 - 7. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 psi Tensile Strength
 - 8. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
 - 9. ASTM A354 Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
 - 10. ASTM A480 Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
 - 11. ASTM A484 Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings
 - 12. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
 - 13. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
 - 14. ASTM A668 Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
 - 15. ASTM E303 Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
- B. American Institute of Steel Construction (AISC)
 - 1. Steel Construction Manual.
- C. American Iron and Steel Institute (AISI):
 - 1. Specification for the Design of Cold-Formed Steel Structural Members.
- D. American Welding Society (AWS):
 - 1. ANSI/AWS D1.1 Structural Welding Code - Steel.
 - 2. ANSI/AWS D1.3 Structural Welding Code - Sheet Steel.
- E. National Association of Architectural Metals Manufacturers (NAAMM):
 - 1. NAAMM AMP-555, Code of Standard Practice for the Architectural Industry

- a. Class 1, Architectural.
 - 2. NAAMM AMP 521, Pipe Railings Systems Manual, and NAAMM AMP-510, Metal Stairs Manual.
- F. Workmanship Standards:
- 1. Railing System Joints: Continuous fillet weld. Type 1 Railing System Joint Construction.
 - 2. Comply with National Ornamental & Miscellaneous Metals Association (NOMMA).

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Layout drawings indicating rise and run.
 - 2. Include full sections, details, handrails, guardrails, and anchoring methods.
- C. Project Information:
 - 1. Structural calculations for stairs, handrails, guardrails and embeds indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
 - a. Submit concurrent with Shop Drawings.

1.4 QUALITY ASSURANCE

- A. Provide Steel Stairs and Railings engineered to support dead, live, lateral, and seismic loads indicated:
 - 1. Include calculations for load-bearing components of stairs and landings.
 - 2. Comply with Section 01 71 21, Specialty Engineering Requirements.
 - 3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.
 - 4. Physical adequacy of structural design and conformance with applicable building codes are responsibility of stair fabricator.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Steel Stairs and Railing:
 - 1. Shop fabricated.
- B. Galvanizing Repair Paint:
 - 1. Base:
 - a. Tnemec.
 - 2. Optional:
 - a. ZRC Worldwide.
 - b. Sherwin-Williams.
- C. Shop Primer:
 - 1. Base:
 - a. As recommended by finish coat manufacturer for substrate.
 - 2. Optional:
 - a. Sherwin-Williams.
 - b. Tnemec.

D. Non-shrink Grout:

1. Base:
 - a. Dayton Superior Corporation.
2. Optional:
 - a. Sauereisen.
 - b. CGM Building Products (Por-Rok).

E. Abrasive Warning Tape:

1. Base:
 - a. 3M.

F. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

A. Design, fabricate, and install in compliance with applicable codes.

1. Enclosed Stairs: Commercial Class per latest edition NAAMM AMP-510, Metal Stairs Manual.
2. Non-enclosed and monumental stairs: Architectural Class per latest edition NAAMM AMP-510, Metal Stairs Manual.

B. Fabricate and design stair and landing assembly to support larger of following loads, whichever results in strongest components:

1. Design Concentrated Moving Load: 300 pounds 136 kg.
2. Design Uniform Load: 100 psf 4790 Pa.
3. Form surface with slip resistant materials.
 - a. See Section 03 35 00.

C. Handrails and Guardrails:

1. Form to profiles indicated.
2. Utilize following loads for design of indicated members and their direct or indirect connection to building superstructure.
 - a. Handrails and top rail of Guardrails, Uniform Load: 50 pounds/LF 75 kg/M minimum applied in any direction.
 - b. Handrails, Concentrated Load: 200 pounds 90.7 kg minimum applied in any direction at any point along rail.
 - c. Guardrail, Concentrated Load: 200 pounds 90.7 kg minimum applied in any direction at any point along rail.
 - d. Uniform and concentrated loads need not be concurrently applied.
3. Intermediate Rails, Balusters, Panels, and other Infill Materials:
 - a. Design to withstand a horizontal applied normal load of 50 pounds 75 kg/M minimum on an area not to exceed 1 square feet 0.093 m² including openings and space between rails.

D. Support stairs at locations indicated.

2.3 MATERIALS

A. Support Brackets and Posts:

1. Attach to structure as required, use welded connections wherever possible.
2. Use concrete expansion anchors for shear connections only.

B. Stringers:

1. Channel shape: MC12, minimum.

2. Design outside stringers span flight length plus landing.
 - a. Intermediate supports are not allowed without prior approval.
- C. Treads:
 1. Steel pans with angle supports as required.
 - a. Minimum 14 GA 1.9 mm thickness.
 - b. Plain steel welded wire reinforcement.
 - c. Fill with concrete specified in Section 03 30 00.
 - d. Coordinate concrete finish with finish flooring.
- D. Risers:
 1. Minimum 14 GA 1.9 mm steel.
- E. Landings:
 1. Minimum 10 GA 3.4 mm pans with angle supports as required.
- F. Metal Lath:
 1. Self-furring diamond mesh with dimples or embossed ribs.
 2. Maintain metal lath, 1/4 inches 6 mm minimum, above tread and landing steel pans.
- G. Abrasive Warning Tape:
 1. Base Product: Safety-Walk 630 General Purpose Tread by 3M.
 2. Use at first and last stair nosings of stair runs.
 3. Self-adhering tape with slip resistant mineral surface.
 4. Color: Safety Yellow.
 5. Width: 2 inches 50 mm, except where noted otherwise.
 6. Thickness: 0.03 inches 0.7 mm.
 7. Do not use where rubber stair treads or carpet is scheduled.
- H. Handrails:
 1. Round Tube: HSS 1.66.x 0.140; ASTM A500.
 2. Schedule 40 Pipe: 1-1/4 inches 32 mm STD; ASTM A53.
 3. Minimum Clearance from wall: 2-1/4 inches 57 mm.
 4. Maximum projection from wall: 4-1/2 inches 115 mm.
 5. Maximum span between mounting brackets and/or newel posts: 8 feet 2.44 M.
 6. Return ends of wall mounted rails to wall.
 7. Make rails smooth with no projections to prevent a hand from sliding along entire length.
- I. Guardrails:
 1. Increase sizes where appropriate to resist design loads.
 2. Refer to drawings for depiction of guardrails.
 3. Maximum span between mounting brackets and newel posts: 8 feet 2.44 M.
 4. Newel posts:
 - a. Round tube: HSS 1.66.x 0.140; ASTM A500.
 - b. Round tube: Schedule 40 Pipe: 1-1/4 inches STD; ASTM A53.
 5. Top rails and bottom rails:
 - a. Round tube: HSS 1.66.x 0.140; ASTM A500.
 - b. Round tube: Schedule 40 Pipe: 1-1/4 inches 38 mm STD; ASTM A53.
 6. Balusters/pickets:

- a. Definition: Vertical elements spanning between top rails and bottom rails in a guardrail panel.
 - b. Round bar: 1/2 inches 13 mm.
- 7. Intermediate Rails:
 - a. Construct parallel to top and bottom rails and spanning the length of a guardrail panel.
 - b. Use only in non-public areas.
 - c. Round tube: Schedule 40 Pipe: 1-1/4 inches STD; ASTM A53
- J. Non-shrink Grout:
 - 1. Compressive strength: 6,000 psi 41.4 MPa at 7 days.
 - 2. Base Product: 1107 Advantage Grout by Dayton Superior Corporation.
- K. Anchorage Devices:
 - 1. Items required securing wood to metal, wood to masonry, metals to masonry, or concrete, metal-to-metal, or metal to other items.
 - 2. Galvanized or stainless where built into exterior walls.
 - 3. Select fasteners for type, grade, and class required.
 - 4. Bolts and Nuts: Regular hexagon head ASTM A307, Grade A.
 - 5. Lag Bolts: Square or octagonal head type.
 - 6. Machine Screws: Zinc-Nickel plated steel.
 - 7. Wood Screws: Flat head carbon steel.
 - 8. Plain Washers: Round, carbon steel.
 - 9. Lock Washers: Helical spring carbon steel.
 - 10. Lead expansion shields for machine screws and bolts 1/4 inches 6 mm and smaller: Head out embedded nut type.
 - a. For machine screws and bolts larger than 1/4 inches 6 mm: Manufacturers' standard.

2.4 FABRICATION

- A. Form to shapes indicated with straight lines, sharp angles, and smooth curves.
- B. Drill or punch holes with smooth edges for temporary field connections and attachment by work of other trades.
- C. Qualify welding processes and welding operators in accordance with American Welding Society.
- D. Make permanent shop and field connections with continuous fillet type welds.
- E. Grind exposed welds smooth and blend seamlessly into pipe.
- F. Conceal fastenings where practicable.
- G. Shop-fabricate in as large assemblies as practicable.
- H. Meet requirements specified under Structural Steel for fabricating items of structural nature or use.

2.5 FINISHES

- A. Shop Primer for Interior (non-wet) Items:
 - 1. Coordinate with finish systems specified in Section 09 91 23.
 - 2. Apply primer for interior finish paint to following surfaces not receiving other coating:
 - a. Surfaces exposed on interior.
 - 3. Clean thoroughly before priming; remove mill scale, rust, dirt, oil, and grease in accordance with SSPC-SP3.
 - 4. Apply in accordance with paint manufacturer's instructions.

- a. Apply minimum 0.002 inches 0.05 mm, dry film thickness.
- B. Hot Dip Galvanized (HDG) Coating for Exterior items:
 - 1. Galvanize following items:
 - a. Handrails, guardrails, and items installed outside building enclosure on site, roof, and walls.
 - b. Items installed in wet or humid areas of greater than 70% RH, inside building.
 - c. Apply HDG coating after cutting, drilling, grinding, welding and other fabrication has been completed.
 - 2. Clean thoroughly prior to galvanizing.
 - 3. Galvanize in accordance with ASTM A123.
 - 4. Prep all exterior galvanized elements to receive paint.
- C. Galvanizing Repair Coating:
 - 1. Tnemec Series 94-H20 Hydro-Zinc.
 - 2. ZRC Worldwide, Galviline 221.
 - 3. Sherwin Williams Zinc Clad III HS 100.
- D. Finish Painting:
 - 1. Exterior: See Section 09 91 13.
 - 2. Interior: See Section 09 91 23.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrate to accept installation.
- B. Installation constitutes acceptance of responsibility for performance.
- C. Verify wall backing has been installed where required for handrails and similar wall-mounted items.

3.2 INSTALLATION

- A. General:
 - 1. Shim and grout as required to set work plumb, level, and true to line.
 - 2. Weld field connections and grind smooth.
 - 3. Conceal fastenings where practical.
 - 4. Secure metal to wood with lag screws and washers.
 - 5. Secure metal to concrete with embedded anchors, setting compounds, caulking and sleeves, or setting grout.
 - 6. Meet design requirements for erecting structural components.
 - 7. Do not field splice fabricated items unless size requires splicing.
 - 8. Weld splices and grind smooth.
 - 9. Provide fabricated items complete with attachment devices as required to install.
- B. Galvanic Repair:
 - 1. Repair abraded areas with galvanizing paint in accordance with manufacturer's recommendations.
 - 2. Surface preparation: Remove contaminants in accordance with SSPC SP-1.
- C. Handrails:
 - 1. Furnish handrails complete with brackets.
 - 2. Coordinate locations and installation of wall backing.

3. Where posts are indicated to be set in sleeves, provide galvanized steel sleeves having a minimum wall thickness of 1/8 inches 3 mm.
4. Set newels or balusters in sleeves with non-shrink grout.
5. Where setting is required for exterior, hold non-shrink grout back 1/4 inches 6 mm from surface and fill flush with self-leveling sealant.

D. Abrasive Warning Tapes:

1. Schedule installation immediately prior to Substantial Completion.
2. Clean and prepare surfaces to receive tape prior to application.
3. Apply tape in accordance with manufacturer's instructions.
4. Where tape is damaged by construction activities, remove, clean, and reapply new material.

END OF SECTION



DIVISION 06

WOOD, PLASTICS, AND COMPOSITES



SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Rough Carpentry, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Lumber Grading Rules and Species:
 - 1. US Department of Commerce (DOC):
 - a. PS 20 American Softwood Lumber Standard.
 - 2. Western Wood Products Association (WWPA).
 - 3. Southern Forest Products Association (SFPA).
- B. Plywood Grading Rules and Recommendations:
 - 1. US Department of Commerce (DOC):
 - a. Softwood plywood: PS1 Structural Plywood.
 - 2. American Plywood Association (APA).
- C. Preservative and Fire Retardant Treatment Standards:
 - 1. American Wood Protection Association (AWPA):
 - a. AWPA U1 User Specification for Treated Wood.
 - b. AWPA T1 Processing and Treatment Standard.
 - 2. Underwriters Laboratories (UL)
 - 3. ASTM International requirements:
 - a. ASTM E84 Standard Test Method for Surface Burning Characteristics
 - b. ASTM D2898 Standard Method of Accelerated Weathering of Fire Retardant Treated Wood for Fire Testing
 - c. ASTM D3201 Standard Test Method for Hygroscopic Properties of Fire-Retardant Wood and Wood-Based Products

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Fabricated items.
 - 2. Fastener Patterns: Full-size templates for fasteners in exposed framing.
- C. Project Information:
 - 1. Certification of fire retardant treated material.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

B. Factory Marking:

1. Identify type, grade, moisture content, inspection service, producing mill, and other qualities.
2. Mark each piece of fire retardant treated material with Underwriters Laboratory Classification mark and fire-retardant treatment for identification.
3. International Building Code (IBC):
 - a. Requirements for identification and labeling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fire-retardant Treated Lumber and Plywood:

1. Base:
 - a. Hoover Treated Wood Products, Inc.
2. Optional:
 - a. Arxada.
 - b. Koppers Performance Chemicals.
 - c. Viance, LLC.

B. Preservative Treated Lumber and Plywood:

1. Base:
 - a. Hoover Treated Wood Products.
2. Optional:
 - a. Arxada.
 - b. Koppers Performance Chemicals.
 - c. Stella-Jones, Inc.
 - d. Viance, LLC.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Dimensional Lumber and Plywood:

1. Thoroughly seasoned, non-treated, well-fabricated materials.
2. Longest practical lengths and sizes.
3. Application, except where treated types are indicated:
 - a. Non-structural framing, blocking, backing, nailers, grounds, and similar members.
 - b. Other locations where indicated.

B. Fire-retardant Treated Lumber and Plywood (FRT):

1. Flame spread index: Less than 25.
2. Smoke developed index: Less than 450.
3. Free of halogens, sulfates, chlorides, arsenic, ammonium phosphate, formaldehyde, and urea formaldehyde.
4. Kiln dried after treatment, (KDAT).
5. FRT material for interior and above grade locations:
 - a. Base: PyroGuard by Hoover Treated Wood Products, Incorporated
 - b. Optional:
 - 1) Dricon FS by Arxada.
 - 2) FirePro by Western Wood Preservers, Ltd.

- c. Natural wood products treated to add fire-retardant qualities.
- d. Type A: not more than 28 percent moisture when tested according to ASTM D3201.
- e. Interior and above grade applications include but not limited to:
 - 1) Platforms and Stages.
 - 2) Wood in concealed spaces.
 - 3) Framing, blocking, cants, and nailers within roof covering and waterproofing systems.
 - 4) Interior wood items in direct contact with exterior concrete and exterior masonry walls.
 - 5) Window frame blocking within non-rated exterior walls.
 - 6) Plywood backing panels for electrical, telecommunication equipment.
 - 7) Similar locations where wood products are indicated and building code does not permit non-fire-resistive treated products.
 - 8) Above grade dimensional lumber and plywood, unless indicated otherwise.
 - a) Exception: Upgrade to exterior grade where scheduled in the following article.
- 6. FRT material for exterior and wet locations:
 - a. Base:
 - 1) ExteriorFireX by Hoover Treated Wood Products, Incorporated.
 - b. Optional:
 - 1) Dricon FRX by Arxada.
 - c. Natural wood products treated to add fire-retardant qualities plus decay and termite resistance.
 - d. Non-leaching treatment under direct exposure to precipitation, sunlight, and effects of weather.
 - e. Exterior applications include but not limited to:
 - 1) Fire-treated wood that is directly exposed to weather.
 - 2) Fire-treated wood in areas of high-humidity, Greater than 80 percent RH.
 - 3) Other areas where indicated.
- C. Preservative Treated Lumber and Plywood:
 - 1. Natural wood products treated to add decay and termite resistance.
 - 2. Use appropriate materials for application by listed Manufacturers.
 - 3. Preservatives:
 - a. Compatible with direct exposure to precipitation, sunlight, and effects of weather.
 - b. Authenticate by factory marking each piece with manufacturer's mark and applicable standards.
 - c. Acceptable treatments:
 - 1) Alkaline Copper Quaternary (ACQ).
 - 2) Copper Azole (CA).
 - 3) Wolman AG non-metallic preservative.
 - 4. Lumber Species:
 - a. Hem-Fir.
 - b. Spruce.
 - c. Pine.
 - d. Other species meeting requirements.
 - 5. Plywood:
 - a. Grading:
 - 1) PS1, B-C Grade.

- 2) PS1, A-C Grade where exposed.
- b. Veneers:
 - 1) Softwood species.
 - 2) Glue with waterproof adhesives.
- 6. Application:
 - a. Below grade, or in contact with earth.
 - b. Where indicated in Drawings.
- D. Sill Sealing Gaskets:
 - 1. Closed cell neoprene foam.
 - 2. Thickness: 1/4-inch 6 mm.
 - 3. Match width of sill members indicated.
- E. Adhesives for bonding furring, sleepers, sills, and similar items to concrete or masonry:
 - 1. Approved for indicated use by adhesive manufacturer.
 - 2. Comply with ASTM D3498.
- F. Water-Repellent Preservative:
 - 1. Treat of exposed ends of posts and beams.
 - 2. National Wood Window and Door Association (NWWDA) tested and accepted formulation.

2.3 FASTENERS

- A. General:
 - 1. Provide fasteners of size and type indicated that comply with requirements specified for material and manufacture.
 - 2. Where rough carpentry is exposed to weather, in contact with earth, pressure-preservative treated, or in area of high relative humidity:
 - a. Use fasteners with hot dip zinc coating complying with ASTM A153.
 - b. Use fasteners of Type 304 stainless steel.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: ASTM A307, Grade A steel bolts with ASTM A563 hex nuts and washers.
- G. Expansion Anchors:
 - 1. Tested in accordance with ASTM E488.
 - 2. Anchor bolt and sleeve assembly:
 - a. Masonry assemblies: Sustain load equal to 6 times load imposed when installed in unit.
 - b. Concrete assemblies: Sustain load equal to 4 times load imposed when installed in unit.
 - 3. Interior applications:
 - a. Carbon-steel components.
 - b. Zinc plated to comply with ASTM B633, Class Fe/Zn 5.
 - 4. Exterior and wet applications:
 - a. Stainless Steel components, ASTM F593 and ASTM F594 Alloy Group 1 or 2.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine conditions under which work is to be installed.
- B. Verify measurements, dimensions, and details before proceeding.
- C. Coordinate location of furring, nailers, blocking, grounds, and similar supports.
- D. Correct unsatisfactory conditions.

3.2 INSTALLATION OF ROUGH CARPENTRY

- A. Form to shapes indicated.
- B. Cut and fit accurately.
- C. Set work to required levels and lines, plumb and true.
- D. Shim as required.
- E. Provide wood grounds or nailers as required for attachment of other work and surface applied items.
- F. Grounds:
 - 1. Dressed, key beveled lumber.
 - 2. Minimum 1-1/2-inch 38 mm wide by thickness required to bring face of ground even with finish material.
 - 3. Remove temporary grounds when no longer required.
- G. Wall Blocking:
 - 1. Provide in-wall fire-treated wood blocking reinforcement where following items are required to be wall-mounted to interior walls:
 - a. Architectural casework, millwork, cabinets, shelving, wardrobes, and bookcases.
 - b. Handrails at stairwells.
 - c. Between studs at height of wall-mounted door stop, behind stop.
 - 2. Metal wall backing:
 - a. See Section 09 22 16.
- H. Anchor work to support applied loading.
 - 1. Provide washers under bolt heads and nuts.
 - 2. Fasten plywood in accordance with APA recommendations.
 - 3. Use fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials.
 - 4. Predrill holes to avoid splitting wood with fasteners.
 - 5. Do not drive threaded friction type fasteners.

3.3 INSTALLATION OF BLOCKING AND NAILERS FOR ROOFING AND PARAPETS

- A. Install in accordance with ANSI/SPRI ES-1 Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems.
- B. Minimum Wood Member Size: 2 by 6-inch 50 mm x 150 mm nominal.
- C. Fasteners:
 - 1. Corrosion resistant.
 - a. Hot dip galvanized: Comply with ASTM A153 or ASTM A653, Class G185.
 - b. Stainless steel: Types 304 or 316.
 - 2. Countersink heads of fasteners.

3. Types required for substrate conditions.
4. Fasteners of diameter and spacing required to resist forces indicated.
5. Spacing:
 - a. Threaded anchor bolts; 3/8-inch 9.5 mm or larger:
 - 1) Provide 5/8-inch 16 mm OD washers or larger.
 - 2) Maximum spacing: 48 inches 1200 mm OC.
 - 3) Stagger 1/3 nailer width.
 - b. Other fastener types:
 - 1) Maximum Spacing:
 - a) Typical: 12 inches 300 mm OC.
 - b) Up to 16 inches 400 mm OC where necessary to match spacing of structural members.
 - 2) Stagger 1/3 nailer width.
 - 3) Install 2 fasteners and within 6 inches 150 mm of nailer ends.
6. Anchor nailers to resist minimum vertical force of 300 pounds/LF 446 kg/M in any direction.
 - a. Locate fasteners approximately 4 inches 100 mm from ends but not less than 3 inches 75 mm.
 - b. Use minimum of 3 anchors for each nailer.
 - c. Where members are wider than 6 inches 150 mm, stagger fasteners from side to side to avoid splitting of the wood member.
 - d. Corner region enhancements:
 - 1) Double the above listed vertical force which must be resisted.
 - 2) Length and width of corners as prescribed by ANSI/SPRI RP-4:
 - a) 40 percent of the building height, but not less than 8-1/2 feet 2.6 M.
- D. Nailers used for perimeter securement of roofing membranes:
 1. Install nailers where indicated and where required to secure perimeter of membrane roofing.
 2. Match height of nailers to adjacent insulation.
 3. Where multiple layers are required to match depth of insulation:
 - a. Attach base layer as indicated in General Requirements above.
 - b. Apply a bead of construction adhesive between laminations.
 - c. Attach subsequent layers using fastener type which is appropriate for wood-to-wood securement.
 - d. Size and locate fasteners as required to resist uplift loading indicated.
- E. Install blocking as indicated for securement of sheet metal edge flashings, parapet copings, and similar items.

3.4 INSTALLATION OF FIRE RETARDANT TREATED WOOD

- A. Fire retardant treated lumber and plywood used in structural applications shall be applied according to lumber and plywood strength tables provided by manufacturer.
- B. Use only fasteners approved by the manufacturer of fire retardant treated or preservative treated wood.
- C. Field Cuts:
 1. Dimensional Lumber: Do not rip or mill fire retardant treated lumber.
 - a. Cross cuts, joining cuts, and drilling holes are permitted.
 2. Plywood: Fire retardant treated plywood may be cut in any direction.

3. Field treat cuts and holes in preservative and fire retardant treated material in accordance with AWPA M4.

END OF SECTION

SECTION 06 16 43

GYPSUM SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Gypsum Sheathing, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.
- C. Related Sections:
 - 1. Plywood Sheathing: Specified in Section 06 10 00 – Rough Carpentry.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C1047 Standard Specification for Accessories for Gypsum Wallboard.
 - 2. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - 3. ASTM C1280 Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.
 - 4. ASTM D6329 Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers.
- B. Gypsum Association (GA):
 - 1. GA-253 Application of Gypsum Sheathing.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Material properties and test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Gypsum Sheathing:
 - 1. Base:
 - a. Georgia Pacific.
 - 2. Optional:
 - a. CertainTeed.
 - b. Continental Building Products.
 - c. National Gypsum Company.
 - d. USG.
- B. Seam Sealant: Refer to Section 07 92 13.
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Exterior Gypsum Sheathing:
 - 1. Water-resistant, mold-resistant, suitable for long term weather exposure during construction.

2. Minimum Mold Resistance: 10 rating per ASTM D3273.
 3. Minimum Thickness: 1/2-inch 12 mm thick.
 - a. Upgrade to 5/8-inch 15 mm thick, Type X product where fire rated exterior walls are indicated.
 - b. Upgrade to appropriate non-sag product where sheathing is used horizontally as in soffits.
 4. Base Product:
 - a. Dens-Glass Gold Exterior Sheathing by Georgia Pacific.
- B. Seam Sealant:
1. Coordinate sealant for compatibility with selected air or vapor barrier systems and sheathing.
- C. Fasteners:
1. Screws: Stainless Steel.
 2. Clips: Galvanized or zinc.
 3. Sized as required.
 4. Thread count as appropriate for stud materials specified.
- D. Sheathing control joints and accessories: Galvanized, or zinc complying with ASTM C 1047.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrate for suitability to accept work.
- B. Start of work constitutes acceptance of substrate and responsibility for performance.

3.2 INSTALLATION

- A. Install sheathing and accessories per manufacturer's written instructions.
- B. Exterior Sheathing:
 1. Align edges of sheathing panels on stud centerlines.
 2. Screw to exterior of each stud as recommended by manufacturer.
 3. Butt sheathing boards together tightly:
 - a. Maximum gap between boards: 1/8-inch 3 mm.
 4. Seal seams with sealant by filling all joints and troweling smooth on sheathing surface to a depth of 1/16-inch 1.5 mm and a width of 2 inches 50 mm.
- C. Control Joints:
 1. Locate control joints as per system requirements and in accordance with ASTM C1280 and as follows:
 - a. Subdivide so that no area exceeds 900 square feet 81 square meter, and no area has a length which exceeds 30 feet 9 m.
 - b. Locate control joints at every building construction joint.

END OF SECTION

SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Architectural Wood Casework, as indicated, in accordance with provisions of Contract Documents.
- B. Related Sections:
 - 1. Section 06 10 00 - Rough Carpentry.
 - 2. Section 12 36 63 - Solid Surface Fabrications.
 - 3. Section 12 36 65 - Engineered Quartz Fabrications.
- C. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM:
 - 1. ASTM D1037 Standard Test Methods for Evaluating Properties of Wood Base Fiber and Particle Panel Materials.
- B. ANSI:
 - 1. ANSI 208.1: American National Standard for Particleboard.
 - 2. ANSI 208.2: Medium Density Fiberboard (MDF) for Interior Applications.
 - 3. ANSI/BHMA A156.9: Cabinet Hardware.
- C. Woodwork Institute:
 - 1. North American Architectural Woodwork Standards (NAAWS).

1.3 SUBMITTALS

- A. Product Data:
 - 1. Typical details of casework construction.
 - 2. Reports indicating favorable outcome to Wall Cabinet Load Testing.
- B. Shop Drawings:
 - 1. Plans of casework at 1/8 inches = 1 foot scale or larger.
 - 2. Elevations of casework at 1/4 inches = 1 foot scale or larger.
 - 3. Cross reference shop drawings to Contract Documents casework elevations.
- C. Samples:
 - 1. Sealant colors for selection.
 - 2. Plastic laminate.
 - 3. Hardware.
 - 4. Edge banding.
- D. Contract Closeout Information:
 - 1. Warranty.
 - 2. Operation and Maintenance Data.
 - a. See Section 01 78 23.

1.4 -WARRANTY

- A. Manufacturer five year warranty against defects in materials and workmanship, such as but not limited to delamination, swelling, or warping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Plastic Laminate:
 - 1. Base:
 - a. As indicated in Interior Notes and Finish Legend.
- B. Contact Adhesive: As recommended by manufacturer.
- C. Wood Glue: As recommended by manufacturer.
- D. Low Pressure Decorative Laminate (LPDL) Panels:
 - 1. Base:
 - a. Casework Manufacturer
- E. Medium Density Fiberboard:
 - 1. Acceptable Manufacturers:
 - a. Roseburg Forest Products.
 - b. Georgia Pacific.
 - c. Uniboard.
- F. Edge Banding:
 - 1. Acceptable Manufacturers:
 - a. Rehau.
 - b. Doellken-Woodtape.
 - c. Rehau.
 - d. Charter Industries.
 - e. Canplast
- G. Cabinet Hardware:
 - 1. Acceptable Manufacturers:
 - a. Accuride.
 - b. Blum.
 - c. Epco.
 - d. Knappe & Vogt.
 - e. Grant.
 - f. Grass.
 - g. Hafele.
 - h. HEWI.
 - i. National Lock.
 - j. Ilco Unican Corporation.
 - k. Stanley Hardware.
 - l. Stylmark.
 - m. TMI Systems Design.
 - n. Rockford Process Control.

- o. U.S. Futaba.
 - p. Weber Knapp Company.
 - q. CCL Security Products.
 - r. Schlage Lock.
 - s. Sugatsune America.
 - t. Olympus Lock.
 - u. Colson Caster Corporation.
- H. Miscellaneous items:
- 1. Products and Manufacturers as listed.
- I. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Design and construct to support listed minimum loads.
- 1. These loads are not intended to limit other locations in the section where more stringent requirements are called for.
 - 2. Base Units: 500 pounds per lineal foot across the cabinet ends.
 - 3. Suspended Units: 300 pounds static load.
 - 4. Drawers: 100 pounds.
 - 5. Hanging Wall Cases: 300 pounds.
 - 6. Shelves: 100 pounds minimum unless heavier weights are designated.

2.3 MATERIALS

- A. General:
- 1. FSC certified wood components.
 - 2. No Added Urea Formaldehyde (NAUF) in materials or fabrication.
- B. Medium Density Fiberboard (MDF):
- 1. ANSI A208.2 Grade 155 MR50.
 - 2. Moisture resistant:
 - a. Water Absorption: 6 percent average, 24 hour soak.
 - b. Thickness Swell: 3 percent.
 - 3. 48 pcf density
 - 4. No added formaldehyde (NAF).
 - 5. Base: Medex by Roseburg
 - 6. Core material for plastic laminate casework.
 - 7. Core material for counters, backsplash, and sidesplashes with sinks.
- C. Plastic Laminate Facings:
- 1. Standard: NEMA LD3.
 - 2. NEMA LD3, Impact rated at 43IN when adhered to MDF.
 - 3. Thickness and Grade:
 - a. Formed surfaces: Post form Grade-HGP, 0.048 inches thick.
 - b. Other exposed surfaces: Grade-VGS, 0.028 inches thick.
 - 4. Backer Sheets for laminated items.
 - a. Semi-exposed cabinet liner: Grade-CLS, 0.020 inches thick; color to match LPDL.
 - b. Concealed backer sheet: Grade-CLS, 0.020 inches thick; any color.
 - 5. See Sheet IN-110 Interior Finish Schedule for selections.

D. Edge Banding:

1. PVC-Free.
2. Machine applied with waterproof hot melt adhesive.
3. Edge of case body and exposed components:
 - a. Thickness: 1mm.
 - b. Color: To match case exterior.
4. Edge of shelves inside plastic laminate clad units:
 - a. Thickness: 1mm.
 - b. Color: To match shelf.
5. Edges of doors and drawer fronts, exposed finished shelves and removable panels:
 - a. Thickness: 3mm.
 - b. Color: To match exterior face of panel.

E. Contact Adhesives:

1. Description:
 - a. Viscosity: 760 cps.
 - b. Density: 7.7 pounds/GAL.
 - c. Solids content: 36 percent +/- 1 percent.
 - d. VAHP content: None.

F. Wood Glue:

1. Description:
 - a. Bond Strength per ASTM D905: 4,000 psi at room temperature.
 - b. ANSI/HPVA Type I water resistant.
 - c. Application temperature: Above 47 deg F.
 - d. FDA approved for indirect food contact.

G. Sealant:

1. Silicone sealant in colors matching components.
2. Specified in Section 07 92 16.

2.4 CABINET HARDWARE

A. Concealed Hinges.

1. Base Product: CLIP Top Series by Blum.
2. All metal heavy duty construction.
3. Finish: Nickel plated.
4. Independent three dimensional adjustment.
5. Open Angle: 170 degrees.
6. Self-closing.
7. Passed 200,000 cycle test.
8. Use on public facing casework.

B. Drawer Slides:

1. Full extension.
2. Stainless steel ball bearings
3. Soft closing.
4. Pull out stops - drawer removable without use of tools.
5. Capacity:
 - a. Standard Drawers: 100 pounds.

- b. File Drawers: 150 pounds.
 - 6. Base Product:
 - a. Model 3832EC by Accuride.
- C. Straight Pulls:
 - 1. Base Product: Hafele – Pull, Svelte
 - a. Item no. 106.70.432
 - 2. 7 inches centers.
 - 3. Finish: Matte Black
- D. Catches:
 - 1. Magnetic or roller type, adjustable.
 - 2. Minimum 4 pound pull.
 - 3. Provide two catches on doors more than 48 inches high.
- E. Elbow Catch:
 - 1. Provide at pairs of doors with locks.
- F. Door Stops:
 - 1. Braided steel cable with clear PVC coating, mounting eyelets, and screws.
 - a. Base Product: Hafele 366.74.900.
 - 2. Finish: zinc plated.
 - 3. Length: 6 inches nominal.
 - 4. Provide at locations where door opens adjacent to walls, cabinets, and equipment.
 - 5. Mount to prevent contacting wall or equipment with door or hardware.
- G. Door Bumpers:
 - 1. Provide on backside of doors and drawer faces.

2.5 LOCKS

- A. Keyed Locks:
 - 1. Small pin tumbler with heavy duty deadbolt.
 - a. Disc tumbler type locks will not be accepted.
 - b. Cam locks will not be accepted.
 - 2. Keyway: D4292, 5-pin.
 - 3. ANSI/BHMA Standard: E07121.
 - a. Cycle Tested per ANSI/BHMA A156.11 Grade 1.
 - 4. Base Products:
 - a. Door Locks: 100DR by Olympus Lock.
 - b. Drawer Locks: 200DW by Olympus Lock.
 - 5. Finish: Satin Chrome US26D (BHMA 626).
 - 6. Include spacers, adapters, fasteners, and strikes.
 - 7. Barrel Length: As appropriate for conditions.
 - 8. Provide 2 keys for each lock.
 - 9. Master key and grand master key as directed.
- B. Keyless Security Lock: Alternate
 - 1. No battery push button cabinet lock.
 - 2. Master key override, for supervisory control.
 - 3. Finish: Champagne

4. Finish: platinum
5. Base Product: Compx ECO-S-U ecoForce Button Cabinet Lock with SlamCAM.
 - a. Location: Cash Drawers at Ticketing

2.6 SUPPORTS AND BRACKETS

A. Adjustable Shelf Supports:

1. Friction fit pins into cabinet end panels and vertical dividers.
2. Space 1/4 inches holes on 1 1/4 inches centers.
3. Locate support holes to avoid conflict with installation of hinges.
4. Retain shelves on support with spring clip shelf lock or screw attachment.
5. Material:
 - a. Injection molded clear polycarbonate.
6. Capacity: 200 pound minimum, per support device.

B. Metal Bracket for Cantilevered Countertop:

1. Material: 1/8 to 1/4 inches thick, 6063 T-6 extruded aluminum.
2. Pre-drilled for attachment to wall and countertop.
3. Include fasteners suitable for conditions.
4. Coordinate locations of blocking (see Section 09 22 16). Brace studs according to bracket manufacturer instructions.
5. Capacity: 450 pounds per bracket.
6. Base Products:
 - a. Rakks Inside Wall Mount EH Counter Support by Rangine Corporation.
 - b. Rakks Surface Mount EH Counter Support by Rangine Corporation.
 - c. Use inside wall mount model unless construction does not allow.
7. Finish: Off white primer.
 - a. See Section 09 91 23 for field painted metal. Paint to match wall.

2.7 MISCELLANEOUS ACCESSORIES

A. Grommets:

1. Base Product: XG-3 by Doug Mockett & Company, Inc.
2. Finish: Black or putty as selected by Architect.
3. Size: Provide 3-1/2 inches diameter flip top grommet cap with 7/8 inches x 1-3/8 inches cord slot.
4. Provide as directed by Owner after installation of equipment at each location such as, but not limited to, undercounter electrical or systems outlet, cord drops, and keyboard drawers.

2.8 FABRICATION

A. General:

1. See Drawings for casework quantities, configurations, finishes, countertops, and casework accessories.
2. Verify dimensions at site.
3. Verify locations of items furnished in other Sections.
4. If necessary to vary from arrangement indicated because of structural, mechanical, electrical, or other considerations, make such variations only after approval of Architect.

B. Definitions:

1. Exposed surfaces: Surfaces visible when doors and drawers are closed.
 - a. Door and drawer fronts, and their edges.

- b. Exposed ends.
 - c. Bottom of wall case.
 - d. Countertop and backsplash and their exposed edges.
 - e. Face of cabinet body not covered by doors or drawer fronts.
 - f. Interior of open cabinets, including shelving.
 - 2. Concealed surfaces: Surfaces not visible after installation.
 - a. Solid top panels.
 - b. Security panels.
 - c. Locking rails.
 - 3. Semi-exposed surfaces: Surfaces only visible when doors and drawers are opened.
 - a. Interior of cabinets with opaque doors.
 - b. Back sides of doors.
 - c. Top of wall cabinets and tall cases.
 - d. Drawer boxes.
- C. Plastic Laminate Faced Casework:
- 1. Factory built casework finished on exterior with high pressure laminate.
 - 2. Core Material:
 - a. Medium Density Fiberboard (MDF).
 - b. MR moisture resistant panels where work surfaces include a sink.
 - c. MR panels shall have 50 percent reduction in thickness swell by ANSI A208.1.
 - 3. Provide units complete with hardware, subbases, and trim, in sizes and configurations indicated.
 - 4. Style:
 - a. Reveal overlay, with doors and drawer fronts overlapping case front with minimum reveal.
 - b. Edge doors and drawer fronts with 3 mm edge banding, machine applied using waterproof hot melt adhesive. Machine profile exposed edges with 1/8 inches radius.
 - 5. Finishes:
 - a. Exposed surfaces: Plastic Laminate.
 - b. Grain Direction, where laminate finish is directional: Vertical grain at frames, cases, door faces, drawer faces and other vertical surfaces.
 - c. Semi-exposed surfaces: LPDL.
 - d. Concealed surfaces: LPDL.
 - e. Edges of Doors and Drawer Fronts: 3 mm edge banding.
 - f. Edges of Case Body panels: 1 mm edge banding.
 - g. Edges of Shelves: 1 mm edge banding (four sides).
- D. Casework Components:
- 1. Case Body:
 - a. Sides: 3/4 inches thick.
 - 1) Locate shelf support holes to avoid conflict with installation of door and drawer hardware.
 - b. Top and Bottom Panels: 3/4 inches thick.
 - c. Backs: 1/2 inches thick.
 - 1) Exception: Where back face is exposed to view: Upgrade to 3/4 inches.
 - d. Security Panels: 1/2 inches thick.
 - e. Drawer Lock Rails: 3/4 inches thick.

- f. Base: 3/4 inches thick, with intermediate reinforcing at 24 inches on center maximum.
 - 2. Shelves:
 - a. Less than 30 inches long: 3/4 inches thick.
 - b. Between 30 and 40 inches long: 1 inch thick.
 - 3. Doors:
 - a. 3/4 inches thick.
 - b. Doors not to exceed 25 inches in width.
 - 4. Drawers:
 - a. Drawer Fronts: 3/4 inches thick.
 - b. Sub-fronts, Sides and Backs: 1/2 inches thick.
 - c. Bottoms: 1/2 inches thick.
 - 1) Include intermediate reinforcing rails where drawer width exceeds 18 inches.
 - 5. Small Compartment Dividers: 1/4 inches clear acrylic panel.
 - 6. Filler Panels and Scribe Pieces: 3/4 inches thick.
 - 7. Soffits:
 - a. Material and finish to match cabinets.
 - b. 3/4 inches thick.
 - c. Abut soffit to acoustical tile ceiling without reveal or gap.
 - d. Cope tegular ceiling tile to overhang face of soffit.
 - e. Where distance between top of cabinet and ceiling is greater than 24 inches: Soffits to be sloped 30 degrees, unless noted otherwise.
- E. Case Configuration:
- 1. Plastic Laminate Faced Units:
 - a. Provide reveal, approximately 1/8 inches, at top of doors and drawer fronts, and between doors and drawer fronts in same unit; reveal approximately 7/16 inches at sides.
 - 2. Provide reveal 1/8 inches x 1/8 inches (black) in upper edge of exposed sides of wall case when plastic laminate soffits provided.
 - 3. Toe space:
 - a. 4 inches high by approximately 3 inches deep; provide on front of each base unit unless noted on architectural drawings.
 - 4. Hardware mounting:
 - a. Drawers:
 - 1) Center the pull in drawer front, horizontally.
 - 2) No more than 4 inches from top.
 - b. Drawers with 2 pulls:
 - 1) Set pulls at 1/4 points.
 - 2) No more than 4 inches from top.
 - c. Framed glass doors:
 - 1) Center the pull in corner of frame.
 - d. Swinging doors:
 - 1) Set door pull in swing side corner, vertically, at top of base units, at bottom of wall units.
 - 5. Adjustable shelves:
 - a. Use drilled hole supports.
 - b. Depth: 1/2 inches less than inside cabinet depth.
 - c. Width: 1/8 inches, maximum, less than inside cabinet width.

6. Provide doors at locations requiring access to electrical devices, as indicated on drawings.

F. Joinery

1. Construct cabinet body of 3/4 inches thick core joined with 10mm diameter industrial grade hardwood dowels, securely glued and clamped under pressure during assembly.
2. Case body:
 - a. Sides, dividers, bottom, and top panels:
 - 1) Minimum of 6 dowels at each joint for 24 inches deep cabinets.
 - 2) Minimum of 4 dowels for 12 inches deep cabinets.
 - 3) Glue joints.
 - b. Back:
 - 1) For dadoed backs, dado into sides, bottom and top. Locate dado 3/4 inches in from back face of cabinet.
 - 2) For on-set backs, rabbet at finished ends, screw at the top and bottom, staple at the sides.
 - 3) Glue joints.
 - c. Compartment dividers and lock rails:
 - 1) Dowel and glue.
 - d. Base:
 - 1) Integral or separate.
 - 2) Construct to receive base material to match adjacent walls, unless shown otherwise.
 - 3) Blind-fasten to bottom of case body when separate.
3. Drawers:
 - a. Sub-front, sides and back: Doweled and glued corner joints.
 - b. Bottom: Dado into 4 sides and glued or screwed to the bottom with the use of bottom supporting drawer slide hardware.
 - c. Front: Secured from sub-front side with no less than four screws.
 - d. Use no blocking or fasteners in exposed or semi-exposed locations.

G. Mechanical Fasteners:

1. Countertop joints:
 - a. Provide joint connectors every 6 inches on-center.
2. Pre-drill and countersink screw holes before installation.
3. Do not use mechanical fasteners or blocking in exposed locations. When fasteners are required on exposed surfaces color, materials, and finish to be approved by Architect.

2.9 COUNTERTOP MATERIALS AND FABRICATION

- A. Solid Surface Countertops (SSF): See Section 12 36 63.
- B. Engineered Quartz Countertops (EQF): See Section 12 36 65.

2.10 WINDOWSILL MATERIALS AND FABRICATIONS

- A. Solid Surface Windowsills (SSF): See Section 12 36 63.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrate to accept installation.
- B. Ensure that adequate Wall Backing has been installed.
 1. Wood Wall Backing: See Section 06 10 00.

2. Metal Wall Backing: See Section 09 22 16.
 3. Coordinate and direct installation of backing where required.
- C. Correct unsatisfactory conditions.
- D. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. Use manufacturer's printed instructions or drawings in cases where items or details are not indicated.
- B. Install casework level and plumb.
- C. Securely attach casework to wall blocking
1. Shim to maintain stable location.
 2. Do not fasten with drywall or bugle head screws.
 3. Fasten to floor or ceiling if casework does not attach to wall.
 4. Fasten in concealed or semi-exposed location.
- D. Hardware:
1. Install hinges, stops, guides and other door and drawer hardware to avoid adjustable shelf holes in case body.
 2. Install up to 10 extra door locks and 10 extra drawer locks in casework not previously shown or scheduled to have locks.
 3. Install extra locks where directed by Owner.
 4. Turn over extra, uninstalled locks to Owner.
- E. Construct units with sinks or lavatories to withstand an applied vertical load of not less than 250 pounds on the front edge of countertop.
- F. Provide cutouts for mechanical and electrical items.

3.3 SEALING OF JOINTS

- A. Seal casework, countertops, and splashes to walls, to seal joints.
1. Sealant color to match countertop color.
- B. Seal perimeter of counter mounted sink fixtures.
1. Sealant color to match countertop or sink color.
- C. Seal windowsills to walls and window frames to seal joints.
1. Sealant color to match color of sill material specified.

3.4 ADJUSTMENTS AND CLEANING

- A. Test and adjust items of equipment for satisfactory operation.
- B. Adjust hinges for proper door alignment.
- C. Adjust drawer guides for proper drawer front alignment and operation.
- D. Adjust countertops to a level position and align to adjacent unit.
- E. Repair damage to casework or countertops to appear in original new condition.
- F. Repair damage to premises as a result of installation.
- G. Remove debris left by this installation.
- H. Clean casework and countertops after above items have been completed.

END OF SECTION



DIVISION 07

THERMAL AND MOISTURE PROTECTION



SECTION 07 05 43
CLADDING SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Cladding Support Systems, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. AA ASD-1 Aluminum Standards and Data.
- B. ANSI A58.1 Minimum Design Loads for Buildings and Other Structures.
- C. AAMA - American Architectural Manufacturers Association:
 - 1. AAMA 501.1 - Standard Test Method for Water Penetration of Windows, Curtain Walls, and Doors Using Dynamic Pressure.
- D. ASCE American Society of Civil Engineers:
 - 1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures with Supplements and Errata
 - 2. ASCE - Structural Plastics Design Manual
- E. ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - 2. ASHRAE 189.1 - Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings.
- F. ASTM International:
 - 1. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 3. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 4. ASTM C209 - Standard Test Methods for Cellulosic Fiber Insulating Board.
 - 5. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - 6. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - 7. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - 8. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw- Attached Gypsum Panel Products.
 - 9. ASTM C1177 - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - 10. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - 11. ASTM C1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
 - 12. ASTM C1396 - Standard Specification for Gypsum Board.
 - 13. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.

14. ASTM D570 - Standard Test Method for Water Absorption of Plastics.
15. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
16. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
17. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
18. ASTM D696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between minus 30 deg C and 30 deg C with a Vitreous Silica Dilatometer.
19. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
20. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
21. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
22. ASTM D2126 - Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
23. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
24. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
25. ASTM D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products.
26. ASTM E72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
27. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
28. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
29. ASTM E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
30. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
31. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
32. ASTM E2178 - Standard Test Method for Air Permeance of Building Materials.
33. ASTM E2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.

G. National Fire Protections Association (NFPA):

1. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.

1.3 SUBMITTALS

A. Product Data:

1. Manufacturer's product data sheets, details and installation instructions including components and accessories, indicating product used to comply with specifications.

B. Shop Drawings:

1. Elevations showing extent of supported panel systems.
2. Details of conditions of installation and attachment.
3. Details of transitions and terminations.

C. Project Information:

1. Structural calculations for Cladding Support indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.

- a. Submit concurrent with Shop Drawings.
- 2. Certification of installer qualifications.
- D. Contract Closeout Information:
 - 1. Warranty.
 - 2. Minutes of Preinstallation Conference.

1.4 QUALITY ASSURANCE

- A. Coordinate construction of wall cladding support system over substrate indicated for proper drainage, flashing, trim, back-up support, soffits, and other related Work.
- B. Manufacturers Qualifications:
 - 1. Manufacturer with a minimum of 10 years of experience.
- C. Installers Qualifications:
 - 1. Minimum of 5 years of experience in installing products of same type and scope specified.
- D. Provide Cladding Support System engineered to support dead, live, and lateral, wind or seismic, loads from floors, roofs, mezzanines, and walkable ceilings supported by system.
 - 1. Comply with Section 01 71 21 Specialty Engineering Requirements.
 - 2. Coordinate with structural support system, building insulation and cladding specified in other Sections.
- E. Preinstallation Meeting:
 - 1. Refer to Section 01 31 19.
 - 2. Attendees:
 - a. Owner
 - b. Architect
 - c. Installer
 - d. Exterior wall cladding manufacturer's representative
 - e. Continuous insulation support system manufacturer's representative
 - f. Installers whose Work interfaces with or affects wall cladding assembly including installers of doors, windows, and louvers
 - 3. Review and finalize construction schedule.
 - 4. Verify availability of materials, installer's personnel, equipment, and facilities needed to maintain schedule.
 - 5. Review means and methods related to installation, including manufacturer's written instructions.
 - 6. Examine support conditions for compliance with requirements, including alignment and attachment to structural support system.
 - 7. Review flashings, wall cladding details, wall penetrations, drainage plane, openings, and condition of other construction that affects this Work.
 - 8. Review temporary protection requirements for during and after installation of this Work.
- F. Mock-up:
 - 1. Construct mock-up wall assembly on site for Architect review.
 - a. 4 by 6 feet minimum to include standard horizontal, vertical joints as well as end conditions where occurs at dissimilar materials.
 - b. Assembly may be built into permanent construction provided area is readily identifiable during construction.
 - c. Mock-up wall to include:
 - 1) Connection to adjacent construction.

- 2) Complete system including specified rainscreen panels.
- 3) Outside corner.
- 4) Joint detail.
- 5) Transitions to adjacent construction
- d. Mock-up wall constitutes standard of quality for balance of cladding work.
- e. Do not proceed with work until mock-up wall approved by Architect.

1.5 WARRANTY

A. Manufacturer Warranty:

- 1. Attachment System: 10-year Limited Warranty.
- 2. Covers components of the attachment system, including structural failure of components when all the materials and components are supplied and installed per manufacturer's requirements.
- 3. Includes labor and material for removal and replacement of defective material.
- 4. Includes labor to remove and reinstall façade finish panels, finish closures and façade finish accessories necessary to access defective material.

B. Contractor's Warranty: 2-year labor warranty, starting from Substantial Completion, to cover repair of materials found to be defective as a result of installation errors.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. Design Loads:

- 1. Design Cladding Support Systems to carry cladding materials and to meet Design Loads.
 - a. Include anchorage to structural system, modifications to meet specified requirements and maintain visual design concepts.
 - b. Wind Loads:
 - 1) Wind Pressures as required per local building code based on wind speed, exposure factor and importance factor noted in the Structural Drawings.
 - c. Deflection Values: Use the most restrictive of the following:
 - 1) Limit deflection to $L/240 + 1/4$ -inch for span over 13 feet - 6 inches.

B. Thermal Expansion and Structural Movement:

- 1. Expansion and contraction, caused by changes in surface temperature equal to delta T.
 - a. Delta T for this project: 120 deg F.
 - b. Thermal contraction/expansion in this range shall not cause buckling, stresses on cladding, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other detrimental effects over this temperature range.

C. Structural Movements of Building Structure:

- 1. Inter-story drift caused by wind or earthquake forces.
 - a. $h/400$ maximum.
- 2. Live load deflection of the supporting members.
 - a. $L/360$ maximum.

D. Design shall eliminate audible harmonic vibrations, and noises from thermal movement.

E. Refer to system descriptions below for additional design and performance requirements.

2.2 CLADDING SUPPORT SYSTEM

A. Basis-of-Design: CLADIATOR CL 300

1. Manufacturers to be pre-submitted and approved that meet material and performance requirements with specified and validated third party testing.
 2. No post-bid substitutions permitted.
- B. Design Requirements:
1. Components:
 - a. Design and size components to withstand loads caused by positive and negative wind pressure acting normal to plane of wall as calculated in accordance with applicable code.
 - b. Components to be designed and constructed to resist gravity loads in accordance with applicable codes.
 - c. Components to be designed for seismic loads and in accordance with applicable Codes.
 2. Design for thermal and moisture movement of cladding in accordance with applicable codes. Design so that local ambient temperature fluctuations do not result in evidence of permanent deformations of assemblies or components and prevent overstressing of the support structure.
 3. Employ a registered Engineer licensed to practice in the jurisdiction where the Project is located. Engineer to design anchorage of cladding attachment system to the structure.
 4. Engineer-of-Record to verify the adequacy of structural wall assembly to support the cladding system.
 5. Cladding Wall Assembly Designed to be in Accordance with Applicable Codes and Adequate to Support the Following:
 - a. Dead loads, wind loads, seismic loads, snow and ice loads, and other applicable loads as shown on Structural Drawings for the Project.
 - b. Components designed for loads in accordance with applicable codes.
 6. Exterior Wall Assembly/Attachment System:
 - a. No framing component may penetrate the layer of continuous exterior insulation other than the polyamide clip and T-track.
 - b. Frequency and spacing of base track, T-track, flush mount (optional) and polyamide clip components as shown on the approved project specific shop drawings and in accordance with applicable codes and these specifications.
 7. Finishing Accessories (optional) to be used as shown on approved project specific shop drawings and in accordance with applicable codes and these specifications.
 8. System, in consideration with other system components, to meet U-Value and R-Values of the project. Cladding support products to meet thermal target requirements as required for Project.
 9. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within cladding support system.
- C. Base Track:
1. Material: extruded 6063-T5 aluminum profile with dimension marks.
 2. Finish: Aluminum Mill (standard)
 3. Length: standard 10 foot
- D. Clip, thermally isolated:
1. Engineered support system designed to integrate with exterior insulation and minimize thermal bridging.
 2. Tested in accordance with NFPA 285.
 3. Height: standard 4-inch
 4. Depth: 3-1/4 inch standard. Accommodates 2 inches to 4 inches of insulation when connected with T-track.

5. Material: Polyamide (PA 6.6).
 6. Color: Purple (standard)
- E. T-track:
1. Material: extruded 6063-T5 aluminum profile with dimension marks.
 2. Finish: Aluminum Mill (standard)
 3. Length: standard 10 foot
- F. Flush-Mount (optional):
1. Material: extruded 6063-T5 aluminum profile (standard to fit with T-track 16 inches o.c.)
 2. Finish: Aluminum Mill (standard)
- G. Flush-Mount EXT (optional):
1. Material: Extruded 6063-T5 aluminum profile cut on site or pre-cut to fit dimensions up to 32 inches o.c.
 2. Finish: Aluminum Mill (standard)
- H. Accessories:
1. Finishing Accessories - Door/Window/Termination:
 - a. Extruded 6063-T5 Aluminum profile.
 - b. Standard Length: 10 ft., custom sizes available.
 - c. Finish: Aluminum Mill (standard)
 - d. Length: Standard 10 foot
 - e. Finish: Aluminum Mill (standard)
 2. Corner Support:
 - a. Extruded 6063-T5 Aluminum Profiles:
 - b. Corner Base Track.
 - c. Corner T-Stem.
 - d. Corner Half-T (2 per corner).
 - e. Length: Standard 10 foot
 - f. Finish: Black Anodized (custom)
- I. Fasteners:
1. Screws for Steel Stud Wall Type:
 - a. #10 by 1-inch or 1-1/2-inch HWH SS for installing base track and clip to 16-gauge steel studs over sheathing.
 - b. #10 by 3/4-inch or 1-inch HWH SS screws to connect adjustable T-track or with clip and flush mounts.
 - c. Verify type of screws with engineer for project specific wind loads, gravity loads, seismic loads, code requirements and according to project wall type.
 2. Screws for Concrete Wall:
 - a. #12 by 1-inch or 1-1/2-inch HWH SS for installing base track and clip to concrete wall.
 - b. #10 by 3/4-inch or 1-inch HWH SS screws to connect adjustable T-track with clip and flush mounts.
 - c. Verify type of screws with engineer for project specific wind loads, gravity loads, seismic loads, code requirements and according to project wall type.
 3. Screws for Finishing Accessories:
 - a. Termination track for windows/doors/termination points used same as screws for T-track.
 - b. Screws for corner base track used same as screws for Base Track.

- c. Screws for corner T-Stem and corner Half-T used same as screws for T-Track.
- d. Verify type of screws with engineer for project specific wind loads, gravity loads, seismic loads, code requirements and according to project wall type.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas of this work, and project conditions with installer present for compliance with requirements for installation tolerances, substrates, CFS system conditions, and other conditions affecting performance of this Work.
- B. Examine structural wall framing to ensure that angles, channels, studs, and other structural support members have been installed within alignment tolerances required by CFS system manufacturer.
- C. Examine rough-in for components and systems penetrating CFS system to coordinate actual locations of penetrations relative to CFS system's joint locations prior to installation.
- D. Verify that mechanical and electrical services for exterior walls have been installed and tested and, if appropriate, verify that adjacent materials and finishes are dry and ready to receive insulation.
- E. Proceed with installation only after wall substrate surfaces have been properly prepared and unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.

3.3 INSTALLATION - CLADDING SUPPORT SYSTEM

- A. Install per manufacturer's written instructions.
- B. Base Track:
 - 1. Vertical Installation:
 - a. Fasten to substrate.
 - b. Install plumb and level to a uniform plane from left to right.
 - c. No shimming is necessary as the vertical plumb 90 degrees from the interior to the exterior direction is done with the T-track to complete process.
 - d. Fasten base track to the substrate at intervals indicated in the Details for each specific project.
 - 2. Horizontal Installation:
 - a. Position base track with the larger of the two narrow channels, found on either side of the base track, on the top and the smaller channel on the bottom in order to stabilize the polyamide clip (THERMAClip) during installation.
 - b. Fasten to substrate.
 - c. Level.
 - d. No shimming is necessary as the vertical plumb 90 degrees from the interior to the exterior direction is done with the T-track to complete process.
 - e. Fasten Base Track to the substrate at intervals indicated in the Details for each specific project.
 - 3. Polyamide Clip (THERMAClip):
 - a. Insert into base track in accordance with the manufacturer's instructions.
 - b. Insert larger flange of the clip into the larger of the two narrow channels found on either side of the base track.
 - c. Secure each clip through the base track with fasteners in accordance with manufacturer's instructions.

4. Insulation:
 - a. Install into the exterior cavity between the base track and polyamide clip (THERMAClip) and between the base track and T-track as indicated and in accordance with insulation manufacturer's instructions.
 - b. Recommended Insulation materials:
 - c. Mineral Wool/Mineral Fiber Insulation.
5. T-track:
 - a. Insert into the narrow slot provided in the polyamide clip (THERMAClip) and slide to adjust to the insulation depth and ventilation requirement as shown on Drawings and fasten in accordance with manufacturer's instructions.
 - b. Complete final finite adjustments to plumb and level with the T-track.
 - c. Ensure assembly is plumb, level, and free of warp or twist; maintain dimensional tolerances and alignment with adjacent work.
6. Proprietary Panel Guidance, Secondary Structural Supports:
 - a. Install girts, angles, and other secondary structural panel support members and anchorage according to the Light Gage Structural Institute's Guide Specifications, and Division 07 Roof and Wall Panels Sections.
7. Flush-Mount:
 - a. Install support onto the T-track with fasteners as shown on Drawings and in accordance with manufacturer's instructions. Spacing as shown on Drawings and in accordance with the project design and engineering requirements.
8. Finishing Accessories, Termination Track, Window/Door/Termination:
 - a. Insert into the narrow slot provided in the polyamide clip (THERMAClip) and slide to adjust to the insulation depth and ventilation requirement as shown on Drawings and fasten in accordance with manufacturer's instructions.
 - b. Complete final finite adjustments to plumb and level with the Termination track.
 - c. Ensure assembly is plumb, level, and free of warp or twist; maintain dimensional tolerances and alignment with adjacent work.
9. Corners, Corner T-Stem, Corner Base Track, Half-T:
 - a. Install Corner Base Track by fastening to the substrate at the corner termination point.
 - b. Insert Corner T-Stem into the narrow slot provided in the polyamide clip and slide to adjust to the insulation depth and ventilation requirement as indicated and fasten in accordance with manufacturer's instructions.
 - c. Place and complete final adjustments of each Half-T on either side of the Corner T-Stem and angle to align in accordance with the project design and engineering requirements.
 - d. Corner Accessories may be used to support acute or obtuse angles or provide additional support at 90-degree corners.
 - e. Ensure assembly is plumb, level, and free of warp or twist; maintain dimensional tolerances and alignment with adjacent work.
 - f. Install sufficient anchorage devices to fasten system securely and rigidly to building in accordance with Drawings and approved Shop Drawings. Fasteners to be concealed.
 - g. Provide anchors to be installed in other work, and setting details, in time for proper installation by trades concerned; verify correct placement.
10. Spacing for Thermal Expansion/Contraction (at 10 ft. Length):
 - a. Base Track and Corner Base Track: 3/8 inch.
 - b. T-track & Corner Half-T: 3/8 inch.
 - c. Termination Track: 3/8 inch.
 - d. Corner T-Stem: 3/8 inch.

C. Built-In Work:

1. As work progresses, build in anchor bolts, flashing and other items supplied by other trades.
2. Install items plumb and true in accordance with manufacturer's instructions.
3. Do not build in organic materials subject to rot or deterioration.

D. Erection Tolerances:

1. Maximum Offset from True Alignment Between Adjacent Members Butting or In Line: 1/16-inch.
2. Maximum Variation from Plane or Location Indicated on Drawings: 1/4-inch.
3. Tolerance: Accurately align and locate components to column lines and floor levels; adjust work to conform with following tolerances.
 - a. Plumb: 1/8-inch in 10 feet; 1/4-inch in 40 feet; non-cumulative.
 - b. Level: 1/8-inch in 20 feet; 1/4-inch in 40 feet; non-cumulative.
 - c. Alignment: limit offset to 1/6-inch where surfaces are flush or less than 1/2-inch out of flush and separated by less than 2-inch (by reveal or protruding work); otherwise limit offsets to 1/8-inch.
 - d. Location: 3/8-inch maximum deviation from measured theoretical location (any member, and location).

3.4 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.
- B. Ensure that insulation panels are not exposed to moisture.
 1. Remove wet insulation panels or allow them to completely dry prior to installation of CFS system.
- C. Replace damaged insulation panels prior to Date of Substantial Completion.

END OF SECTION

SECTION 07 13 26
SELF-ADHERING SHEET MEMBRANE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Self-Adhering Sheet Membrane Waterproofing, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.
- C. Scope: slab perimeter. See Drawings.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM D412 Standard Test Methods for Rubber Properties in Tension.
 - 2. ASTM D570 Standard Test Method for Water Absorption of Plastics.
 - 3. ASTM D903 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
 - 4. ASTM D1970 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
 - 5. ASTM D3767 Standard Practice for Rubber - Measurements of Dimensions.
 - 6. ASTM D5385 Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes.
 - 7. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
 - 8. ASTM E154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturers' product data sheets, details and installation instructions including components and accessories, indicating product used comply with specifications.
- B. Project Information:
 - 1. Manufacturer certification of installer qualifications.
 - 2. Product test reports from qualified independent testing agency evidencing compliance of waterproofing with physical properties and other requirements based on comprehensive testing in accordance with specified test methods within previous five years.
 - 3. Minutes of Preinstallation Conference.
- C. Contract Closeout Information:
 - 1. Warranty.

1.4 QUALITY ASSURANCE

- A. Apply waterproofing to exterior of walls below grade including exterior of walls surrounding elevator pits and other areas having lowered floor slabs.
- B. Applicator Qualifications:
 - 1. Not less than five similar sized projects with material specified.

1.5 WARRANTY

- A. Provide written five year material warranty signed by manufacturer for waterproof integrity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Self-Adhering Sheet Membrane Waterproofing:
 - 1. Base:
 - a. Henry Company
 - 2. Optional:
 - a. Carlisle Coatings and Waterproofing Incorporated
 - b. Grace Construction Products
 - c. Polyguard Products, Inc.
 - d. W.R. Meadows.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Self-Adhering Sheet Membrane Waterproofing:
 - 1. Self-adhesive rubberized asphalt composite sheet membrane:
 - a. Total minimum thickness: 60 mil thick, composite sheet consisting of:
 - 1) Minimum 56 mil thick rubberized asphalt membrane laminated to
 - 2) Minimum 4 mil thick cross-laminated polyethylene film with release liner on adhesive side.
 - b. Base Product: Henry Blueskin WP 200.
 - 2. Sheet shall be formulated for use with ambient and substrate temperatures at time of installation, and for use with primer or surface conditioner complying with VOC limits of authorities having jurisdiction.
 - 3. Provide waterproofing complying with following physical properties:

Physical Properties		
Property	Test Method	Typical Value
Film Thickness	ASTM D3767	60 mils
Low Temperature Flexibility	ASTM D1970	Unaffected at -40 deg F
Elongation	ASTM D412	Greater than 300 percent
Tensile Strength, Membrane	ASTM D412	325 psi minimum
Peel Adhesion to Concrete	ASTM D903	9.0 pounds/inch
Resistance to Hydrostatic Head	ASTM D5385	231 feet minimum
Puncture Resistance	ASTM E154	50 lbs minimum
Permeance	ASTM E96	0.02 perms
Water Absorption	ASTM D570	Less than 0.1 percent

- 4. Surface primer:
 - a. Liquid primer recommended by manufacturer of sheet waterproofing material for substrate and application temperatures.
- 5. Sheet flashing:
 - a. Self-adhering, polymer-modified rubberized-asphalt composite sheet of same material, construction, and thickness as waterproofing sheet membrane.
- 6. Liquid membrane:
 - a. Elastomeric, 2-component, liquid, cold fluid-applied, trowel grade, or low viscosity as recommended by waterproofing manufacturer for application.
- 7. Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.

8. Penetration seal:
 - a. Self-adhering reinforced membrane, 2-1/2 inches wide, with a tack-free protective adhesive coating on 1 side and a release film on self-adhering side.
- B. Protection Course Fabric:
 1. Vertical applications:
 - a. CCW 200V.
 - b. 2-Ply polyester fabric.
- C. Drainage Composite Panels:
 1. Composite 3-dimensional non-biodegradable panels with permeable geotextile bonded to dimpled, molded plastic drainage core:
 - a. Geotextile: Non-woven or woven fabric of polypropylene or polyester fibers, or combination of both.
 - b. Select geotextile fabric porosity as recommended for soil/backfill encountered on project.
 2. Vertical Applications:
 - a. CCW MiraDRAIN 6200:
 - 1) Material Thickness: 0.40 inches (7/16 inches nominal); ASTM D1777.
 - 2) Compressive strength: 15,000 psf, (104 psi) 720 kPa; ASTM D1621
 - 3) Core Flow Rate when installed vertically: 12.5 gpm/FT of width; ASTM D4716.
- D. Rigid Board Insulation: Specified in Section 07 21 00.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cure concrete to moisture content acceptable to waterproofing manufacturer.
 1. Verify substrate is visibly dry and free of moisture.
 2. Test for capillary moisture by plastic sheet method according to ASTM D4263.
- B. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- C. Clean, prepare and treat substrate according to manufacturer's written instructions, to provide clean, dust-free, and dry substrate for waterproofing application.
- D. Mask off adjoining surfaces not receiving waterproofing to prevent spillage affecting other construction.
- E. Prime as recommended by manufacturer.
- F. Install in accordance with manufacturer's instructions.

3.2 MEMBRANE INSTALLATION

- A. Construction joint, control joints, cracks and voids exceeding 1/16 inches:
 1. Fill with liquid membrane and install 8 inches membrane strip.
- B. Expansion Joints:
 1. Where anticipated movement is less than 1/2 inches, install 3-ply membrane system as recommended by manufacturer.
- C. Vertical Inside and Outside Corners:
 1. Prepare, prime, and treat inside corners according to waterproofing manufacturer's instructions.
 2. Install 12 inches membrane strip centered over vertical corners.

- D. Horizontal inside corners including foundation wall to footing intersections:
 - 1. Prepare, prime, and treat inside corners according to waterproofing manufacturer's instructions.
 - 2. Install 3/4 inches fillets of liquid membrane.
 - 3. Extend liquid membrane each direction from corner or install membrane strip centered over corner.
- E. Horizontal outside corners:
 - 1. Prepare and treat outside corners according to waterproofing manufacturer's instructions.
 - 2. Apply double layer overlapping membranes.
- F. Drains:
 - 1. Apply a double layer of membrane extending 12 inches beyond drain.
 - 2. Install field sheet centered over drain.
- G. Pipes, posts, conduits, and similar penetrations:
 - 1. Apply a double layer of membrane extending out at least 6 inches from the penetrating item.
 - 2. Seal with mastic or liquid membrane product.
 - 3. Coordinate detailing at penetrations made after waterproofing system is complete with subcontractors responsible for penetrations.
- H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at protrusions according to waterproofing manufacturer's instructions.
 - 1. At top of wall conditions: Terminate membrane below final grade.
 - a. Apply mastic to terminations and joints.

3.3 SELF-ADHERING COMPOSITE SHEET APPLICATION

- A. Install self-adhering composite sheet according to waterproofing manufacturer's written instructions.
- B. Apply primer to substrate at required rate.
 - 1. Limit priming to areas that will be covered by waterproofing membrane in same day.
 - 2. Re-prime areas exposed for more than 24 hours.
- C. Apply and firmly adhere sheet membrane over area to receive waterproofing:
 - 1. Accurately align sheets and maintain uniform 2-1/2 inches minimum lap widths and end laps.
 - 2. Overlap and seal seams and stagger end laps to ensure watertight installation.
 - 3. Install from low point to high point to ensure proper lap direction.
 - 4. Roll laps of membrane installed on vertical surfaces and roll membrane on sloping and horizontal surfaces.
- D. Apply continuous sheet membrane over membrane strips bridging each type of joint to dimensions required by manufacturer.
- E. Seal exposed edges of membrane terminations.
- F. Install sheet membrane and auxiliary materials to tie in adjacent waterproofing.
- G. Repair tears, voids, and lapped seams in waterproofing not meeting requirements.
 - 1. Slit and flatten fish mouths and blisters.
 - 2. Patch with sheet membrane extending 6 inches beyond repaired areas.

- H. Waterproofing membrane must not be left exposed to construction traffic or ultraviolet rays without protection.

3.4 PROTECTION COURSE INSTALLATION

- A. Install protection course over waterproofing membrane using tape or adhesive according to manufacturer's written instructions and before commencing subsequent construction operations.
- B. Do not penetrate waterproofing, and do not use stick clips to install protection course.
- C. Minimize exposure of membrane

3.5 DRAINAGE PANEL INSTALLATION

- A. Place and secure drainage panels according to manufacturer's written instructions.
- B. Use adhesives and mechanical fasteners that do not penetrate waterproofing.
- C. Do not penetrate waterproofing, and do not use stick clips to install protection course.
- D. Lap edges and ends of geotextile to maintain continuity.
- E. Protect installed panels during subsequent construction.
- F. Adhesively attach drainage board at top-of-wall termination.
 - 1. Hold top of composite drainage board 6 inches below finish grade.
 - 2. Fold fabric over and tuck into wall in such a way that will avoid intrusion of backfill material in to the drainage channels.

3.6 PROTECTING AND CLEANING

- A. Protect waterproofing from damage and wear during application and remainder of construction period, according to manufacturer's written instructions.
- B. Protect installed system from damage due to ultraviolet light exposure, physical abuse, and other causes.
 - 1. Provide temporary coverings where system will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Building Insulation in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.
- C. See 09 29 00 for sound attenuation batt insulation.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. C209 Standard Test Method for Cellulosic Fiber Insulating Board.
 - 2. C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - 3. C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - 4. C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - 5. C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - 6. C665 Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - 7. C739 Standard Specification for Cellulosic Fiber Loose Fill-Thermal Insulation.
 - 8. C947 Standard Test Method for Flexural Properties of Thin-Section Glass-Fiber-Reinforced Concrete (Using Simple Beam with Third-Point Loading).
 - 9. C1104/C1104M Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
 - 10. C1289 Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - 11. C1728 Standard Specification for Flexible Aerogel Insulation.
 - 12. D696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 deg C and 30 deg C with a Vitreous Silica Dilatometer.
 - 13. D1621 Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - 14. D2842 Standard Test Method for Water Absorption of Rigid Cellular Plastics.
 - 15. E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 16. E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - 17. E96/E96M Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
 - 18. E119 Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 19. E136 Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 deg C.
 - 20. E605/E605M Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 268 Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source

2. NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components

1.3 SUBMITTALS

- A. Product Data:
 1. Manufacturers' product data sheets, details and installation instructions including components and accessories, indicating product complies with specifications.
- B. Shop Drawings:
 1. Plan or elevation drawings showing locations and extents of each type of insulation.
- C. Project Information:
 1. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Rigid Board Insulation Extruded Polystyrene (XPS):
 1. Base:
 - a. Owens-Corning.
 - b.
 2. Optional:
 - a. DuPont.
 - b. Kingspan.
- B. Mineral Fiber Insulation:
 1. Base:
 - a. Thermafiber, Inc., an Owens Corning company.
 2. Optional:
 - a. Rockwool.
 - b. Johns Manville.
 - c. Knauf.
- C. Mineral Fiber Spandrel Insulation:
 1. Base:

- a. Thermafiber, Inc., an Owens Corning company.
- 2. Optional:
 - a. Rockwool.
 - b. Johns Manville.
- D. Other Materials:
 - 1. Base:
 - a. As indicated.
- E. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Rigid Board Insulation - Extruded Polystyrene Foam (XPS):
 - 1. Minimum Compressive Strength:
 - a. 25 psi 172 kPa. (type IV).
 - 2. Minimum Surface Burning Characteristics per ASTM E84 and NFPA 268:
 - a. Flame Spread: 25 or less.
 - b. Smoke Developed: less than 450.
 - c. No ignition from radiant heat source.
 - 3. Water vapor permeance per ASTM E96:
 - a. 1.50 perm 85.8 NG/S/M2/Pa, maximum.
 - 4. Water absorption per ASTM D2842:
 - a. 0.3 percent, maximum.
 - 5. Thermal resistance per ASTM C518:
 - a. R-value of 5.0 per inch at 75 deg F 0.88 per 25 mm at 24 deg C mean temperature.
 - 6. Base Product:
 - a. Foamular Next Generation Extruded (NGX) by Owens Corning.
 - 7. Optional:
 - a. GreenGuard by Kingspan.
 - b. Styrofoam by DuPont.
 - 8. Minimum thickness: 2 inches 50 mm or as otherwise shown or required.
 - 9. Adhesives for adhering polystyrene insulation: As recommended by insulation manufacturer.
- B. Mineral Fiber Insulation:
 - 1. Unfaced, non-combustible, water repellant, semi-rigid fiber insulation board.
 - 2. Temperature Resistance: Per ASTM C612.
 - a. Over 2000 deg F 1093 deg C.
 - 3. Surface Burning Characteristics per ASTM E84.
 - a. Flame Spread: 0.
 - b. Smoke Developed: 0.
 - 4. Moisture Resistance: Absorbs less 0.03 percent by volume, per ASTM C1104.
 - 5. R-value: 4.2 per inch 0.74 per 25 mm.
 - 6. Density: 4.5 pcf 72 kg/M3.
 - 7. Non-corrosive per ASTM C665.
 - 8. Thickness: As noted in drawings.
 - 9. Base Product: Thermafiber RainBarrier 45 Insulation.

10. Mechanical fasteners; impaling clips/pins:
 - a. Pronged hangers and slotted washers or arrow pointed hangers.
 - b. Size pins to fit insulation thickness.
 - c. Base Product: GEMCO as manufactured by Goodloe E. Moore.
 - 1) Gemco pronged hanger with pronged washer.
11. Mastic for use with mechanical fasteners:
 - a. Base Product: As approved by fastener manufacturer.
- C. Unfaced Fiberglass Batt Insulation:
 1. Inorganic fibers and resinous binders formed into flexible blankets or semi-rigid sheets.
 2. Un-faced, Type I in accordance with ASTM C665.
 3. Minimum Surface Burning Characteristics per ASTM E84: Flame Spread: Less than 25; Smoke Developed: Less than 50.
 4. Combustion characteristics: Noncombustible; unfaced per ASTM E136.
 5. Manufactured without urea-formaldehyde binders.
 6. Nominal Thickness / Thermal Resistance Value, measured at 75 deg F 23.9 deg C:
 - a. Nominal Thickness: 6-1/2 inches / R-19 165 mm/R-3.3.
 7. Minimum 25 percent total recovered material content per EPA/CPG guidelines.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrate to accept installation.
- B. Installation indicates acceptance of responsibility for performance.

3.2 INSTALLATION

- A. General:
 1. Insulate full thickness over surfaces to be insulated.
 2. Fit tightly around obstructions, fill voids.
 3. Cover penetrations with insulation.
 4. Comply with manufacturer's instructions for installation unless more stringent requirements are specified.
 5. Consult manufacturer's technical representative if installation instructions are not applicable.
 6. Where rigid insulation is indicated over 2 inches 50 mm thick, apply in double layer with staggered joints to achieve total thickness.
 7. Do not use broken or torn pieces of insulation.
 8. Provide minimum cover of 5/8 inches 16 mm type X gypsum wallboard or approved ignition barrier over exposed foam surfaces.
- B. Rigid Fiber Insulation in Rain Screen and Cavity Wall construction:
 1. Verify vapor retarder and moisture barrier installation is complete.
 2. Comply with manufacturer's directions for particular conditions of installation.
 3. Secure insulation by use of mechanical fasteners; impaling clips and pins.
 - a. Locate fasteners 6 inches 150 mm from edges and at 12 inches 300 mm OC each direction.
 - b. Lay out work before installing mechanical fasteners.
 - c. Lay out fasteners and install in mastic.
 - d. Allow mastic to set.

- e. Test to ensure fasteners are secure.
 - f. Install washers and bend prongs of fasteners.
 - 4. Extend insulation full thickness over entire surface to be installed.
 - 5. Cut and fit tightly around penetrating elements and abutting construction.
 - 6. Install rigid fiber insulation with tight joints, without voids, pressing onto mechanical fasteners.
 - 7. Do not install insulation over or within 3 inches 75 mm of recessed lighting fixtures, ballasts, wiring compartments, fans, or other heat-generating devices unless fixtures are protected.
- C. Un-Faced Batt Insulation and Vapor Retarder in exterior Stud Wall systems:
- 1. Installing Batts:
 - a. Friction fit un-faced batts between studs.
 - b. Tightly butt ends.
 - c. Where specified thickness of batts is less than the depth of framing, install retaining devices to prevent sagging.
 - 2. Installing Vapor Retarder:
 - a. Position vapor retarder over inside face of framing.
 - b. Position vapor retarder over outside face of framing.
 - c. Install vapor retarder in 50 inches 1270 mm wide sheets.
 - d. Install vapor retarder vertically.
 - e. Install in continuous sheets, floor to structure above, without horizontal joints.
 - f. Vertical Seams:
 - 1) Tape vertical edge of vapor retarder to stud.
 - 2) Position subsequent adjoining sheet and continuously tape vertical edge to preceding sheet.
 - g. Tape bottom and top edges to structure continuously.
 - h. Tape edges to window, door frames, and penetrations to maintain continuity.
 - 3. Sealing vapor retarder to sheet metal vapor retarder continuous taping flange:
 - a. Include where wall adjoins steel columns, spandrel beams and similar structural steel members, and where indicated.
 - b. Install sheet metal vapor retarder continuous taping flange to flange of structural steel members prior to application of fireproofing.
 - 1) Seal to structure with urethane sealant and mechanical fasteners.
 - 2) Protect flange with masking tape to prevent accumulation of fireproofing over-spray.
 - 3) Remove masking tape after fireproofing application.
 - c. Prior to installation of vapor retarder tape: Clean taping flange to remove oily residue and remaining fireproofing over-spray, if present.
 - d. Continuously tape vapor retarder to previously installed taping flange.
 - 1) Seal vapor retarder to taping flange continuously, using vapor retarder tape specified.
 - 2) Optional: Continuous clips may be used in lieu of tape.
 - a) Product: Finish Trim No. 3910 by Trim-Tex.
 - 4. Sealing vapor retarder at other areas of discontinuity:
 - a. Prior to installation of gypsum wallboard or other covering:
 - 1) Repair tears, flaw in seams and terminations with vapor retarder tape.
 - 2) Seal vapor retarder to conduit, electrical boxes, piping and other penetrating items using vapor retarder tape.

- b. Continuously seal or tape vapor retarder sheets to abutting materials and penetrations such as windows, doors, conduit, boxes, pipes or other items to maintain vapor tightness.
 - c. Continuously seal joints or voids in abutting materials and penetrations with sealant or tape as applicable to provide continuous vapor tightness.
 - D. Rigid Board Insulation at foundations:
 - 1. Extend down for distance indicated in one layer.
 - a. If not indicated, extend down to design frost line.
 - 2. Install in mastic with tight joints on walls.
 - 3. Protect from damage and/or displacement during backfilling.
 - E. Mineral Fiber spandrel insulation:
 - 1. Install insulation at each spandrel location.
 - a. Tightly fit boards between window framing members.
 - b. FSK facing to be installed facing to inside of building.
 - c. Leave a minimum of 1 inch 25 mm air space between glass and insulation.
 - d. Construct per UL-approved methods at floor line. See Section 07 84 53.
 - 2. Secure insulation by use of mechanical fasteners, impaling clips or pins.
 - a. Locate fasteners 6 inches 150 mm from edges and at 12 inches 300 mm OC each direction.
 - b. Install washers and clip prongs of fasteners.
 - 3. Tape seams, washers, penetrations and edge terminations.
 - a. Cover fastener with 6 inches 150 mm square of vapor retarder tape.
 - b. Tape edges of vapor retarder to window frame to form continuous vapor retarder.
 - c. Tape butt edges of insulation to each other.
 - d. Cover penetrations or connections that remain exposed after insulation is in place and sealed, with minimum 1 inch 25 mm thick insulation.
 - e. Seal penetrations for a minimum of 6 inches 150 mm on each side.

3.3 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 07 27 43
VAPOR RESISTIVE AIR BARRIER

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Vapor Resistive Air Barrier, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.
- C. Scope: Air/Weather Barrier at exterior walls above grade. Coordinate with below-grade perimeter waterproofing and roofing vapor retarder.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM E96 Test Methods for Water Vapor Transmission of Materials.
 - 2. ASTM E2178 Test Methods for Air Permeance of Building Materials.
 - 3. ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
 - 4. ASTM D903 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
 - 5. ASTM D1876 Test Method for Peel Resistance of Adhesives.
 - 6. ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
- B. International Code Council Evaluation Service, Inc.: ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers.
- C. National Fire Protection Association (NFPA):
 - 1. NFPA 285, Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's literature indicating specified material and required components.
- B. Shop Drawings:
 - 1. Elevations showing locations and extent of air barrier.
 - 2. Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
 - 3. Details and isometrics at openings showing layouts of Air Barrier Flashings and sequence of installation.
- C. Project Information:
 - 1. Written documentation of applicator's qualifications.
 - 2. Minutes of Preinstallation Conference.
- D. Contract Closeout Information:
 - 1. Installer Warranty.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Air and vapor barrier systems shall be manufactured by firm with minimum of 20 years of experience in production of waterproofing.

2. Obtain primary air barrier materials and air barrier accessories from single source from single manufacturer.
- B. Installer Qualifications:
 1. Minimum five years of continued experience in successful installation of vapor and water resistive air barrier products on similar project applications.

1.5 WARRANTY

- A. Installer five-year warranty for air and vapor barrier and accessories have been installed in accordance with manufacturer's recommendations, and that components used in this section have been sourced from one manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Vapor Resistive Air Barrier:
 1. Base:
 - a. Henry Company.
 2. Optional:
 - a. Carlisle Coatings and Waterproofing.
 - b. GCP Applied Technologies.
 - c. Tremco.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Air Barrier System:
 1. Air barrier capable of performing as a continuous, vapor resistive air barrier.
 2. Design system to accommodate substrate movement and to seal to expansion and control joints.
 3. Select components to accommodate construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air Permeance:
 1. Maximum 0.004 cubic feet per minute per square foot 0.3 water pressure differential (1.57 psf), as tested in accordance with ASTM E2178.
- C. Vapor Permeance:
 1. Maximum 0.08 perm when tested in accordance with ASTM E96.
- D. Exposure Rating:
 1. Provide material with appropriate exposure rating to suit construction schedule.
- E. Application Window:
 1. Provide standard or low temperature wall membrane based upon ambient weather conditions at time of installation.
 2. Verify specialty product meets design criteria of standard product.
 3. Submit for approval.

2.3 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Fluid applied membrane:

1. 40 dry MIL elastomeric membrane.
 2. Base Product:
 - a. Henry Air Bloc 16MR.
 3. Optional Product:
 - a. Carlisle Fire Resist Barritech NP.
 - b. Tremco ExoAir 130.
- B. Transition Membrane:
1. Self-adhesive.
 2. Compatible with air barrier and adjacent substrate.
 3. As recommended by air barrier manufacturer.
- C. Engineered Transition Assembly:
1. Extruded aluminum adaptor.
 2. Silicone rubber extrusion.
 3. Premolded silicone rubber corners.
 4. Silicone sealant.
 5. Metal screws.
 6. Base Product: Proglaze.ETA Engineered Transition Assembly by Tremco.
- D. Termination Mastic:
1. Rubberized asphalt-based mastic.
 2. Bituthene Mastic.
 3. Manufacturer's recommended termination for non-asphaltic products.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine conditions for compliance with requirements for installation, tolerances and other specific conditions affecting performance of air barrier.
- B. Substrate to be smooth and free of voids, spalled areas, and sharp protrusions.
- C. Exterior Sheathing Panels:
 1. Pre-treat joints with reinforced self-adhesive tape or mesh style wallboard tape.
 2. Caulk gaps greater than 1/4 inches.
- D. Remove deleterious materials from surfaces to be covered.
- E. Do not proceed with installation until unsatisfactory conditions have been corrected.
- F. Installation indicates acceptance of substrates and responsibility for performance.

3.2 INSTALLATION

- A. Install according to manufacturer's instructions.
- B. Perform work only when existing and forecast weather conditions are within limits established by manufacturer.
- C. Join air barrier in an airtight and flexible manner to air barrier material of adjacent systems, allowing relative movement of systems due to thermal and moisture variations and creep between:
 1. Foundation and walls.
 2. Walls and windows or doors.
 3. Different wall systems.

4. Wall and roof.
 5. Wall and roof over unconditioned space.
 6. Walls, floors and roof across construction, control, and expansion joints.
 7. Walls, floors and roof to utility, pipe, and duct penetrations.
- D. Air and Vapor Barrier Membrane:
1. Primer: Apply at rate recommended by manufacturer prior to membrane installation. Allow primer to dry completely before membrane application.
 2. Sheet Membranes:
 - a. Apply membrane horizontally or vertically and press firmly into place with hand roller.
 - b. Start at the bottom of vertical surfaces and work up.
 - c. Do not reverse shingle membranes or detail tape.
 - d. Stagger end lap seams.
 3. Fluid Applied Membranes:
 - a. Spray or trowel apply continuous uniform film using multiple, overlapping passes to ensure even thickness and coverage.
 - b. Carry membrane into openings minimum 3 inches.
 - c. Seal brick ties and penetrations as work progresses.
- E. Transition Membrane:
1. Install mastic at terminations, substrate transitions, penetrations and overlaps according to manufacturer's standard details.
 2. Overlap fluid applied membrane onto each surface at beams, columns, and joints.
 3. Tie in to window and door frames, spandrel panels, roof and floor intersections, and changes in substrate.
 4. Seal top edge of flashing with termination mastic.

3.3 FIELD QUALITY CONTROL

- A. Quality Assurance Program:
1. Enlist project in ABAA Quality Assurance Program (QAP).
 2. Include cost of program in bid.
- B. Air barrier materials and installation are subject to inspection and may include following:
1. Testing to be performed determined by Owner's testing agency for compliance with requirements.
 2. Where test results do not meet requirements: Correct deficiencies, retest, and implement improved installation procedures for completing balance of Air Barrier.

3.4 PROTECTION

- A. Schedule work to ensure that system is covered as soon as practicable.
1. Protect system from damage during subsequent operations.
- B. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer.
1. Apply temporary UV protection if system cannot be covered within prescribed period.
 2. Replace air barrier if determined be damaged by UV exposure by Manufacturer.
 3. Replace air barrier exposed to UV for longer than recommended period.
- C. Clean spills, stains, and soiling from construction that would be exposed in completed work as recommended by manufacturer of affected construction.
- D. Remove masking materials after installation.

END OF SECTION

SECTION 07 42 47

Architectural Ultra High Performance Concrete (A|UHPC) Façade Panels

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. This scope includes the furnishing and installation of factory-cast, alkali-resistant glass mesh-reinforced Ultra High Performance Concrete (UHPC) solid exterior or interior wall panels, associated components, and engineered support structure (subframe). Panels shall be factory cut and pre-drilled for concealed and/or visible fastening based on approved shop drawings and to the extent feasible for the installation and field conditions.
- B. In a ventilated rainscreen application, complete system shall include the design and installation of the solid exterior wall panels and support structure system to provide, in conjunction with wall substrate and air barrier, a weather-tight wall assembly utilizing back-ventilated and drained façade standards.

1.2 REFERENCE STANDARDS

- A. ASTM C1185-08: Standard Test Methods for Sampling and Testing Non-Asbestos Fiber-Cement Flat Sheet, Roofing and Siding.
- B. ASTM C1186-22: Standard Specification for Flat Fiber-Cement Sheets.
- C. ASTM E 330: Standard Test Method for Structural Performance of ... Curtain Walls by Uniform Static Air Pressure Difference.
- D. ASTM C496: Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
- E. ASTM C531: Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing's, and Polymer Concretes.
- F. ASTM C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars Using Cube Specimens.
- G. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.
- H. ASTM E136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace At 750 Degrees C; 2012.
- I. ASTM E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements; 2010.
- J. AISI 905.4: Standard Test Methods for Steel Fasteners

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 05 Section "Cold-Formed Metal Framing"
- B. Division 06 Section "Sheathing"
- C. Division 07 Section "Thermal Insulation"
- D. Division 07 Section "Membrane Air Barriers"
- E. Division 08 Section "Windows"

1.4 DEFINITIONS

- A. **Ultra High Performance Concrete:** Concrete made with a low water to cement ratio (0.3) and high material packing density to achieve impermeability and a strength to weight ratio superior to other concrete materials.

- B. **Alkali-Resistant Glass Mesh:** Glass alloyed to achieve stability in an alkaline environment, which is then woven into a continuous glass mesh to be cast into panels as an added level of structural security in the event of panel breakage.
- C. **Panel Hardware System:** System of hardware for attachment of panels, consisting of either concealed or exposed fasteners and the clip and rail or hat channel attached the panels.
- D. **Subgirt:** Engineered support structure system attaching the panel hardware system to the building wall. This generally consists of an adjustable wall bracket and rail assembly.
- E. **Panel Layout Drawings:** Set of submittal drawings created from the architectural drawings which show panel finishes, dimensions, and attachment locations.

1.5 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by testing of manufacturers' products representing those indicated for this Project without failure due to:
 - 1. Defective manufacture, fabrication, installation, or other defects in construction.
 - 2. Thermal stresses transferring to building structure
 - 3. Solid exterior wall panels and support structure cracking or breakage
 - 4. Loosening or weakening of fasteners, attachments, and other components
- B. Structural Performance – Wall Panel and Support System:
 - 1. Must accommodate thermal movement from annual ambient temperature change of 120 degF.
 - 2. Will not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2% of span at 150% of positive and negative wind loads. Durations are as required by design criteria but not less than 10 seconds.
 - 3. Panel and panel hardware system to be designed to accommodate building deflection and deflection of adjacent materials at design wind loads.
 - a. Deflection of panels:
 - 1) Deflection normal to wall plane: Maximum of L/240 between anchor points
 - 2) Deflection parallel to wall plane: Maximum of L/360 between anchor points
 - b. Deflection of panel hardware and subframe members:
 - 1) Deflection normal to wall plane: Maximum of L/240 of panel support span
 - 2) Deflection parallel to wall plane: Maximum of L/360 of panel support span
 - 4. Story Drift: Accommodate displacement of adjacent stories as indicated by design displacement on structural drawings.
 - 5. Solid exterior or interior wall panel systems shall comply with International Building Code 1405.16.1 Panel Siding

1.6 SUBMITTALS

- A. Product Data
 - 1. Product Data
 - 2. Quality Management Tolerances and Acceptance Criteria
 - 3. Aggregate Acceptance Criteria
 - 4. Color Variation Chart
 - 5. Hardware Product Data Sheet
 - 6. Field Guide
- B. Samples representative of finished exposed face of UHPC panel, 6" x 6" nominal size. For each material type selected, submit a minimum of four samples. Approved samples to be photographed front and back, photographs to be sent to manufacturer.

- C. Shop Drawings for project to show fabrication and installation details for UHPC panels including panel elevations, sections, and dimensions, panel attributes, connection details, and relationships to adjacent materials.
- D. Delegated-Design Submittals.
 - 1. Engineering analysis for UHPC panels and panel system hardware confirming compliance with performance requirements and design criteria, signed and sealed by a professional engineer. Structural, wind, and pressure loads are as indicated on Structural Drawings.
 - 2. Panel Layout Drawings showing actual sizes of panels with anchor/fastener locations, typical details, and unique transition condition details. Drawings shall be utilized for review and approval, as well as coordination with other trades. Verification of field dimensions by installing contractor.
- E. Quality Assurance Submittals:
 - 1. Test Reports: Submit certified test reports showing material compliance with specified performance characteristics and physical properties.
 - 2. Independent Quality Management System Certification and Listing Document
- F. Closeout Submittals:
 - 1. Operation and Maintenance Data
 - 2. Manufacturer's Limited Liability Product Warranty

1.7 QUALITY ASSURANCE

- A. UHPC Panel Manufacturer Qualifications: Minimum of 10 years experience in manufacturing thin, mesh-reinforced Ultra High Performance Concrete façade panels.
- B. Installer Qualifications: Minimum 5 years experience performing work with thin cladding panels of similar type and scope.
- C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in the state where the Project is located and who is experienced in providing engineering services of the type listed.

1.8 MOCKUPS

- A. Build mockup indicated on drawings to verify material selections made under sample submittals to demonstrate assembly of full scale components and details.
- B. Evaluation and acceptance of UHPC Panels on mockup shall be in accordance with the manufacturer's quality acceptance criteria.
- C. Approval of mockup does not constitute approval of deviations from the Contract Documents unless Architect specifically approves such deviations in writing.
- D. Mockups are to be used for approval panels finishes and assembly details. Mockups will not represent full range of conditions, variations, or aesthetic effects for finished Project.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Deliver UHPC wall panels and panel hardware components packaged to comply with manufacturer's requirements and adequately protected from damage during shipment.
- B. Protect components from adverse job conditions prior to installation
- C. Protect components from damage after installation including impact damage, abrasion, or staining from chemicals used in adjacent work.
- D. Panels to be stored and handled vertically until installed.
- E. Store UHPC panels in shipment packaging, or on platforms or pallets, covered with tarpaulins so that water accumulations will drain freely
- F. Store with non-staining resilient spacers between panels with suitable ventilation for water evaporation.

- G. Do not store UHPC panels or hardware system components in contact with other materials that might cause staining, denting, surface damage, or other deleterious effects.

1.10 PROJECT CONDITIONS

A. Field Measurements:

1. If field measurements are required, installer to verify critical field dimensions and indicate measurements on Panel Layout Drawings.
2. Any required field measurements are to be provided prior to panel fabrication.
3. Cutting and drilling panels in the field will be required for any and all penetrations through panels, and any angled features due to grade or adjacent materials.

B. Established Dimensions

1. If field measurements are not provided, establish framing and opening dimensions to proceed with fabricating concrete panels without field measurements. Coordinate wall construction with all trades to ensure that the actual building dimensions, locations of structural members, and openings correspond to established dimensions.
2. It is recommended that a select number of panels be oversized to trim to size in the field and accommodate any dimensional variations in the building construction.
3. Cutting and drilling panels in the field will be required for any and all penetrations through panels, and any angled features due to grade or adjacent materials.

1.11 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of cladding support system that do not comply with requirements or that fail due to installation or workmanship within the specified warranty period.

B. Warranty Period:

1. Cladding support system: Five (5) years from date of substantial completion
2. UHPC Panels: Twenty (20) years from date of substantial completion

PART 2 - PRODUCTS

2.1 UHPC PANELS

- A. Manufacturers: Provide integrally-pigmented Ultra High Performance Concrete façade panels with two layers of alkali-resistant continuous glass mesh.
- B. Basis of Design Product / Manufacturer: TAKTL Ultra High Performance Concrete (A)UHPC) façade panels, fully reinforced for breakage prevention with continuous alkali-resistant (AR) glass mesh. Or Approved Equal.
- C. Panel Performance Characteristics
1. Strength Classification | ASTM C1186: Type A, Grade IV
 2. Thermal Expansion | ASTM C531: < 6.50 E-06 in/in/degreeF
 3. Density | ASTM C1185: 137 lb/ft³
 4. Flexural Strength | ASTM C1185: minimum 3,400 lb/in²
 5. Freeze/Thaw | ASTM C1185: minimum 90% flexural strength retention
 6. Moisture Movement | ASTM C1185: 0%
 7. Water Absorption | ASTM C1185: Less than 4%
 8. Water Tightness | ASTM C1185: Pass
 9. Anchor Pullout Strength | ASTM E488:
 - a. Minimum 520 lbf in tension
 - b. Minimum 890 lbf in shear
 10. Compressive Strength | ASTM C109: > 12,000 lb/in²

11. Tensile Strength | ASTM C496: > 13,000 lb/in²
12. Surface Burning | ASTM E84: Class A
13. Combustibility | ASTM E136: Non-Combustible

D. Panel Finishes, Thickness, Weight

1. Basis of Design: Taktl White, Cast.
 - a. Color: White 87.
 - b. Texture: Rough 1 Cast.
 - c. Finish: Cast.
 - d. Thickness: 5/8" standard base; 7.2 – 7.8 lb/square foot weight

E. Outside Corners

1. Mitered edges, open joint and
2. Mitered, fully-adhered bonded corners, where shown (soffit).

2.2 UHPC PANEL HARDWARE SYSTEM AND SUBFRAME

A. Concealed Attachment Components

1. KEIL stainless steel concealed undercut anchors and bolts.
2. Mfr's interlocking clips and continuous horizontal rail, c-shape extruded aluminum, rail painted black.
3. Adjustment bolts and fixing screws for leveling and securing panels
4. Seismic panel restraint hardware, as required by structural design.

B. Exposed Attachment Components

1. Mfr's 300 series stainless steel fasteners, self-drilling, color-matched and painted
2. Vertical or horizontal furring members

C. Subframe (Concealed Attachment)

1. Vertical girt profile, self-shimming extrusions or cold formed channels that fasten into support brackets and supports.
2. Screws complying with ASTM C1002 (for steel members < 0.033 inches thick) or ASTM C954 (for steel members 0.033 – 0.112 inches thick)
3. Material requirements
 - a. Aluminum extrusions: ASTM B221, alloy 6005 T5 or better
 - b. Aluminum sheet: ASTM B209, alloy 6061 T5 or better
 - c. Carbon steel shapes and plates, ASTM A36
 - 1) ZAM, galvalume, or hot dipped OR
 - 2) Shop-primed with paint complying with MPI#79 on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning" or better.
 - d. Stainless steel bars and shapes: ASTM A276, type 304 or better.
4. Complete subframe assembly to support and anchor UHPC panels and Panel Hardware System.

2.3 FABRICATION

- A. Fabricate wall panels and accessory items in accordance with manufacturer recommendations and approved submittals.
- B. Panels shall be primarily fabricated to size and pre-drilled in the factory by the UHPC manufacturer.
- C. Panels may be cut and drilled in the field in accordance with UHPC manufacturer instructions.

- D. Penetrations for lighting, electrical, HVAC, and other utilities must be cut in the field by the installing contractor and in accordance with panel manufacturer guidelines and limitations.

2.4 FABRICATION TOLERANCES

A. UHPC Panel Factory Tolerances

1. Dimensional
 - a. Length, width, thickness: per ASTM C1186 Standard Specification
 - b. Anchor Location: +/- 1/16"
 - c. Square: tolerance +/- 1/16 inches per 72 inches up to a maximum of +/- 1/8 inch
2. Color Variation
 - a. Clear Sealer): Natural color variation in accordance with Manufacturer Color Variation Chart
 - b. Opaque Sealer: Minimal variations associated with changes in sealer color itself.
3. Blemishes and Chips
 - a. Reference UHPC manufacturer's Quality Control Tolerances and Acceptance Criteria.
 - b. Acceptance of installed panels shall be assessed when viewed from a distance of 20 feet, under even light, and from a position 90 degrees to the building elevation.

PART 3 - EXECUTION

3.1 MANUFACTURERS' INSTRUCTIONS

- A. Comply with manufacturers' product data, including product technical bulletins, product catalog installation instructions and site handling instructions for installation.

3.2 EXAMINATION

- A. Examine structure and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 ERECTION / INSTALLATION

- A. Install wall reinforcements, channel cleats, clips, hangers, and other accessories required for connecting UHPC wall panels to supporting members and backup materials per project/façade engineers approved design.
- B. Provide miscellaneous reinforcement of adhered panel parts and unitized panel parts per manufacturer and installation contractor's engineer.
- C. Lift UHPC wall panels and install without damage.
- D. Install UHPC wall panels level, plumb, square, and in alignment.
- E. Provide temporary supports and bracing as required to maintain position, stability, and alignment of panels until permanent connections are completed.
 1. Maintain horizontal and vertical joint alignment and uniform joint width.
 2. Remove temporary shims, wedges, and spacers as soon as possible after connecting is complete.
 3. Remove temporary projecting hoisting devices.

3.4 ERECTION TOLERANCES

- A. This portion applies only to subframe and panel installation. System tolerance should account for building wall and structure tolerances.
- B. Deviations from Plans
 1. Plan location from building grid datum: +/- 1/2 inch.

2. Top elevation from nominal top elevation / exposed panel face relative to adjacent panel: +/- 3/16".
 3. Support elevation from nominal elevation: maximum low – 1/8", maximum high + 1/8 inch.
- C. Plumb
1. Maximum plumb variation over lesser of 100 feet or height of structure: 1 inch.
 2. Plumb in any 10 feet of panel height: 1/4 inch.
- D. Panel Joint Tolerances
1. Maximum offset of vertical/horizontal alignment: 3/16" inch.
 2. Maximum joint width variation: 1/4 inch over 10 feet for a 1/2 inch joint.
- E. Differential Bowing: 1/4 inch between adjacent members of same design, as erected.

3.5 CLEANING AND PROTECTION

- A. Perform cleaning procedures according to UHPC panel manufacturer's written instructions.
- B. Clean soiled UHPC surfaces with water, using soft fiber brushes, microfiber rags, or soft sponges, and rinse with clean water. Mild detergent may be used if water alone is not satisfactory.
- C. Power washing is permitted, in accordance with manufacturer's instructions. Spray must not be concentrated, and must be held at least 5 feet from the panel surface.
- D. Should standard cleaning procedure be found ineffective in special circumstances, do not proceed without consulting the UHPC panel manufacturer.
- E. Prevent damage to UHPC surfaces and staining of adjacent materials.
- F. The installer is responsible for removing all metal, UHPC scraps, unused clips and fasteners, and crates with packing materials from this work and from the site when the installation is complete.

END OF SECTION

SECTION 07 42 93

Aluminum Soffits

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Aluminum Soffits.
 - 2. Aluminum Trim and Accessories.

1.2 RELATED SECTIONS

- A. Section 05400 - Cold-Formed Metal Framing: Metal framing for support of aluminum soffits.
- B. Section 06000 – Rough Carpentry: Wood stud framing, furring and sheathing for support of aluminum soffits.
- C. Section 07210 – Building Insulation: Rigid thermal insulation installed behind soffit.

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E 136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
 - 3. ASTM E 2768-11 – Standard Test Method for Extended Duration Surface Burning Characteristics for Building Materials (30 min Tunnel Test). Results: Zero Flame Spread, Smoke Developed Index of 5. Meets criteria for Class A fire rating.
- B. American Architectural Manufacturers Association (AAMA)
 - 1. AAMA 2604 - Voluntary Specification, Performance requirements and Test Procedures for High Performing Organic Coatings on Aluminum Extrusions and Panels.
- C. Aluminum Association Standards (AA ASM)
 - 1. AA ASM 35 - Aluminum Sheet Metal Work in building construction.
 - 2. AA ADM 1 - Aluminum Design.

1.4 PERFORMANCE REQUIREMENTS

- A. Components: Design and size components to withstand dead and live loads in accordance with applicable code.
- B. Movement: Accommodate movement within system without damage to components or movement within system:
 - 1. Movement between system and perimeter components when subject to seasonal temperature cycling.
 - 2. Dynamic loading and release of loads.
 - 3. Deflection of structural support framing.
- C. Drainage: Provide positive drainage to the exterior for moisture entering or condensation occurring within the soffit system.

1.5 SUBMITTALS

- A. Submit under provisions of section 01 30 00 Administrative Requirements.

- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop drawings: indicate dimensions, layout, joints, expansion joints, construction details, methods of anchorage, and interface with adjacent materials.
- D. Verification Samples: For each finish product specified, two samples, minimum size 2 inches by 3-1/2 inches, representing actual product, color and gloss.
- E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- F. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic cleaning and maintenance of components.

1.6 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Minimum ten years' experience producing aluminum finishes of the types specified in AAMA 2604 Certified.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.
- C. Mock-up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designed by the Architect.
 - 2. Do not proceed with remaining work until workmanship, color, and gloss are approved by the Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package and store products under cover in manufacturer's unopened packaging until ready for transport and installation.
- B. Unload and store prefinished material off ground protected from weather, to prevent warping, twisting, bending, or abrasion.
- C. Prevent contact with materials capable of causing discoloration or staining.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by the manufacturer for optimum results.
- B. Do not fabricate products under environmental conditions outside manufacturer's absolute limits.
- C. Weather limitations: Proceed with installation when existing and forecasted weather conditions permit assembly of metal fabrications to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

- A. Coordinate work with installation of adjacent components or materials to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. 15 year limited lifetime warranty against cracking, peeling and gloss/color retention within the guidelines stated by the American Aluminum Manufacturers Association (AAMA).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of design: Knotwood Aluminum Soffits

Represented by: KNOTWOOD USA

5555 W Roosevelt St Suite 400,

Phoenix, AZ 85043 United States

1-602-313-1641

Request information at: sales@knotwood.com

Web: www.knotwood.com

- B. Or Approved Equal.

2.2 MATERIALS

- A. Extruded Aluminum Soffits, Accessories and Trim: Knotwood Wood Grain Aluminum Soffit Trim and Accessories with Aluminate bonded film finish is extruded aluminum.

1. Flip Batten - 4" x 5/8"
2. Cast End Cap - 4" x 5/8"

- B. Manufactured length is 18'6" – useable is 18'4".

2.3 FINISHES

- A. Pretreatment: E-CLPS Chrome Free five stage aluminum pretreatment system. Complies with, AAMA 2604 Performance Standard and meets EPA, OSHA, State and Local environmental requirements and contains no chromates, cyanides, or other heavy metals. Waste treatment is usually a simple pH neutralization and disposal to the sanitary sewer.
- B. Dulux Group Mannex base coat and Duratec Series electrostatic applied Architectural Powder Coatings are approved to AAMA 2604 Performance Standard.
- C. Gloss Level: Standard Gloss is 30 percent, plus or minus 5 percent.
- D. Super Durable Powder Coatings: Aluminate Premium Wood Finishes use a polyurethane powder coat with ink-based wood grain patterns sublimated into the base powder effectively tattooing the powder coating. The combined effect creates all the aesthetic aspects of real wood while offering the same environmental advantages of powder coated finishes.
1. Standard Woodgrain Colors:
 - a. White Ash

2.1 FABRICATION

- A. Prepare surfaces, pre-treat and coat components in accordance with AAMA 2604 Quality Standards.
- B. Wrap and package coated components using methods suitable for transit and covered site storage without damage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until colors have been verified.
- B. Verify framing members are ready to receive the soffit system.
- C. If preparation is the responsibility of another installer, notify the Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by the manufacturer.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions.
- B. Barrier Protection: Do not install over cementitious materials, dissimilar metals or pressure treated material without adequate barrier protection.
- C. Fasten siding to structural supports; aligned, level, and plumb.
- D. Locate joints over supports.
- E. Install expansion control joints where needed.
- F. Use concealed fasteners unless otherwise approved by the Architect.
- G. Install soffits, and accessories in accordance with best practice, with all joint members plumb and true.
- H. Allow for expansion and contraction of materials according to manufacturer's instructions.
- I. Reveal – Install with (0" / 1/4") reveal between soffits.

3.4 FIELD QUALITY CONTROL

- A. After installation of soffits, check the entire surface for obvious flaws or defects.
- B. Replace and repair any problem areas, paying close attention to the substrate for causes of the problem.

3.5 CLEANING

- A. After application of soffits, clean as necessary to remove all fingerprints and soiled areas.
- B. Upon completion of soffit application, clean the entire area, removing all scrap, packaging and unused materials related to this work.

3.6 PROTECTION

- A. Protect installed products until completion of project
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 07 53 25
FULLY ADHERED EPDM ROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Fully Adhered EPDM Roofing in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
 - 2. ASTM C1289 Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
 - 3. ASTM C1303 Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation
 - 4. ASTM D312 Standard Specification for Asphalt Used in Roofing
 - 5. ASTM D4637 Standard Specification for EPDM Sheet Used in Single-Ply Roofing
 - 6. ASTM D4811 Standard Specification for Non-vulcanized Rubber Sheet Used as Roof Flashing
 - 7. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - 8. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials
- B. American National Standards Institute (ANSI) / Single Ply Roofing Industry (SPRI):
 - 1. ANSI/SPRI ES-1 Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems
- C. National Roofing Contractors Association (NRCA):
 - 1. Roofing and Waterproofing Manual
- D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - 1. Architectural Sheet Metal Manual
- E. Underwriters Laboratories (UL):
 - 1. 790, Standard for Tests for Fire Resistance of Roof Covering Materials

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer standard literature for vapor barrier, insulation, and roofing system components, including adhesives and accessories indicating compliance with specification requirements.
 - 2. Manufacturer standard literature for roof coping system indicating components and accessories including anchor plate configuration.
- B. Shop Drawings:
 - 1. Roof layout showing insulation thicknesses and details.
 - 2. Detail and indicate location of expansion joints, crickets, saddles, curbs, safety tiebacks, vents, drains and other penetrations.
 - 3. Indicate slope direction, slope amount, and key vertical elevation points.
 - 4. Indicate components included for installation including anchor plate configuration.

- 5. Profiles of flashing assemblies.
- 6. Installation drawings.
- C. Samples:
 - 1. Roofing manufacturer's facsimile of each sheet metal color for pre-selection.
 - 2. 3 inches x 5 inches samples of roofing manufacturer's sheet metal color for final approval.
- D. Project Information:
 - 1. Minutes from Preinstallation Conference.
- E. Contract Closeout Information:
 - 1. Warranty.
 - 2. Maintenance Data:
 - a. Include cleaning instruction.
 - b. See Section 01 78 23.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Manufacturer authorized roofing installer.
- B. Component products produced by single manufacturer or approved for use by roofing manufacturer to achieve a warranted system.
- C. Concrete Moisture Vapor Testing:
 - 1. Coordinate maximum moisture allowed in concrete deck with roofing manufacturer.
 - 2. Test concrete decks for moisture in accordance with Section 07 16 04.
 - 3. If moisture content exceeds manufacturer's recommendation, install moisture control system per Section 07 16 05.
- D. Static pressure of building interior: Less than 0.5 inches water.
- E. Fire Resistance Rating:
 - 1. UL 790, Class A.
 - 2. Assembly in conformance with fireproofing as specified.

1.5 WARRANTY

- A. Manufacturer's standard 15-year warranty of weathertightness signed by roofing materials manufacturer.
 - 1. Warranty to include coverage for peak gusts of wind to:
 - a. 55 mph at 33 feet above ground.
 - 2. Warranty to include the entire system: membrane, flashings, adhesives, sealants, counterflashings, insulation, fasteners, fastener plates, fastener strips, hard rubber or metal edging, metal termination bars, sheet metal copings and edge metal, and other material authorized by manufacturer.
- B. Manufacturer's 20-year warranty on 70 percent PVDF, Kynar 500, coatings on edge metal and copings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fully Adhered EPDM Roofing:
 - 1. Base:
 - a. Carlisle SynTec Systems.

2. Optional:
 - a. Holcim Elevate.
 - b. Johns Manville.
 - c. Versico.
- B. Sheathing:
 1. Base:
 - a. Georgia-Pacific.
 2. Optional:
 - a. Same as roofing manufacturer.
 - b. USG Corporation.
 - c. National Gypsum.
- C. Vapor Retarder (VR):
 1. Base:
 - a. Same as roofing manufacturer.
- D. Sheet Metal Coving and Edge Metal:
 1. Base:
 - a. Same as roofing manufacturer.
- E. Other Materials:
 1. Base:
 - a. Manufacturers as noted.
- F. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Determine per Wind Load Design Guide for Low Sloped Flexible Membrane Roofing Systems published by SPRI.
- B. Design roof system and anchorage fastener type and spacing needed to resist uplift pressures including roof covering and metal edge securement to meet design loads and satisfy requirements of applicable building codes, local amendments, and ANSI/SPRI ES-1.
- C. Wind loads: Use the greater of the following:
 1. Wind pressures as required per local building code based on wind speed, exposure factor and importance factor noted in Structural Drawings.
- D. Requirements applicable to designated warranty.
- E. Roof height and parapet height: As indicated.
- F. Static pressure of building interior: Less than 0.5 inches water.

2.3 MATERIAL: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Vapor Retarder:
 1. Rubberized asphalt membrane adhered to polyethylene or polyolefin top sheet.
 2. 30 mil thick, minimum.
 3. Vapor Permeance: Not exceeding 0.05 Perm US.
 4. Primer or adhesive as recommended for substrate by manufacturer.
 5. 725TR by Carlisle SynTec Systems
- B. Roof Insulation:

1. Furnished by roofing manufacturer.
 2. UL listed for assembly indicated.
 3. Provide crickets and saddles as required.
 4. Polyisocyanurate (PISO) roof insulation:
 - a. Rigid, closed cell foam core bonded to heavy-duty glass fiber mat facers.
 - b. ASTM C1289 Type II, Class 1.
 - c. R-value: 5.6 per inch in accordance with ASTM C1303, CAN/ULC S770.
 - d. Compressive strength: 25 psi minimum per ASTM D1621, Grade 3.
 - e. Dimensional stability: 2 percent maximum linear change in seven days per ASTM D2126.
 - f. Minimum insulation thickness:
 - 1) Areas where tapered insulation is indicated:
 - a) Minimum R-30 at roof drains.
 - b) Taper to provide slope of 1/4 inches per foot.
 - 2) Areas with uniform insulation thickness (sloped structures):
 - a) Minimum R-30 at roof drains.
 5. InsulBase polyisocyanurate by Carlisle SynTec Systems.
- C. Cover Board:
1. Moisture resistant gypsum core with fiberglass mat and non-asphaltic surfacing.
 2. Minimum Thickness: 5/8 inches.
 3. DensDeck Prime Roof Board by Georgia-Pacific.
- D. Roofing Membrane:
1. Ethylene propylene diene terpolymer (EPDM).
 - a. Comply with ASTM D4637.
 2. Non-reinforced.
 - a. Comply with ANSI/RMA IPR-1.
 3. Minimum Physical Properties:
 - a. Thickness: 60 mil.
 - b. Tensile Strength: 1305 psi minimum by ASTM D412.
 - c. Ultimate Elongation: 350 percent minimum by ASTM D412.
 - d. Tearing Strength: 175 pounds minimum by ASTM D624, Die C.
 - e. Factory Seam Strength: Tested to membrane rupture by ASTM D816, modified.
 - f. Fire Retardant.
 - g. Color: Black.
 4. Sure-Seal by Carlisle SynTec Systems.
- E. Membrane Flashings, Fasteners, Adhesives, Tapes and Sealants:
1. Roofing manufacturer's standard.
- F. Edge Metal and Coping:
1. Roofing manufacturer's pre-engineered, prefabricated system for termination of roofing membrane.
 2. Obtain approval in writing by roofing manufacturer for field fabricated components to ensure a warranted system.
 3. Design for wind pressure indicated for balance of roof system.
 4. Conceal fasteners from view.
 5. Conceal splice plates, with color matching snap-on covers.

6. Anchor cleats:
 - a. Material: G90 galvanized steel.
 - b. Thickness: 20 GA.
7. Snap-on cover:
 - a. Material: G90 galvanized steel.
 - b. Thickness:
 - 1) For dimensions less than 10 inches: 24 GA.
 - 2) For dimensions 10 to 24 inches: 22 GA.
 - c. Finish: 70 percent PVDF Kynar 500.
 - d. Color:
 - 1) Custom Color As selected by Architect.
8. Roof Edge/Fascia:
 - a. Include accessories such as pre-fabricated inside and outside corners, spill out, overflow and downspout scuppers, edging extensions, fascia sumps, and other items indicated.
 - b. SecurEdge 200 Fascia by Carlisle SynTec Systems.
9. Coping:
 - a. Include accessories such as pre-fabricated inside and seamed outside corners, end caps, saddles, tees, crosses, transition pieces and radius copings, and other items indicated.
 - b. SecurEdge 200 Coping by Carlisle SynTec Systems.
- G. Fasteners:
 1. Type, spacing and quantity as recommended by manufacturer.
 - a. Designed to resist uplift forces generated by specified wind speed.
 2. Minimum pullout values per fastener:
 - a. For use with 22 GA steel decks: 350 pounds each.
 - b. For use with normal weight concrete decks: 800 pounds each.
 3. Fasteners shall be capable of providing a static back-out resistance of at least 10 inches-LBS.
- H. Miscellaneous Items:
 1. Roofing accessories:
 - a. Use manufacturer's standard prefabricated accessories where available.
 - b. Nailing strips: As detailed and required.
 - c. Pipe flashings: Provide for each pipe penetration; include clamps, adhesive and sealants.
 - d. Expansion joint covers.
 - e. Underlayment for pavers: As recommended by roofing manufacturer.
 2. Adhesives, cleaners, and primers: As recommended by roofing manufacturer.
 3. Fire-retardant Treated (FRT) wood blocking: Specified in Section 06 10 00.
 4. Other materials as required by manufacturer for complete system warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect entire area to be roofed for acceptability.
- B. Surface on which insulation or roofing membrane is applied shall be clean, smooth, dry, and free of projections such as fins, sharp edges, or foreign materials.

- C. Correct unsatisfactory conditions.
- D. Commencement of roofing activities constitutes acceptance of conditions affecting installation and roofing system performance.

3.2 INSTALLATION

A. Vapor Retarder:

1. Install in largest practical widths.
2. Bond vapor retarder to substrate using approved adhesive.
3. Install continuously.
 - a. Ensure surfaces to be taped are clean and dry.
 - b. Ensure that no discontinuities occur, including at seams, penetrations, and edge terminations.
 - c. Join sections of vapor retarder and lap seams in direction of water flow.
 - d. Continuously seal roof vapor retarder to wall air and moisture retarder.
4. Seal around pipes, conduits, curbs, safety tie-backs, and other penetrations with pipe boots in accordance with manufacturer's instructions.
5. Maintain continuity of vapor retarder over expansion joints.
6. Repair holes in vapor retarder with method and material recommended by manufacturer.
7. Protect vapor retarder from damage until covered with insulation.

B. Wood Nailers:

1. Design to resist a minimum of 200 pounds/LF in any direction per SPRI Test Method RE-1.
2. Provide where indicated or required for proper securement of roofing system.
3. Install top of blocking flush with top of insulation.

C. Insulation:

1. Attach with adhesive in full spray or beads, or mechanically attach with fasteners in accordance with roofing manufacturer's recommendations.
2. Where required thickness of insulation is greater than 2 inches, install insulation in at least 2 layers.
3. Cut insulation neatly to fit around roof penetrations and projections.
4. Butt joints tightly.
5. Install overlay board over insulation.
 - a. Fasten through overlay board and insulation to deck.

D. Cover Board:

1. Install cover board continuously over insulation.
2. Secure to substrate in same manner specified for insulation securement.

E. Membrane:

1. Do not allow grease, fats, oils, and other contaminants to contact roofing membrane.
2. Unroll and position membrane without stretching.
3. Position sheets to accommodate contours of roof deck.
4. Apply bonding adhesive in accordance with manufacturer's instructions, to underside of membrane and substrate.
5. Roll coated membrane into coated substrate.
 - a. Avoiding wrinkles.
6. Membrane splices:
 - a. Comply with manufacturer's instructions for splicing procedures.
 - b. Locate field splices away from low areas and drain sumps.

- c. Shingle splices to avoid bucking water.
- 7. Membrane flashing:
 - a. Flash penetrations and walls with cured EPDM membrane or flashing.
 - b. Exceptions:
 - 1) Limit uncured flashings and pressure sensitive uncured flashing to overlaying of vertical seams, flashing of inside and outside corners, scuppers, and other unusually shaped penetrations.
 - 2) Utilize manufacturer's standard pre-manufactured accessories.
 - c. Terminate base-of-wall flashings in accordance with manufacturer's approved details.
 - d. Pre-flashing at sheet metal parapet copings:
 - 1) Extend EPDM membrane and/or flashing over top of parapet prior to capping with sheet metal.
 - e. Expansion joints:
 - 1) Extend EPDM membrane across roofing expansion joints.
 - 2) Include adequate slack in membrane to accommodate anticipated movement.
- 8. Hot or cold weather procedures:
 - a. Comply with manufacturer's instructions.
- F. Edge Metal and Coping:
 - 1. Sub-flash details with a layer of EPDM membrane prior to installation of edge metal or coping system.
 - 2. Secure anchor cleat to blocking as recommended, using corrosion-resistant fasteners.
 - 3. Install splice plates and snap-on covers.
- G. Protection:
 - 1. Seal system at end of work day to temporarily close membrane to prevent water infiltration.
 - 2. Remove temporary water cutoffs prior to proceeding with Work.
 - 3. Remove and replace wet insulation.

3.3 SCHEDULE OF ROOF SYSTEMS

- A. Roof System - Fully Adhered EPDM over Concrete Deck:
 - 1. Vapor retarder.
 - 2. Insulation.
 - 3. Cover board.
 - 4. EPDM membrane, adhered.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Flashing and Sheet Metal, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - 2. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - 3. ASTM B209 Standard Specification for Aluminum-Alloy Sheet and Plate
 - 4. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
 - 5. ASTM B308/B308M Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
 - 6. ASTM F2329/F2329M Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
- B. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - 1. Architectural Sheet Metal Manual

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Dimensioned drawings of profiles and shapes.
 - 2. Plans and elevations to show locations of each shape.
- C. Samples:
 - 1. For finish, color, and color range selection.
- D. Contract Closeout Information:
 - 1. Warranty.

1.4 WARRANTY

- A. Furnish 20 year finish warranty on PVDF coated sheet metal, covering color, fade, chalking and film integrity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Formed Sheet Metal:
 - 1. Base:
 - a. AlumaKlad/ColorKlad.

- 2. Optional:
 - a. Berridge Manufacturing Company.
 - b. Petersen Aluminum, PAC-CLAD.
- B. Reglets:
 - 1. Base:
 - a. Fry Reglet.
- C. Other Materials:
 - 1. Base Manufacturers as noted.
- D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Sheet Metal – Galvanized Steel with PVDF coating.
 - 1. ASTM A653/A653M galvanized steel, Z275 G90.
 - 2. Minimum thickness: 0.024 inches or as noted for individual fabrications.
 - 3. Smooth
 - 4. PVDF coating: Minimum 1 mil fluorocarbon coating, 70% PVDF.
 - a. Color:
 - 1) Custom color to be selected by Architect
- B. Sheet Metal - Aluminum, PVDF coated:
 - 1. Sheets and plates: ASTM B209.
 - 2. Extrusions: ASTM B221.
 - 3. Minimum thickness 0.05 inches or as noted for individual fabrications.
 - 4. PVDF coating: Minimum 1 mil fluorocarbon coating, 70% PVDF.
 - a. Color(s):
 - 1) To be selected by Architect from manufacturer's premium lines.
 - b. Multiple colors: Architect reserves the right to select a maximum of 4 different colors.

2.3 SHEET METAL FABRICATIONS

- A. Formed Roof Edge Flashing, Gravel Stop and Fascia Coping:
 - 1. Fabricate to size and profile indicated.
 - 2. Supply sections with minimum length of 96 inches, but not exceeding 10 feet.
 - 3. Joint Style:
 - a. 1/4 inches Butt Joint with 6 inches wide, exposed cover plate
 - 4. Integral Scuppers:
 - a. Locate integral scuppers along length of roof edge.
 - 1) Space 10 feet apart where continuous gutter is indicated.
 - b. Fabricate to dimensions indicated. Include a minimum 4 inches wide flanges on 3 sides for embedment into roofing system.
 - c. Fasten gravel guard angles to base of scupper where applicable.
- B. Formed Sheet Metal Copings:
 - 1. Fabricate to size and profile indicated.
 - 2. Supply sections with minimum length of 96 inches, but not exceeding 10 feet.
 - 3. Fabricate joint plates of same sheet thickness as copings.
 - 4. Securement:

- a. External Leg: Continuous cleats, no exposed fasteners.
- b. Internal Leg: Color-matched fasteners in slotted holes.
- 5. Miter corners, seal, and solder or weld watertight.
- 6. Joint Style:
 - a. 1/4 inches Butt Joint with 6 inches wide, exposed cover plate.

2.4 ACCESSORIES

A. Fasteners:

- 1. Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by flashing manufacturer.
- 2. Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
- 3. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
- 4. Blind Fasteners: High strength aluminum or stainless steel rivets suitable for metal being fastened.
- 5. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
- 6. Fastener Materials:
 - a. Fasteners for Galvanized Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329/F2320M.

B. Cleats:

- 1. 16 GA galvanized or stainless steel.

C. Dissimilar metal and cementitious materials protection:

- 1. Alkali resistant bituminous paint.
- 2. Tnemec TnemeTar 46-413.

D. Base Flashing:

- 1. Fabricate to size and profile indicated.

E. Counterflashing and Flashing Reglets:

- 1. Fabricate to size and profile indicated.
- 2. Provide interior and exterior preformed corners as required.
- 3. Fabricate as required to fit special conditions.

F. Sealants: Specified in Section 07 92 13.

2.5 FABRICATION

A. General:

- 1. Fabricate true and sharp to profiles and sizes indicated.
- 2. Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA Architectural Sheet Metal Manual, which apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated.
- 3. Shop fabricate items to greatest extent possible.
- 4. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
- 5. Form sheet metal flashing and trim without oil canning, buckling, and tool marks, true to line and level indicated, with exposed edges folded back to form hems.
- 6. Conceal fasteners and expansion provisions where possible. Exposed fasteners not allowed on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim to tolerance of 1/4 inches in 20 feet on slope and location lines as indicated and within 1/8 inches offset of adjoining faces and alignment of matching profiles.

C. Sealed Joints: Form movable joints in metal to accommodate elastomeric sealant.

D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep. Fill with butyl sealant concealed within joints.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA Architectural Sheet Metal Manual for application, but not less than thickness of metal being secured.

G. Seams in metals with painted, coated, or lacquered finishes:

1. Fabricate nonmoving seams with flat-lock seams.
2. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

H. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify suitability of substrates to accept work.

1. Verify continuous wood blocking is sloped 1:12 and covered with one layer of building paper or roofing membrane.

B. Installation constitutes acceptance of conditions and responsibility for performance.

3.2 INSTALLATION - GENERAL

A. Install in accordance with details and recommendations of SMACNA, current edition.

B. Set shop fabricated interior and exterior preformed corners and intersections.

C. Set top edges of flashings into reglets as indicated.

D. Fasten materials at recommended intervals.

E. Provide slip joints to allow for thermal movement.

1. Use SMACNA Table 3-1, Design J9 - J12, with caulked lap.
2. Maximum spacing: 10 feet on center.
3. Provide slip joint in conjunction with splices and corners.

F. Caulk joints with 2 beads of sealant on each overlap: See Section 07 92 13.

G. Turn down cap flashing over base flashings 4 inches and caulk.

H. Form flashings to provide spring action with exposed edges hemmed or folded.

I. Provide dissimilar metals and materials protection where dissimilar metals come in contact, or where sheet metal contacts mortar or concrete.

J. Provide miscellaneous sheet metal items not specifically covered elsewhere as indicated or as required to provide a weathertight installation.

3.3 INSTALLATION – GUTTERS AND DOWNSPOUTS

A. Install gutters below slope line of roof, supported on adjustable hangers spaced maximum 30 inches on center or by continuous cleats.

- B. Join gutter sections with flat locked, riveted, and sealed joints with hard setting sealant fill.
- C. Adjust gutters to slope uniformly to downspout outlets, with high point midway between outlets.
- D. Install downspouts supported by leader straps or concealed rack and pin type fasteners at top, bottom and intermediate points not exceeding 5 feet on center.
- E. Install downspout 1 inch clear of building wall.

3.4 INSTALLATION – FORMED COPINGS AND FORMED ROOF EDGES

- A. Prefabricated corner sections with no joint within 30 inches of corners.
- B. Space gutter bars and anchor bolts as recommended by coping manufacturer for installation indicated.
- C. Conceal joints with cover plates and top of adjacent wall counter flashing under coping leg.

3.5 INSTALLATION - ROOFING EXPANSION JOINT COVERS

- A. Comply with manufacturer's instructions for handling and installation of elastic expansion joint materials.
- B. Coordinate installation and associated work to provide a complete system.
- C. Extend over curbs, parapets, gutters, valleys, fascia, and other elements in construction, to provide continuous, uninterrupted, watertight expansion joint.
- D. Provide uniform hump throughout length of installation.
- E. Do not stretch elastic sheet.
- F. Anchor edges of units and seal in compliance with manufacturer's instructions.

3.6 CLEAN-UP

- A. Upon completion of work, repair damaged areas.
- B. Repair finish of PVDF coated flashing which fades or is damaged.
- C. Clean stains and debris.
- D. Remove protective coverings.

END OF SECTION

SECTION 07 72 13

MANUFACTURED CURBS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for roof curbs, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. National Roofing Council of America (NRCA):
 - 1. Roofing Manual.
- C. American Welding Society (AWS):
 - 1. Welding codes, specifications, manuals, and handbooks.
 - 2. Qualify welding processes and operations in accordance with AWS Standard Qualification Procedure.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Materials and general construction features of each curb type.
- B. Shop Drawings:
 - 1. Layout including size, location, and type of each curb.
 - 2. Indicate framing, blocking and anchorage details.
- C. Project Information:
 - 1. Manufacturer's load tables.
 - 2. Seismic certification where required by AHJ. Coordinate with Division 01 and Division 23 specifications.
 - 3. Structural calculations for Prefabricated Roof Curbing indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
 - a. Submit concurrent with Shop Drawings.

1.4 QUALITY ASSURANCE

- A. Provide Prefabricated Roof Curbing engineered to support dead, live, and lateral (wind or seismic) loads indicated.
 - 1. Comply with Section 01 71 21, Specialty Engineering Requirements.
 - 2. Include headers and reinforcing members around openings.
 - 3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Prefabricated Roof Curbing:

1. Base:
 - a. Thybar Corporation/ThyCurb.
2. Optional:
 - a. Curbs Plus Inc.
 - b. Roof Products, Inc.
 - c. Roof Products Systems Corporation (RPS).

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIAL: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Shell, Liner, and Base:

1. Galvanized steel ASTM A653, G60.
2. Thicknesses as indicated for each curb type.
3. Paint exposed portions in field.
4. Integral Base Plate.

B. Insulation:

1. Factory installed 1-1/2 inches thick, 3 pcf density fiberglass.

C. Wood Nailers:

1. Factory-installed, pressure-treated wood.
2. Sizes as indicated.

D. Provide splice plates, connector clips and integral crickets as required.

E. Provide sloped transition units as required.

F. Construct curbs in maximum practical lengths, with fully mitered and welded corners at intersections and closed end sections.

G. Slope bottom surface of curbs (base plates) as required to match structural deck slope and provide continuous level top of curb where structural deck slope occurs.

H. Roof Curbing:

1. Prefabricate roof curbs to elevate fans, condensers, and other rooftop equipment.
2. Sizes: As indicated on roof plan.
3. Material thickness (outer shell & base flange):
 - a. Min 0.053 inches (16 GA).
4. Material thickness (liner):
 - a. Min 0.042 inches (18 GA).
5. Wood nailer: Nominal 2x2.
6. Internal Reinforcing:
 - a. Provide lateral stiffeners at not more than 36 inches on-center.
 - b. Same gauge as outer shell.
7. Curb Height: Minimum 12 inches from the highest surface of the roof membrane adjacent to the curb to the top of curb.
8. Base product: TC-3 by Thybar Corporation.

I. Roof Curbs Surrounding HVAC Ducts:

1. Description: Prefabricated roof curbs, as described above, with additional Damper Tray.
2. See Mechanical Drawings for Fire Dampers & Ducts.

J. Pipe Curb and Cap Assemblies:

1. Description: Prefabricated roof curb and cap assembly designed to seal around piping, conduit and similar items which pass through roofing.
 2. Base Curb:
 - a. Material Thickness (outer shell, base flange, and liner): 18 GA minimum.
 - b. Size: 15 inches x 15 inches.
 3. Curb Height: Minimum 12 inches from the highest surface of the roof membrane adjacent to the curb to the top of curb.
 4. Base Product: TC-3 by Thybar Corporation.
 5. Curb Cap (top-outlet pipes):
 - a. ABS thermoplastic korad acrylic cover, graduated boots molded of weather-resistant Plastisol and 2 stainless steel pipe clamps per boot.
 - b. Base Product: TCC-1, TCC-3, or TCC-5 by Thybar Corporation. Contractor to select appropriate cap model for pipe quantity and sizes.
 6. Curb Cap (side-outlet pipes):
 - a. Sheet metal or ABS cover with horizontally projecting hood flanges.
 - b. 2x8 preservative treated wood nailer (vertical) on side where pipes exit.
 - c. Base Product: TP-2 by Thybar Corporation.
- K. Curb and Solid Cap Assemblies:
1. Description: Prefabricated roof curb and solid cap assembly designed to seal-off a curved opening for future use.
 2. Base Curb:
 - a. Material Thickness (outer shell, base flange, and liner): Min 0.042 inches (18 GA).
 - b. Size: As indicated.
 3. Curb Height: Minimum 12 inches from the highest surface of the roof membrane adjacent to the curb to the top of curb.
 4. Wood Nailer: Nominal 2x2.
 5. Base Product: TC-3 by Thybar Corporation.
- L. Solid Cap (no penetrations):
1. Definition: Custom sheet metal cap used to cap Curb for future use.
 2. Sub-Frame:
 - a. Cold-formed steel members designed for roof loads anticipated.
 3. Plywood Sheathing: Type:
 - a. Preservative-treated, structural grade, CDX or better.
 - b. Min Thickness: 3/4 inches.
 4. Sheet Metal Cap:
 - a. Min 0.042 inches (18 GA) steel.
 - b. Uniformly slope to drain.
 5. Base Product: custom item by Thybar Corporation.
- M. Straight Curbs:
1. Prefabricated roof curbs designed to support and elevate fans, condensers, and other roof-top equipment.
 2. Curb Lengths and Spacing: As indicated on Roof Plan.
 3. Curb Width: Matching width of Nailer.
 4. Material Thickness (shell, base flange & counterflashing):
 - a. Min 0.067 inches (14 GA).
 5. Wood Nailer:

- a. Nominal Size: 2x6.
- 6. Internal Reinforcing/Gussets:
 - a. Provide lateral stiffeners at not more than 36 inches on-center.
 - b. Same gauge as shell.
- 7. Curb Height: Minimum 12 inches from the highest surface of the roof membrane adjacent to the curb to the top of curb.
- 8. Base Product: TEMS-3 by Thybar Corporation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which curbs are to be installed for conditions detrimental to proper and timely completion of work.
- B. Start of installation constitutes acceptance of responsibility for correct installation and performance.

3.2 INSTALLATION - GENERAL

- A. Install units and accessories as indicated.
- B. Coordinate installation with decking, roofing, and equipment to be supported.
- C. Do not start placement until deck work is complete.
- D. Do not overload supporting members.
- E. Install metal closure and flashing strips required.
- F. Caulk units as required for weather tightness.
- G. Provide pedestals and curbs with load carrying capacities adequate for items being supported.
- H. Provide roof pedestals for roof-mounted pipe and ductwork.
- I. Provide roof pedestals or curbs for roof-mounted equipment.
 - 1. Use closed rectangular curbs only when interior of curb is completely protected from weather by any or all of the following elements: equipment or item being supported, curb cap, roofing system, or weather tight curb construction.
- J. Verify attachments have been installed, to both roof construction and supported equipment/components, in accordance with seismic and wind load requirements.

3.3 CLEAN AND TOUCH-UP

- A. Wire brush, clean and touch up scarred areas, welds, and rust spots.
- B. Touch-up damaged galvanized surfaces with galvanizing repair paint.

END OF SECTION

SECTION 07 72 33

ROOF HATCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Roof Hatches, thermally improved.
 - 2. Hatch Guardrail System.
 - 3. Retracting Ladder Post.
- B. Furnish labor, materials, tools, equipment, and services for Roof Hatches, as indicated, in accordance with provisions of Contract Documents.
- C. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM A36 Standard Specification for Structural Steel.
 - 2. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. Occupational Safety & Health Administration (OSHA):
 - 1. 29 CFR 1910.28 Fall Protection in General Industry.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's literature for listed materials.
- B. Shop Drawings:
 - 1. Show profiles, accessories, locations, and dimensions.
- C. Contract Closeout Information:
 - 1. Warranty.

1.4 WARRANTY

- A. Hatch:
 - 1. Manufacturer's standard 5-year warranty.
 - 2. Warranty to cover repair or replacement in event of defects in material and workmanship including leakage, materials, or construction.
- B. Guardrails:
 - 1. Manufacturer's standard 5-year warranty from defects in material and workmanship.
- C. Retractable Ladder Posts:
 - 1. Manufacturer's standard 5-year warranty from defects in material and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Roof Hatches:
 - 1. Base: Bilco Company.
 - 2. Optional:

- a. Milcor.
 - b. Nystrom.
 - c. Wasco Products.
- B. Hatch Guardrail:
 - 1. Base: Bilco Company.
 - 2. Optional:
 - a. KeeHatch.
 - b. Nystrom.
- C. Retracting Ladder Post:
 - 1. Base: Bilco Company.
 - 2. Optional:
 - a. Nystrom.
- D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Reinforce for 40 psf live loading with a maximum deflection of 1/150th of span and 20 psf wind uplift.
- B. Controlled cover operation throughout the entire arc of opening and closing.
- C. Entire assembly and installation shall be weathertight with fully welded corner joints on cover and curb.

2.3 ROOF HATCHES, THERMALLY IMPROVED

- A. Basis of Design: Subject to compliance with requirements, provide the following or approved equal by one of the optional manufacturers listed above.
 - 1. Size and Model Number:
 - a. 36 by 36 inches; Bilco Series E-50TB
 - b. Where standard units are not available for sizes and types, provide custom fabricated units and modify to comply with requirements.
- B. Curb:
 - 1. Curb: 0.0907-inch (11 gauge) Aluminum.
 - 2. 30 inches high with 4-1/2-inch flange.
 - 3. Thermally broken.
 - 4. Fully welded corners.
 - 5. Integral metal cap-flashing.
 - 6. Liner: 0.0403-inch (18 gauge) Aluminum.
- C. Cover:
 - 1. Cover: 0.0907-inch (11 gauge) Aluminum.
 - 2. Liner: 0.0403-inch (18 gauge) Aluminum.
 - 3. Thermally broken.
 - 4. 4-inch beaded flange with formed reinforcing members
 - 5. Bonded EPDM rubber gasket.
- D. Insulation:
 - 1. Curb and Cover: 3 inches Polyisocyanurate.
 - 2. R-value: Minimum R-18.
- E. Hardware:

1. Self-lifting mechanism with automatic locking hold open device.
2. Pintle hinges: Type 316 stainless steel.
3. Slam latch with handles and padlock hasps:
 - a. Provide handles inside and outside.
 - b. Zinc-plated, chromate-sealed.

F. Finish:

1. Mill Finish.

2.4 HATCH GUARDRAIL SYSTEM

A. General:

1. Provide at each hatch.
2. Provide model to match hatch size and ladder position.
3. Base Product: Bil-Guard 2.0 by Bilco.

B. Performance characteristics:

1. Attach to the cap flashing of roof hatch without penetrating roofing material.
2. Comply with OSHA 29 CFR 1910.23 and other applicable codes.
3. Exceed OSHA strength requirements with a factor of safety of 2.

C. Posts and Rails:

1. 1-1/4-inch Schedule 40 pipe
 - a. Material: 6061 T6 Aluminum.
 - b. Finish: Powder Coat
 - c. Color: High visibility safety yellow.

D. Hardware:

1. Mounting brackets: 6063T5 Aluminum extrusions.
2. Locking mechanism: Cast Aluminum.
3. Spring Hinges: Type 316 Stainless Steel.
4. Fasteners: Type 316 Stainless Steel.

E. Gate:

1. Self-closing and latching design of material matching guardrail system.
2. Locate Gate on most safe and convenient side of each hatch (relative to ladder position) while avoiding roof obstructions.
 - a. Exception: Locations specifically indicated on Drawings.

2.5 RETRACTING LADDER POST

A. Description:

1. Telescoping tubular section that automatically locks in extended position.
2. Attach to fixed ladder by bolting to rungs of fixed ladder.
3. Full Extension: 42 inches.
4. Retraction activated manually.
5. Movement counterbalanced by Stainless Steel spring

B. Base Product: Ladder-UP Safety Post by Bilco Company.

C. Material:

1. Steel, manufacturer's yellow powder coat finish.
2. Steel, Hot-dipped Galvanized.

3. Stainless Steel, Type 304.
4. Aluminum, Mill finish.

2.6 FABRICATION

- A. Fabricate from metal sheet and plate in shop, to sizes indicated; modify if necessary to comply with requirements.
- B. Where standard hatch units are not available for sizes and types required, provide custom fabricated units.
- C. Curb:
 1. 12 inches high with a 3-1/2 inch flange with holes for securing curb to the roof deck.
 2. Integral metal cap-flashing
 - a. Same gauge and material as curb.
 - b. Fully welded corners.
- D. Cover:
 1. Minimum 2-1/2 inch weather flange.
- E. Insulation:
 1. Rigid board glass or mineral fiber, laminated between sheets of metal.
 2. Insulate curbs and covers with minimum 1 inch thick insulation.
- F. Gaskets:
 1. Tubular or fingered gaskets
 2. Neoprene, PVC, or molded block design sponge neoprene.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Coordinate with decking and roofing.
- B. Verify as-built conditions and coordinate with hatch manufacturer's details.
- C. Verify that hatch rail system installation will not disrupt other trades.
- D. Report and correct defects prior to installation.

3.2 INSTALLATION

- A. Roof Hatches:
 1. Install wood blocking, specified in Division 06, as needed to ensure that the curb has a minimum exposure of 8 inches of vertical surface above adjacent roof insulation for proper flashing.
 2. Securely anchor units by bolting or welding, as appropriate.
 3. Flash and counter flash to provide weathertight installation.
 4. Touch up abraded areas with zinc rich paint.
- B. Hatch Guardrails:
 1. Install hatch guardrail system per the manufacturer's instructions.
 2. Permanently bolt guardrail assembly to vertical face of Roof Hatch curb.
 3. Seal per manufacturer's instructions to make penetrations watertight.

3.3 ADJUSTING AND CLEANING

- A. Test units for proper function and adjust until proper operation is achieved.

- B. Clean exposed surfaces using methods acceptable to the manufacturer which will not damage finish.
- C. Repair finishes damaged during installation.

END OF SECTION

SECTION 07 72 73
MODULAR VEGETATED ROOF SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Modular Vegetated Roof System, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM D3786/D3786M Standard Test Method for Bursting Strength of Textile Fabrics - Diaphragm Bursting Strength Tester Method.
 - 2. ASTM D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - 3. ASTM D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - 4. ASTM D4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
 - 5. ASTM D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.
 - 6. ASTM D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
 - 7. ASTM E2396 Standard Test Method for Saturated Water Permeability of Granular Drainage Media for Green Roof Systems.
 - 8. ASTM E2397 Standard Practice for Determination of Dead Loads and Live Loads associated with Green Roof Systems.
 - 9. ASTM E2398 Standard Test Method for Water Capture and Media Retention of Geocomposite Drain Layers for Green Roof Systems.
 - 10. ASTM E2399 Standard Test Method for Maximum Media Density for Dead Load Analysis of Green Roof Systems.
 - 11. ASTM E2400 Standard Guide for Selection, Installation, and Maintenance of Plants for Green Roof Systems.
- B. American National Standards Institute / Single Ply Roofing Industry (ANSI/SPRI):
 - 1. ANSI/SPRI RP 14 Wind Design Standards for Vegetated Roofing Systems.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's standard product data sheets indicating product to be used and conformance to specifications.
 - 2. Manufacturer's data for vegetation and growing medium.
- B. Shop Drawings:
 - 1. Showing layout of containment grids, details, and special conditions.
- C. Samples:
 - 1. Module system, one in each size and color required.
 - 2. Pre-planted vegetative mat, 12 by 12 inches.
 - 3. Growing medium, 1 pint volume of each growing medium, in sealed plastic bags labeled with content and source. Each sample shall be typical of the lots of growing media to be furnished. Provide an accurate representation of texture and composition.
 - 4. Moisture retention mat, 12 by 12 inches.

D. Project Information:

1. Manufacturer's growing medium data.
2. Minutes from preinstallation conference.
3. Certification of installer qualifications.
4. A letter from the manufacturer certifying that the installer is an approved applicator in good standing.

E. Contract Closeout Information:

1. Warranty.
2. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Modular Vegetated Roof System Installer, approved, authorized, or licensed by manufacturer, whose work has resulted in successful establishment of modular vegetated systems.
 - a. Not less than five similar sized projects with material specified.
 - b. Licensed or certified in writing by manufacturer.
 - c. Complete work with authorized trained personnel.
 - d. Field Supervision: Maintain an experienced full-time supervisor on Project site when work is in progress.
 - e. Professional Member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - f. Installer's Field Supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - 1) Certified Landscape Technician - Exterior, with installation, maintenance and irrigation specialty areas, designated CLT-Exterior.
 - 2) Certified Ornamental Landscape Professional designated COLP.

1.5 WARRANTY

A. Modular Vegetated Roof System Components:

1. Provide a warranty signed by manufacturer against failure of components in modular vegetated roof system, except vegetation.
2. Include repair of flaws which impair functioning of modular vegetated roof system, provided flaws originate from errors in design, material defects, improper assembly, incompatibility between components, or deterioration.
3. Failure of components shall include, but shall not be limited to, following:
 - a. Loss or dislocations of media due to wind scour during establishment period.
 - b. Persistent ponding of water after rainfalls.
 - c. Anaerobic conditions developed in media due to inadequate drainage.
 - d. Cracking or deterioration of drain access chambers and border units, clogging of roof drains or scuppers.

B. Modular Vegetated Roof System Vegetation:

1. Provide a warranty signed by Installer against failure of vegetation in modular vegetated roof system, including, but not limited to, failure of plants to thrive due to compression or decomposition of media.
2. Warranty shall provide for following:
 - a. Overseeding of plant cover after 12 months if surface coverage rate is less than 60 percent.

- 1) If overseeding is required, the deficient grids shall be manually re-seeded and stabilized.
- 2) Estimate cover rates separately for each 400 square feet grid of the vegetated surface.
- b. Overseeding of plant cover after the 24 month establishment period as necessary to provide a minimum plant cover of 80 percent.
 - 1) Estimate cover rates separately for each 400 square feet grid of the vegetated surface.
- c. Emendation of media, if required to provide a viable growing medium for vegetation.
- C. Warranties shall include, but shall not be limited to, cost of labor and materials to inspect, repair, remove, and replace components in modular vegetated roof system without financial limit.
- D. Warranty Period:
 1. Modular Roof Garden System Components: Fifteen years.
 2. Modular Roof Garden System Vegetation: Two years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Modular Vegetated Roof System:
 1. Base:
 - a. GreenGrid
 2. Optional:
 - a. Carlisle
 - b. Live Roof
 - c. GreenRoof Blocks
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Modular Vegetated Roof System:
 1. Modular assembly consisting of manufacturer's standard pre-planted trays for field-assembly adjacent to and interlocking with each other over roofing.
 2. Tray size:
 - a. 24 inches x 48 inches x 4 inches or Manufacturers standard for required plantings.
 3. Assembly weight:
 - a. Maximum 29 pounds/SQ FT including growing medium and plants and saturated with captured water.
 1. Soil height approximately 3.5 inches.
 2. Plantings:
 - a. Preplanted vegetative mat as selected by Architect from manufacturer's standard mixes.
 - b. Sedum as selected by Architect from manufacturer's standard varieties.
 3. Growing medium:
 - a. Modular vegetated roof system manufacturer's lightweight, manufactured soil mixture.
 4. Module shall have positive drain holes placed at lowest point in the module.
 5. Module bottom shall have water dispersal via drain channels.
 6. Separation fabric:

- a. Non-woven polypropylene or polyester fabric
- b. Characteristics:
 - 1) Permittivity as per ASTM D4491: 1.5 sec-1.
 - 2) Weight per ASTM D5261: 6 oz/SQYD.
 - 3) Puncture Resistance as per ASTM D4833: 130 pounds.
 - 4) Mullen Burst Strength as per ASTM D3786/D3786M: 350 pound/SQ IN.
 - 5) Grab Tensile as per ASTM D 4632: 150 pounds.
- 7. Protection layer:
 - a. Thickness, core only per ASTM D5199: ≥ 200 mil.
 - b. Puncture Resistance of each fabric per ASTM D4833: ≥ 110 pounds.
- 8. Drainage Layer:
 - a. Dimpled plastic sheet with non-woven polypropylene or polyester filter fabric and separation fabric attached.
 - b. Characteristics:
 - 1) Thickness: 1 inch
 - 2) Flow Rate at 1/4:12 slope: 0.015 gallons per minute per square foot.
 - 3) Flow Rate for filter fabric: 132 gallons per minute per square foot.
 - 4) Grab Tensile as per ASTM D 4632: 169 pounds.
 - c. Base Product: Miradrain G4 by Carlisle
- 9. Aluminum Edging:
 - a. 0.08 inches thick, extruded aluminum angle.
 - b. Vertical slots cut in vertical leg to allow drainage.
 - c. Locate covered, pre-formed drain boxes at each roof drain.
 - d. Height:
 - 1) Match soil depth plus 1/2 inches.
 - e. Finish:
 - 1) Mill Finish.
- B. Roofing System:
 - 1. See Section 07 53 25 Fully Adhered EPDM Roofing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine each area to receive modular vegetated roof system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Verify roof insulation over membrane roofing is in place, secure, and flush along seams.
 - 2. Verify perimeter and other flashings are in place and secure along entire lengths where they will be covered by modular vegetated roof system.
- B. Inspect growing medium. If growing medium is contaminated by foreign or deleterious material or liquid, remove growing medium and contamination and replace with new growing medium.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and areas from damage caused by installation.
- B. Cover roofing with protection board with butted and fully taped joints before roofing is subject to modular vegetated roof system installation work.
- C. Clean, prepare and treat substrate according to manufacturer's written instructions.

1. Surfaces shall be smooth, free of debris, soil, and grit prior to placing modules.
 2. Surfaces shall be maintained clean and free of debris, soil, and grit during installation process.
- D. Conduct the following prior to installing green roof modules:
1. Slip sheet/root barrier shall be properly installed, seams overlapped and bonded, in accord with Architect's and manufacturer's specifications.
 2. The roof shall be inspected and determined ready to accept vegetated roof modules by a Technical Representative of the Installer.

3.3 INSTALLATION

- A. Separation Layer:
1. Apply separation layer over completed waterproofing membrane and overlap minimum of 4 inches.
- B. Protection Layer:
1. Install protection layer over roofing and over separator layer where specified.
 2. Install protection layer over completed roof assemblies as soon as possible.
 - a. Coordinate this work with Owner and roofing materials manufacturer's representative to allow inspection and acceptance of roofing and water tests before installation of protection layer.
 3. Overlap the protection layer a minimum of 4 inches.
 - a. Lap seams in direction of water flow where possible.
 4. Install subsequent layers or overburden immediately whenever possible.
 - a. Avoid prolonged UV exposure on protection layer.
- C. Module Installation:
1. Install in accordance with manufacturer's written installation guidelines.
 2. Rows shall be straight; modules shall be tight against each other with edges overlapping and arranged in proper directional orientation.
 3. Conduct module installation in accordance with roof design.
 4. After installing modules, immediately water to thoroughly moisten media from top to bottom.

3.4 CLEANING AND PROTECTION

- A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
- B. Protect roofing from damage and wear during application of modular vegetated roof system.
- C. Protect installed system from damage due to ultraviolet light exposure, physical abuse, and other causes.

END OF SECTION

SECTION 07 76 16

ROOF PAVERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Precast Concrete Paver System, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C33 Standard Specification for Concrete Aggregates
 - 2. ASTM C150 Standard Specification for Portland Cement
 - 3. ASTM C936 Standard Specification for Solid Concrete Interlocking Paving Units
 - 4. ASTM D746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
 - 5. ASTM D1525 Standard Test Method for Vicat Softening Temperature of Plastics
 - 6. ASTM D2240 Standard Test Method for Rubber Property-Durometer Hardness

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Layout showing patterns and colors.
 - 2. Details for penetrations, perimeters, and other edge conditions.
 - 3. Pedestals.
 - 4. Protection board.
- B. Product Data:
 - 1. Manufacturer's standard catalogs for pavers, pedestals, and accessories.
 - 2. Manufacturer's installation instructions.
- C. Samples:
 - 1. Three 12 by 12 inches samples of each color and/or texture for approval of appearance.
- D. Project Information:
 - 1. Installer's qualifications.
- E. Contract Closeout Information:
 - 1. Maintenance data.
 - 2. Letter stating that extra material has been delivered.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. More than five years' experience in the manufacture of pavers or pedestals of type specified as one of their principal products.
 - 2. At least ten installations of paving systems with requirements similar to the products specified and conditions indicated.
- B. Manufacturing Tolerance:
 - 1. Manufacture exposed paver faces comply with following dimensional requirements.

- a. Warp: One corner out of plane of other three not more than 3/32 inches from nearest adjacent corner.
 - b. Bow: Maximum 1/16 inches in 12 inches length or width.
 - c. Face edge lengths: Plus or minus 1/8 inches.
 - d. Thickness: Plus 1/8 inches, minus 3/32 inches.
 - e. Angular deviation of plane of side mold: 1/16 inches.
 - f. Deviation from square: 1/16 inches in any length.
- C. Installer Qualifications:
 - 1. More than five years of experience in the installation of pavers and pedestals of the type specified.
 - 2. At least five installations with requirements similar to the products specified and the conditions indicated.
 - 3. Superintendent for Installation:
 - a. Supervised at least three installations with similar products and project conditions to those specified and indicated.
- D. Installation Tolerance:
 - 1. Joints:
 - a. Variation in width: Plus 1/8 inches.
 - b. Taper in any length: 1/8 inches.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pavers:
 - 1. Base:
 - a. Wausau Tile, Inc.
 - 2. Optional:
 - a. Oldcastle, Westile Dix.
 - b. Tile Tech Pavers
 - c. Hanover Architectural Products, Inc.
- B. Pedestals:
 - 1. Base:
 - a. Wausau Tile, Inc.
 - 2. Optional:
 - a. Bison Screw Jack.
 - b. Envirospecs, Inc.
 - c. Tile Tech Pavers
 - d. Hanover Architectural Products, Inc.
- C. Protection Board:
 - 1. Base:
 - a. DuPont.
 - 2. Optional:
 - a. Owens-Corning.
- D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Design complete paver system in compliance with ACI 318-83, to include pavers, pedestals, and protection board.
- B. Design system to withstand:
 - 1. Dead loads plus superimposed loads.
 - 2. Erection forces.
 - 3. Temperature and shrinkage stresses.
 - 4. Thermal movements.
 - 5. Building movements.

2.3 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Precast Concrete Pavers:
 - 1. Solid precast concrete units complying with:
 - a. ASTM C936, except without provisions for interlocking.
 - b. Precast/Pre-stressed Concrete Institute (PCI) MNL-117.
 - 2. Concrete Mix and properties:
 - a. Mix of clean water, Portland cement, coarse and fine aggregates, and pigments and other coloring agents to produce colors and textures specified.
 - b. Portland Cement: ASTM C150, Type I or III, from one source.
 - c. Aggregates: ASTM C33.
 - d. Pigments and other coloring agents:
 - e. Unfading mineral oxide.
 - f. Lime and alkali resistant.
 - 1) Limit type and amount used so as not to reduce quality of concrete.
 - g. Air entrainment: Between 6 and 8% including entrapped air.
 - h. Concrete weight: .
 - 3. Fabrication:
 - a. Face dimensions: from centerline of joint to centerline of joint.
 - b. Thickness: 2 in.
 - 4. Schedule of Colors/Textures
 - a. Field Color (PCP-1):
 - 1) Base Product/Series:
 - a) Wausau Type Estate Series.
 - 2) Color: HRT 15.
 - 3) Location used:
 - a) Where indicated on Drawings.
 - b. Provide special shapes and profiles indicated.
- B. Pedestals:
 - 1. Base Product: Terra System by Wausau Tile.
 - 2. System of high density polyethylene plastic components providing:
 - a. Support for pavers, minimally one at each corner of each paver.
 - b. Capable of supporting the weight of pavers plus imposed loads.
 - c. Height as indicated.
 - d. Leveling to within 3/16 inches differential across 7 inches bearing pad.

- e. Uniform open paver joint widths created by upright integral space ribs.
- f. Cellular grid construction for through-drainage.
- 3. Material properties:
 - a. Low temperature brittleness: ASTM D746, minus.
 - b. Resistant to ultra-violet: UV stabilized.
 - c. Hardness: ASTM D2240, shore D65.
 - d. Unaffected by freeze-thaw cycling, ozone and humidity, and not water absorbent.
- C. Protection Board:
 - 1. Type VII, Extruded Polystyrene (XPS) panels.
 - 2. Compressive strength: 60 psi.
 - 3. Thickness: 1-1/2 inches.
 - 4. Base Product: DuPont Styrofoam Plazamate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Perform installation under supervision of qualified superintendent, utilizing skilled and experienced personnel in the work.
- B. Erect system with pavers installed within specified tolerance limits, with nominal 3/16 inches wide joints.
- C. Install system to total thickness required for finished elevations indicated on Drawings.
- D. Protection Board:
 - 1. Loose lay protection board over clean roof surface.
 - a. Joint width: hand tight, not exceeding 3/16 inches.
 - b. Place board without damaging roofing membrane.
 - 2. Cut protection board to coincide with paver edges at perimeter and protrusions through paving.
 - 3. Do not cover roof drains.
 - 4. Maintain flow patterns to prevent damming of water.
- E. Pedestals:
 - 1. Place pedestals on protection board to support corners of pavers and at intermediate locations where required for load distribution without damaging protection board or roofing membrane.
 - 2. Provide leveling plates at pedestals where necessary to produce indicated finished paving elevations.
 - 3. Provide partial pedestals at perimeter of paving and protrusions through paving, sized and shaped for full support of edge pavers without extending beyond paving edges.
- F. Pavers:
 - 1. Set pavers with full support on pedestals in accordance with the manufacturer's instructions.
 - 2. Finished surface to comply with elevations indicated on Drawings to within 3/32 inches.
 - 3. Cut pavers only as necessary to fit paving perimeters and to accommodate penetrating items.
 - a. Support partial pavers at 4 corners.
 - b. Provide uniform cuts to result in cut edges of pavers matching cast uncut edges.
 - 4. After completion of setting, clean precast pavers thoroughly.
 - a. Replaced stained or warped or other defective pavers.

- b. Leave pavers free of cleaning compound.

3.2 CLEANING

- A. Remove debris and stored materials.
- B. Sweep broom clean.
- C. Replace damaged or stained items.
- D. Clean with solution recommended by Manufacturer.

END OF SECTION

SECTION 07 84 00

FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Firestopping, in accordance with provisions of Contract Documents.
- B. System Description:
 - 1. Through Penetration Firestop Systems for protection of penetrations through following fire resistance rated assemblies, including both blank openings and openings containing penetrating items:
 - a. Roof assemblies.
 - b. Floor assemblies.
 - c. Wall and partition assemblies.
 - d. Fire rated smoke barrier assemblies.
 - e. Construction enclosing compartmentalized areas.
 - 2. Fire Resistive Joint Assemblies for linear voids where fire rated floor, roof, or wall assemblies abut one another, including following types of joints:
 - a. Top and bottom of wall interface with overhead roof or floor structure:
 - 1) Coordinate with acoustical sealant specified in Section 07 92 16.
 - 2) These products may also be provided as an accessory to Non-structural Metal Framing in Section 09 22 16.
 - 3) Select products to maintain acoustical, smoke and fire ratings indicated.
 - b. Fire Rated Expansion Joints: Specified in Section 07 95 13.
- C. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. UL:
 - 1. UL 263, Fire Tests of Building Construction and Materials
 - 2. UL 723, Surface Burning Characteristics of Building Materials
 - 3. UL 1479, Fire Tests of Through Penetration Firestops
 - 4. UL 1489, Fire Tests of Fire Resistant Pipe Protection Systems Carrying Combustible Liquids
 - 5. UL 2079, Tests for Fire Resistance of Building Joint Systems
 - 6. UL Fire Resistance Directory:
 - a. Through Penetration Firestop Systems (XHEZ).
 - b. Joint Systems (XHBN).
 - c. Fill, Void, or Cavity Materials (XHHW).
 - d. Firestop Devices (XHJI).
 - e. Forming Materials (XHKU).
 - f. Wall Opening Protective Materials (CLIV).
 - g. Fire Resistance Ratings (BXRH)
- B. ASTM International (ASTM):
 - 1. ASTM E84 Surface Burning Characteristics of Building Materials
 - 2. ASTM E119 Fire Tests of Building Construction and Materials
 - 3. ASTM E136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750F

4. ASTM E814 Fire Tests of Through Penetration Fire Stops
 5. ASTM E1399 Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
 6. ASTM E1725, Standard Test Method for Fire Tests of Fire Resistive Barrier Systems for Electrical System Components.
 7. ASTM E1966 Test Method for Fire Resistive Joint Systems
 8. ASTM E2174 Standard Practice for On-site Inspection of Installed Fire Stops
 9. ASTM E2307 Standard Test Method for Determining the Fire Endurance of Perimeter Fire Barrier Systems Using the Intermediate-Scale, Multi Story Test Apparatus (ISMA)
 10. ASTM E2393 Standard Practice for On-site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers
 11. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
- C. National Fire Protection Association (NFPA):
1. NFPA 70 National Electrical Code
 2. NFPA 101 Life Safety Code
 3. NFPA 221 Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls
 4. NFPA 251 Fire Tests of Building Construction and Materials
- D. Firestop Contractors International Association (FCIA):
1. FCIA Firestop Manual of Practice (MOP).
- E. International Firestop Council (IFC):
1. Recommended IFC Guidelines for Evaluating Firestop Engineering Judgments.
 2. Inspectors Field Pocket Guide.

1.3 SUBMITTALS

- A. Product Data:
1. Product technical data, including:
 - a. Manufacturer's listed design number.
 - b. Manufacturer's installation instructions.
 - c. Manufacturer's specification and technical data for each material including the
 - d. composition and limitations.
 - e. Data sheet for all products and accessories used.
- B. Shop Drawings:
1. Detailed drawings of special conditions:
 - a. Provide UL listing for each type of firestopping assembly to be used.
 - b. When UL listing is not available, provide a written Engineering Judgment in accordance with IFC Recommended Guidelines.
 - 1) Engineering Judgments shall be sealed by a Fire Protection Engineer licensed in Nebraska.
- C. Project Information:
1. UL reports with illustration of systems, system numbers, temperature ratings, and products proposed for use on project.
 2. Contractor Certification per UL, HAFSC, or all.
 3. Contractor Certification as UL Qualified Firestop Contractor.
- D. Contract Closeout Information:
1. Provide electronic PDF file of firestop documentation to include following:

- a. Written statement that all fire-rated penetrations have been sealed using products specified in accordance with UL requirements for required rating.
 - b. Documentation of all listed systems installed and all engineering judgments.
 - c. Firestop system photograph of each type.
 - d. Installation log.
 - e. IFC guidelines for Engineering Judgments.
 - f. Building Code sections relevant to firestop systems.
2. Provide documentation of Special Inspection of Firestopping.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Certified, licensed or approved by firestopping manufacturer, trained to install firestop products per specified requirements.
2. Licensed by State or local authority, where applicable.
3. Shown to have successfully completed not less than 5 comparable scale projects.
4. FM Approved in accordance with FM Standard 4991 – Approval of Firestop Contractors.
5. UL Qualified Firestop Contractor.

B. Identification Labels for Firestop Assemblies:

1. Follow guidelines set in Chapter 7 of International Building Code.
2. Coordinate with Section 04 22 00 and Section 09 29 00.

C. Identification Labels for Firestop Penetrations:

1. Label penetration on both sides of wall or slab.
2. Label each penetration or group of similar penetrations with a permanent label marked with the following information:
 - a. UL system number.
 - b. Rating.
 - c. Products used.
 - d. Installation date.
 - e. Installer name.
 - f. Penetration reference number unique to each location.

D. Pipe insulation shall not be removed, cut away or otherwise interrupted at wall penetrations or floor openings.

1. Provide products appropriately tested for the thickness and type of insulation utilized.

E. Cabling where frequent cable moves, additions, and changes are likely to occur in future:

1. Where cable trays are used:
 - a. Utilize re-enterable products (e.g., removable intumescent blocks) specifically designed for retrofit.
2. Where cable trays are not used:
 - a. Utilize fire rated cable pathway devices.
 - b. Where not practical, re-enterable products designed for retrofit may be used.

F. Protect penetrations passing through fire resistance rated floor-to-ceiling assemblies contained within chase wall assemblies with products tested by being fully exposed to fire outside of chase wall.

1. Identify systems within UL Fire Resistance Directory with the words: Chase Wall Optional.

G. Fire-resistive Joint Sealant:

1. Provide flexible fire resistive joint sealants to accommodate normal and thermal building movement without seal damage.
 2. Provide fire resistive joint sealants designed to accommodate a specific range of movement.
 - a. Test in accordance with cyclic movement test criteria as outlined in: ASTM E1399, ASTM E1966 or UL 2079.
 3. Provide fire resistive joint systems subjected to an air leakage test.
 - a. Conduct in accordance with UL 2079, with published L-Ratings for ambient and elevated temperatures.
 4. Coordinate firestopping with acoustical sealant requirements in Section 07 92 16.
- H. Subject smoke barrier containment systems to air leakage test.
1. Conduct in accordance with UL 1479, with published L-Ratings for ambient and elevated temperatures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Firestopping:
1. Base:
 - a. Hilti Inc.
 2. Optional:
 - a. 3M
 - b. Rectorseal.
 - c. Specified Technologies, Inc.
 - d. Tremco, Inc.
 - e. United States Gypsum Company.
- B. Forming Materials:
1. Base:
 - a. Hilti Inc.
 2. Optional:
 - a. Rockwool.
 - b. Thermafiber.
- C. Fire Rated Enclosures:
1. Base:
 - a. Tenmat, Inc.
 2. Optional:
 - a. EZ Barrier, Inc.
- D. Other manufacturers desiring approval comply with Section 01 61 00.
1. See systems Volume 2 of UL Building Materials Directory.

2.2 DESIGN CRITERIA

- A. Provide firestop systems in compliance with following requirements:
1. Obtain firestop system for each type of penetration and construction condition from a single firestop systems manufacturer.
 2. Firestop products and systems shall bear classification marking of qualified testing and inspection agency.
 3. Firestopping tests, performed by qualified, testing and inspection agency.

- a. UL or other agency, performing testing and follow up inspection services for firestop systems, acceptable to local authorities having jurisdiction.
- 4. Existing applications for which no tested and listed classified system is available through a manufacturer:
 - a. Provide Engineering Judgment or Equivalent Fire Resistance Rated Assembly (EFRR) for submittal derived from similar UL system designs or other tests approved by local authorities having jurisdiction, prior to installation.
 - b. Engineering judgment drawings must follow requirements set forth by International Firestop Council.
 - c. Fire Protection Engineer providing Engineering Judgements to be NFPA Certified.
- 5. Mold Resistance:
 - a. Less than 1 per ASTM G21.
- 6. Firestopping products and systems installed in Clean Zone areas and exposed to clean air management system shall comply with outgassing requirements specified in Section 01 35 34. See Section 13 60 13 for definition of Clean Zone.
- 7. Inspect applied firestopping systems in accordance with International Building Code (IBC) Chapter 17.
 - a. See Section 01 45 23.

2.3 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Through Penetration Firestop Systems:

- 1. VOC content not to exceed 250 g/L.
- 2. Base Products:
 - a. FS-ONE MAX Intumescent Firestop Sealant.
 - b. CFS-S SIL GG Elastomeric Firestop Sealant.
 - c. CFS-S SIL SL Elastomeric Firestop Sealant.
 - d. CP 620 Fire Foam.
 - e. CP 606 Flexible Firestop Sealant.

B. Fire Resistive Joints:

- 1. VOC content not to exceed 250 g/L.
- 2. Base Products:
 - a. CFS-SP WB Firestop Joint Spray.
 - b. CFS-S SIL GG Elastomeric Firestop Sealant.
 - c. CFS-S SIL SL Elastomeric Firestop Sealant.
 - d. CP 606 Flexible Firestop Sealant.
- 3. Coordinate with pre-applied firestopping in Section 09 22 16.

C. Firestop Devices:

- 1. Factory assembled collars lined with intumescent material sized to fit specific outside diameter of penetrating item.
- 2. Base Products:
 - a. CP 680 / CID-U / CFS-CID MD-P Cast-in-Place Firestop Device.
 - b. CP 680 / CID-U / CFS-CID MD-M Cast-in-Place Firestop Device.
 - c. CP 681 Tub Box Kit.
 - d. CFS-DID Firestop Drop-In Device.

D. Intumescent Pads, Wall Opening Protective Materials:

1. Intumescent, non-curing pads or inserts for protection of electrical panels, switch and receptacle boxes, medical gas outlets and valve boxes and other items recessed in face of fire rated walls.
 2. Base Product:
 - a. CFP-ES Endo-Shield Low Bio Persistent Endothermic Mat.
 - b. CFS-P PA Firestop Putty Pad.
 - c. CP 617 Firestop Putty Pad.
 - d. Hilti Biox Insert.
- E. Fire Rated Cable Pathways:
1. Steel raceway and intumescent pads with adjustable smoke seal sleeve.
 2. Fire rating equal to rating of barrier device penetrates.
 3. Pathway devices:
 - a. Allow 0 to 100 percent fill of cables.
 - b. Adjust automatically to cable additions or subtractions.
 4. Size to accommodate quantity and size of electrical wires and data cables indicated plus 100 percent expansion.
 5. Provide cable management devices with gang plates for single or multiple devices.
 6. Base products:
 - a. CFS-MSL Modular Sleeve.
 - b. CFS-MSL Modular Sleeve Floor Grid System.
 - c. CP 653 BA Speed Sleeve.
 - d. CFS-SL GP Gangplate.
 - e. CFS-SL GP CAP Gangplate Cap.
 - f. CFS-CC Firestop Cable Collar.
 - g. CFS-SL SK Firestop Sleeve.
 - h. CFS-SL RK Retrofit Sleeve.
 - i. CFS-COS Composite Sheet.
- F. Smoke and Acoustic Cable Pathways:
1. Non-rated steel raceway with adjustable smoke seal polyurethane sleeve for single cables and cable bundles.
 2. Re-penetrable and self-closing.
 3. Base product:
 - a. CS-SL SA Smoke and Acoustic Sleeve.
- G. Single Cable and Cable Bundles to 1 inch Diameter:
1. CFS-D Firestop Cable Disc.
- H. Endothermic Mat:
1. Low Bio Persistent Endothermic Mat evaluated for protection of cable pathways and liquid fuel lines, for firestopping of through-penetrations and membrane-penetrations, and for achieving T-ratings.
 2. Endothermic mat shall be LBC Red list compliant, with foil scrim on both sides.
 3. Base Products:
 - a. CFP-ES Endo-Shield Low Bio Persistent Endothermic Mat.
- I. Firestop Putty:
1. Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers, or silicone compounds.

2. Provide firestop putty at, but not limited to, the gap between wire, cabling, or both, exiting an open end of conduit, where conduit penetrates one or both sides of a smoke or fire rated wall assembly.
 3. Base products:
 - a. CP 618 Firestop Putty Stick.
 - b. CFS-PL Firestop Plug.
- J. Wrap Strips:
1. Single component intumescent elastomeric strips faced on both sides with a plastic film:
 2. Base Products:
 - a. CP 643N Firestop Collar.
 - b. CP 644 Firestop Collar.
 - c. CP 648E/648S Wrap Strips.
- K. Firestop Blocks and Plugs:
1. Non-curing, flexible intumescent device.
 2. Re-enterable.
 3. Base products:
 - a. CFS-BL Fire Block.
 - b. CFS-PL Firestop Plug.
- L. Mortar:
1. Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar.
 2. Base product:
 - a. CP 637 Firestop Mortar.
- M. Silicone Sealants:
1. Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces pourable or non-sag or vertical surface non-sag.
 2. Base product:
 - a. CFS-S SIL GG Elastomeric Firestop Sealant.
 - b. CFS-S SIL SL Elastomeric Firestop Sealant.
- N. Pre-formed materials for use with fire-resistance-rated construction joints:
1. Base Products:
 - a. CFS-TTS Firestop Top-Track Seal.
 - b. CFS-TTS MD Firestop Top-Track Seal Metal Deck System.
 - c. CFS-BTS Firestop Bottom-Track Seal.
- O. Preformed Mineral Wool:
1. CP 767 Speed Strips
 2. CP 777 Speed Plugs
- P. Fire Sealant:
1. Single component latex or acrylic formulations that upon cure do not re-emulsify during exposure to moisture.
 2. Base Products:
 - a. CFS-S SIL GG Elastomeric Firestop Sealant.
 - b. CFS-S SIL SL Elastomeric Firestop Sealant.
 - c. CFS-SP WB Firestop Joint Spray.

Q. Composite Sheet:

1. Non-curing, re-penetrable material.
2. Base Products:
 - a. CP 675T Firestop Board.
 - b. CFS-BL FireBlock.

R. Forming Materials:

1. Materials listed as components in laboratory approved designs.
2. Mineral Wool:
 - a. Base Product: SAF by Thermafiber, or
 - b. Similar product specifically named as components in laboratory approved designs.

S. Perimeter Fire Containment:

1. Specified in Section 07 84 53.
2. Pre-formed materials for use as part of a Perimeter Fire Barrier System between fire-resistance-rated floors and exterior wall assemblies:
3. Base Product:
 - a. CFS-EOS Quick Seal Preformed Firestop Device.

T. Acoustical Sealant:

1. Specified in Section 07 92 16.
2. Base Products:
 - a. CS-TTS SA Smoke and Acoustic Track Seal
 - b. CFS-BTS Bottom Track Seal.
 - c. CS-S SA Light Smoke and Acoustic Sealant
 - d. CP 506 Smoke and Acoustic Sealant
 - e. CP 572 Smoke and Acoustic Spray

U. Through Penetration Firestop Systems:

1. Comply with building code and fire code as locally adopted and amended.
2. Requirements for single membrane penetrations and through penetration firestops are identical.
 - a. Unless otherwise noted, treat penetrants which pass through a single membrane same as though passed through entire fire resistive assembly.
3. Select each firestop system based on actual field conditions, including penetration type, shape, size, quantities, and physical position within opening.
4. See Drawings for indication of the required ratings of fire resistive wall, floor, and roof assemblies.
 - a. Indicated ratings are minimum and may be exceeded.
5. Firestop assemblies at fire rated walls:
 - a. Minimum fire (F) rating for firestop assemblies in walls shall equal that of wall, but not less than 1 hour.
 - b. Minimum temperature (T) rating of firestop assemblies in walls may equal zero.
 - c. Smoke barrier:
 - 1) In addition to (F) rating, (L) rating of maximum 5 cfm/SF 0.000423 m3/s per m2.
 - d. Non-rated walls and smoke partitions with no fire resistive requirement:
 - 1) Assembly with (L) rating.
6. Firestop assemblies at fire rated floors and roofs:
 - a. Minimum fire (F) and temperature (T) ratings of firestop assemblies used in floors or roof shall equal hourly rating of floor or roof being penetrated, but not less than 1 hour.

- 1) Exception 1: T-rating may equal zero when portion of penetration, above or below floor, is contained within a wall.
- 2) Exception 2: Firestops are not required for floor penetrations within a 2-hour rated shaft enclosure.

V. Voids in Wall with No Penetrations:

1. Fill with approved through penetration firestopping system.
2. Contractor's option: Patch void in wall with like construction.

W. Penetrating Ducts with Dampers:

1. Utilize only firestop materials which are included in damper's classification.
2. Do not install firestop systems that hamper performance of fire dampers.

X. Cable Trays and Similar Devices:

1. Provide re-enterable products specifically designed for removal and re-installation at openings within walls and floors designed to accommodate voice, data, and video cabling.

Y. Electrical panels and devices, medical gas outlets and valve boxes, and other items recessed in to face of rated walls:

1. Where electrical devices are placed on opposite sides of wall and are less than 24 inches 610 mm apart measured horizontally, install intumescent pads over back of devices in approved manner or maintain continuity of rated barrier within wall cavity surrounding recessed item.

Z. Fire Resistive Joint Assemblies:

1. Where joint will be exposed to elements, fire resistive joint sealant must be approved by manufacturer for use in exterior applications and shall comply with ASTM C920.
2. Head of Wall Assemblies:
 - a. Use at top of fire rated and smoke barrier walls and partitions where they abut floor and roof structures above.
 - b. Select systems with D designation, rated for dynamic movement capability.
 - c. Select systems that can accommodate deflection of structure above.
 - d. Maximum Leakage for Fire resistive Joints in Smoke Barriers: 5 cfm or less per linear foot 7.75 L/s or less per linear meter as tested in accordance with UL 2079.
 - e. Seal non-fire rated sound control walls and smoke partitions with acoustical sealant as specified in Section 07 92 16.
3. Minimum F and T ratings:
 - a. The minimum fire rating for firestop assemblies in walls shall equal that of wall, but not less than 1 hour.
 - b. The minimum temperature rating of firestop assemblies in walls may equal zero.
4. Acceptable Systems:
 - a. Metal stud and drywall partitions: Select system from UL HW-D-0000 Series.
 - 1) For metal stud partitions installed on flat concrete slab use one piece, pre-formed polyurethane foam firestop seal designed for use with standard head joint top tracks and bottom joint tracks or slip-type head joints to maintain continuity of the fire resistance rated assembly indicated.
 - 2) Provide in width and configuration required to accommodate depth and installation of studs and designed to saddle over the top track or under the bottom track.
 - b. Concrete and Masonry Walls: Select system from UL HW-D-1000 Series.
5. Fire rated Expansion Joints:
 - a. See Section 07 95 13.

AA. Fire Rated Enclosures:

1. Provide where required as part of a UL Fire Resistance Directory design for fixtures mounted in rated walls or ceilings.
 - a. Field constructed enclosures meeting Fire Resistance Directory designs will be accepted.
2. Include accessories and install according to enclosure manufacturer's written instructions.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install firestop systems in accordance with manufacturer's instructions and conditions of testing and classification as specified in UL or other acceptable third party testing agency listing.
- B. Penetrations through fire resistive floor assemblies shall be sealed with firestop system providing minimum Class 1 W-rating as tested in accordance with UL 1479 to ensure air and water resistant seal.
- C. Protect materials from damage on surfaces subjected to traffic.
- D. Identification Labels:
 1. Identify each firestop assembly as defined in Quality Assurance.
 2. Do not locate identification labels, tags, or both, on finished surfaces and where exposed to view by public.

3.3 IDENTIFICATION

- A. Provide identification in accordance with FCIA MOP and FM 4991.
 1. Identify firestop systems with pressure-sensitive, self-adhesive, preprinted labels.
 2. Attach labels permanently to surfaces of construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems.
 3. The following information shall be on the label:
 - a. Firestop Joint Systems:
 - 1) The words "Warning-Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
 - b. Through-Penetration Firestop Systems:
 - 1) The words "Warning-Through Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
 - c. Installing Contractor's name and Contact Information.
 - d. Through-Penetration firestop listing designation.
 - e. Date of Installation.
 - f. Through-Penetration firestop system manufacturer.
 - g. Installer's Name.

3.4 FIELD QUALITY CONTROL

- A. Provide Special Inspection of all firestopping in accordance with IBC Chapter 17 and Specification Section 01 45 23.
 - 1. Owner shall engage a qualified independent inspection agency to inspect firestop systems in accordance with ASTM E2174, Standard Practice for On-site Inspection of Installed Fire Stops, and ASTM E2393, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
- B. Construct mock up on site to include typical through penetration and fire resistive joint applications for project.
- C. Maintain areas of work accessible until inspection by authorities having jurisdiction.
- D. Where deficiencies are found, repair or replace assemblies to comply with requirements.

3.5 ADJUSTING AND CLEANING

- A. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- B. Clean surfaces adjacent to sealed openings free of excess materials and soiling as work progresses.
- C. Perform patching and repair of firestopping systems damaged by other trades.

END OF SECTION

SECTION 07 84 53
BUILDING PERIMETER FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Perimeter Fire Containment Systems, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Underwriters Laboratories, Inc. (UL):
 - 1. UL 263 Fire Tests of Building Construction and Materials.
 - 2. UL 723 Surface Burning Characteristics of Building Materials.
 - 3. UL 2079 Tests for Fire Resistance of Building Joint Systems.
- B. American Society of Testing and Materials (ASTM):
 - 1. ASTM E84 Surface Burning Characteristics of Building Materials
 - 2. ASTM E119 Fire Tests of Building Construction and Materials.
 - 3. ASTM E2307 Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-Story Test Apparatus.
 - 4. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- C. National Fire Protection Association (NFPA):
 - 1. NFPA 285 Tests for Evaluation of Flammability Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components Using the Intermediate-Scale, Multi-Story Test Apparatus.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's standard information indicating certification of products proposed for use on project.
- B. Project Information:
 - 1. UL reports with illustration of systems, system numbers, temperature ratings, and products proposed for use on project.
- C. Contract Closeout Information:

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Certified, licensed or approved by firestopping manufacturer as having necessary training to install firestop products per specified requirements.
 - 2. Licensed by the State or local authority, where applicable.
 - 3. Shown to have successfully completed not less than five (5) comparable scale projects.
- B. Obtain Perimeter Fire Containment Systems for each slab edge and wall condition indicated from a single manufacturer.
- C. Certification Requirements:
 - 1. Firestopping tests, performed by a qualified, testing and inspection agency.

- a. Intertek, UL, or agency performing testing and follow-up inspection services for firestop systems acceptable to local authorities having jurisdiction.
- 2. Perimeter fire containment system products bear classification marking of qualified testing and inspection agency.
- 3. Applications for which no tested system is available through a manufacturer:
 - a. Provide engineering judgment derived from similar UL system designs, Intertek system designs or tests approved by local authorities having jurisdiction, prior to installation.
 - b. Engineering judgment drawings must follow requirements set forth by International Firestop Council.
 - c. Coordinate Engineering Judgment with manufacturer representative.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Perimeter Fire Containment System:
 - 1. Base:
 - a. Hilti, Inc.
 - 2. Optional:
 - a. 3M
 - b. Rectorseal
 - c. Specified Technologies, Inc.
 - d. Tremco, Inc.
 - e. United States Gypsum Company
 - f. W.R. Grace & Company
- B. Forming Materials:
 - 1. Base:
 - a. As listed by Perimeter System Manufacturer.
 - 2. Optional:
 - a. IIG Minwool
 - b. Rockwool.
 - c. Thermafiber by Owens Corning.
- C. Other manufacturers, which have UL or Intertek listed systems for fire resistant joint systems and conditions indicated, desiring approval comply with Section 01 61 00.
 - 1. See UL Building Materials Directory XHDG systems in Volume 2.

2.2 DESIGN CRITERIA

- A. Select approved fire containment assemblies which meet or exceed hourly fire resistive requirements between building elements.
 - 1. Utilize fire containment systems which have been tested for use in proposed manner.
 - 2. Underwriters Laboratories (UL) Fire Resistance Directory:
 - a. Perimeter Fire Containment Systems (XHDG)
 - b. Fill, Void, or Cavity Materials (XHHW)
 - c. Forming Materials (XHKU)
 - d. Curtain Wall Insulation (XHGU)
 - 3. Building Code as locally adopted and amended.
 - a. International Building Code, Chapter 7.
 - 4. National Fire Protection Association (NFPA):
 - a. NFPA 101: Life Safety Code.

5. Intertek Listed Products Directory, Volume II.
 - a. Fire Resistant Joint Systems.
- B. Coordinate construction of Perimeter Fire Containment Systems with installation of adjacent materials to ensure items are installed in accordance with specified requirements.
- C. Flexible Sealants:
 1. Accommodate movement resulting from thermal expansion, inter-story differential building sway and other normal building movement without damage to system.
- D. Pre-printed Identification Labels:
 1. Provide for each perimeter fire containment assembly.
 2. Identification labels may be in the form of self-adhering stickers, tie-on identification tags, or combination of both as appropriate for permanent identification of firestop assemblies and include following:
 - a. Name of supplier of firestop system.
 - b. UL design number, Intertek design number or approved testing agency.
 - c. Date of installation.
 - d. Name of firestopping installer.

2.3 MATERIAL: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Provide compatible perimeter fire containment system products, forming material, fillers, sealants, and other items, to substrates forming openings, under conditions of service and application.
- B. Provide components for each perimeter fire containment system needed to install fill materials.
- C. Provide products that upon curing do not re-emulsify, dissolve, leach, break down or deteriorate resulting from atmospheric moisture, ponding water, or other forms of moisture.
- D. Edge of slab conditions with vision glass to floor line:
 1. Utilize Intertek Laboratories design, HI/BPF 120-10.
 2. Should HI/BPF 120-10 not meet project conditions, submit engineering judgment to authorities having jurisdiction for review and approval.
- E. Silicone Sealant:
 1. One part non-sag or self-leveling silicone elastomeric firestopping sealant.
 2. Base Product: CFS-S SIL SL Firestop Silicone Sealant by Hilti, Inc.
- F. Latex Spray Sealants:
 1. Non re-emulsifying single component latex formulation.
 - a. Base Product: CFS-SP WB, CP 672, or CP 672 FC Firestop Joint Spray by Hilti, Inc.
- G. Mineral Wool Insulation:
 1. Faced or unfaced batts or blankets used for exterior curtain walls.
 2. Base Product: FireSpan or FireSpan SS by Thermafiber.
- H. Safing Insulation:
 1. Board or sheet products used as forming materials in edge of slab openings.
 2. Approved component of the UL system proposed.
 3. Base Product: Type SAF by Thermafiber.
- I. Spandrel Insulation:
 1. For use at non-fire rated conditions.

2. See Section 07 21 00.
- J. Through Penetration Firestop Systems:
 1. See Section 07 84 00.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine areas and conditions under which work is to be performed and identify conditions detrimental to completion.
- B. Prepare surfaces to which firestop materials will be applied in accordance with manufacturer's recommendations.
 1. Make free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any substance inhibiting adhesion.
- C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
- D. Do not proceed until unsatisfactory conditions have been corrected.
- E. Installation indicates acceptance of substrates and responsibility for performance.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Seal edge of slab openings to ensure an air and water resistant seal.
- C. Curtain wall insulation that is an integral component of the perimeter fire containment system shall be installed in accordance with the conditions of testing and classification as specified.
 1. Upgrade as required where additional R-value is needed to comply with thermal insulation requirements as specified in Section 07 21 00, Building Insulation.
- D. Install safing insulation with the grain oriented vertically to maintain effective compression between edge of floor assembly and curtain wall.

3.3 FIELD QUALITY CONTROL

- A. Identification Labels:
 1. Identify each Perimeter Fire Containment System as defined in Quality Assurance.
 2. Do not locate identification labels, tags, or both on finished surfaces or exposed to public view.
- B. Keep areas of work accessible until inspection by authorities having jurisdiction.

3.4 ADJUSTING AND CLEANING

- A. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- B. Clean surfaces adjacent to sealed openings to be free of excess materials and soiling as work progresses.
- C. Perform patching and repair of firestopping systems damaged by other trades.

END OF SECTION

SECTION 07 92 13
EXTERIOR JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Exterior Joint Sealants, as indicated, in accordance with provisions of Contract Documents.
- B. Related materials specified elsewhere:
 - 1. Interior Joint Sealants: Specified in Section 07 92 16.
 - 2. Firestopping: Specified in Section 07 84 00.
- C. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C510 Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants
 - 2. ASTM C920 Standard Specification for Elastomeric Joint Sealants
 - 3. ASTM C1193 Standard Guide for Use of Joint Sealants

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Sealant Schedule with the following information:
 - a. General description of locations requiring sealants (i.e. Brick to Aluminum Window).
 - b. List type of sealant and name of product proposed for each location.
 - c. Include a blank Color Column on schedule for selection.
 - d. Architect to complete Color Column upon selection from submitted samples.
- B. Product Data:
 - 1. Performance characteristics and limitations.
 - 2. Recommended installation.
- C. Samples:
 - 1. Cured sample of each color. Submit with Sealant Schedule.
- D. Contract Closeout Information:
 - 1. Field Quality Control Test and Inspection Reports.
 - 2. Warranty.

1.4 QUALITY ASSURANCE

- A. Caulk and Caulking are synonymous with sealant work.
- B. Paving Joints include joints in floor slabs, sidewalks, steps, ramps, and curbs.
- C. Seal joints which would otherwise permit penetration of moisture or air, unless sealant work is specifically required under other Section.
- D. Provide sealant at following locations:
 - 1. Flashing reglets and retainers.
 - 2. Exterior wall joints.
 - 3. Masonry control joints, and between masonry and other materials.

4. Isolation joints.
 5. Joints between paving or sidewalks and building.
 6. Joints at penetrations of walls, floors, and decks by piping and other services and equipment not requiring firestopping.
 7. Perimeters of door and window frames, louvers, grilles, etc.
 8. Joints between dissimilar materials, to provide visually acceptable closures.
 9. Solidly bed thresholds at exterior doors.
 10. Other joints where caulking, or sealant is indicated.
- E. Staining Potential of adjacent materials caused by sealants:
1. Pre-test proposed sealants where sealants are used with any of following materials:
 - a. Brick Masonry.
 - b. Manufactured Stone Masonry.
 - c. Concrete Masonry.
 2. Test Method: ASTM C1248 Standard Test Method for Staining of Porous Substrate by Joint Sealants.
 3. Historical testing using same materials and cataloged by sealant manufacturer will be considered acceptable.
 4. Where testing suggests that staining potential exists: Reselect sealant and retest.
 5. Certify that staining potential has been evaluated.

1.5 WARRANTY

- A. Provide written warranty that sealant work will remain free of defects for a period of 3 years from Date of Substantial Completion:
1. Failure of water or air tightness constitutes defect.
 2. Loss of adhesion, cohesion, or failure to cure constitutes defect.
 3. Remove defective work and materials and replace with new work and materials.
 4. Non- prorated warranty to include labor and material.
 5. Warranty signed by Installer, Contractor, or both.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Silicone Sealant:
1. Base:
 - a. Pecora Corporation.
 2. Optional:
 - a. Dow.
 - b. GE Silicone by Momentive Performance Materials.
 - c. Sika Corporation.
 - d. Tremco.
- B. Polyurethane Sealants:
1. Base:
 - a. Pecora Corporation.
 2. Optional:
 - a. Master Builders Solutions.
 - b. Sika Corporation.
- C. Silane-Modified Polymer Sealant (STPE, STPU, Polyurea):

1. Base:
 - a. Pecora Corporation.
 2. Optional:
 - a. Master Builders Solutions.
 - b. Tremco.
- D. Other Sealants:
1. Base: As indicated.
- E. Pre-molded Compressible Sealant:
1. Base:
 - a. Emseal.
 2. Optional:
 - a. Master Builders Solutions.
 - b. Construction Specialties.
 - c. Erie Metal Specialties.
 - d. Nystrom.
 - e. Willseal by Tremco.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Elastomeric Sealants:
1. ASTM C920 Type S or M, Grade-NS at vertical joints, Grade-P or –NS at horizontal joints, minimum Class as scheduled.
 2. Non-staining sealant complying with ASTM C1248.
 3. Where sealant is not exposed to view, use manufacturer's standard color which has best performance.
 4. Before use of sealant, investigate its compatibility with surfaces, fillers, and other materials in joint system.
 5. Refer to Sealant Selection Guide for Base Products.
 6. Comply with lowest VOC limits as required by local laws and sustainable design requirements, if any.
 7. VOC content no greater than 250 g/L.

13 mm32 mm	5 mm
0 mm	5 mm
45 mm255 mm	65 mm
5 mm	0 mm
0 mm0 mm	0 mm

- B. Pre-molded Compressible Sealant:
1. Foam backing: Multiple layers of acrylic-impregnated, expanding foam sealant and closed-cell (EVA) foam.
 2. Weather Facing: Low-modulus silicone with bellows profile.
 3. Movement capability: +/-50% movement.
 4. Material to be sized appropriately for joint widths indicated.
 5. Select color from manufacturer's standard line.
 6. Base Product: Seismic ColorSeal by Emseal.

C. Compressible Backer:

1. Foam backing with multiple layers of acrylic-impregnated, expanding foam sealant.
2. Provide behind conventional backer-rod and sealant where indicated.
3. Movement capability: +/- 25% movement.
4. Material to be sized appropriately for joint widths indicated.
5. Base Product: Backerseal by Emseal.

D. Installation Adhesive:

1. As recommended by manufacturer of compressible sealants and backers.
2. Comply with VOC limits as required by local laws.

E. Joint Primer:

1. As recommended by sealant manufacturer.
2. Sealant primers for nonporous surfaces as recommended by manufacturer with a VOC content no greater than 250 g/L.
3. Sealant primers for porous surfaces as recommended by manufacturer with a VOC content no greater than 775 g/L.

F. Backer Rod:

1. Polyethylene, polyethylene jacketed polyurethane foam, flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not proceed with installation of joint sealants under following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 degrees F 4.4 degrees C.
 2. When joint substrates are wet.
- B. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Apply only to joints free of material which may inhibit bond.
- D. Apply to cementitious materials only when thoroughly cured and dry.

3.2 PREPARATION

- A. Clean joints and prime as required by sealant manufacturer.
- B. Install sealant after finish coating or covering is scheduled to be applied.
- C. Limit application to surfaces to receive sealants and mask edges of joints to protect adjacent surfaces.

3.3 INSTALLATION

- A. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
1. Control joint depth.
 2. Break bond of sealant at bottom of joint.
 3. Provide proper shape of sealant.
 4. Do not leave gaps between ends of sealant backings.
 5. Do not stretch, twist, puncture, or tear sealant backings.

6. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- B. Make depth of sealant not more than one-half width of joint, but not less than 1/4 inches 6 mm.
- C. Sub-caulk joints without suitable backstop, to proper depth.
- D. Install correctly sized backer rods.
- E. Apply bond breaker as required or recommended by sealant manufacturer.
- F. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- G. Make joints watertight and airtight.
- H. Install sealants using proven techniques that comply with the following and at same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- I. Tooling of Non-sag Sealants:
 1. Tool immediately after sealant application and before skinning or curing begins, to form smooth, uniform beads, eliminate air pockets, and ensure contact and adhesion of sealant with sides of joint.
 2. Remove excess sealant adjacent to joints as the Work progresses with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.
 3. Use tooling agents that are approved by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 4. Provide concave joint profile per Figure 8A in ASTM C1193, unless otherwise indicated.
- J. At traffic joints, slightly recess sealant to avoid direct contact with wheeled traffic.

3.4 SEALANT USAGE GUIDELINES

Guide to Sealant Types - Exterior				
Location	Materials	Sealant Type	Base Product	Remarks / Exceptions
General Exterior	Cast in Place Concrete	Multi-part Polyurethane, chemically curing, epoxidized	Pecora Dynatrol II	Exception: Use Dymonic where used as bedding sealant for frames, sills, thresholds etc.
	Brick and Concrete Masonry			
	Portland Cement Plaster			
	Hollow Metal Door and Window Perimeters			
	Aluminum Composite Panels (ACM) and Metal Column Covers	Silane-Modified Polymer (STPU, STPE, Polyurea)	Pecora Dynatrol I-XL Hybrid	--
	Joints in materials with high coefficients of linear expansion			
	Weatherseal of Aluminum Window Frames (including perimeter joints)			
	Precast Concrete Panels	Silicone or Silyl Terminated Polyether (STPE)	Pecora 890NST or 890FTS or Pecora Dynatrol I-XL Hybrid	--
	EIFS Systems			

	Stone Work	Silicone or Silane-Modified Polymer (STPU, STPE, Polyurea)	Pecora 864NST or Pecora Dynatrol I-XL Hybrid	Exception: Pre-test for staining potential per ASTM C1248, with stain-sensitive stone Note: Silane-modified Polyurethane will not stain.
	General Exterior Glazing	Silicone; Neutral-cure	Pecora 895NST	Exception: Select alternate silicone sealant types as appropriate for specific glazing application.
	Butt Glazing and Structural Silicone Joints	Silicone; 1-part, Neutral-cure	Pecora 895NST	--
	Fabrication of Insulating Glass Units (IGU)	Primary Seal: Polyisobutylene	Select high quality sealants, of basic type listed, as appropriate for specific application.	
		Secondary Seal: Silicone	Dowsil 982	--
	Zone dams, shear blocks and other internal component of Aluminum Window Systems	Silicone	Use product which offers optimal adhesion and performance for application.	
	Sheet Metal Gutters, Downspouts, Scuppers, etc.	Butyl Rubber	Pecora BC-158	--
Exterior Flatwork	Existing joints where Silicone was previously used	Silicone	Use product which offers optimal adhesion and performance for condition, and which offers suitable color choices for matching.	
	Concrete Paving and Parking Structures	Multi-part Polyurethane	Pecora Dynatred	Pecora DynaTred is rated for continual water emersion. Others may not be.
	Concrete Walks			
	Brick Paving and Walks			
	Stone and Precast Plazas			

Notes

1. The above is intended to be an overall guide. Additional conditions and materials may be required. Notify Architect if additional Guidance is required to select unlisted items.
2. Optional sealant products shall offer same number of color choices as the Base Product listed or custom color matching.
3. All of the conditions and materials listed may not apply to subject project.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - a. Extent of Testing: Test completed, and cured sealant joints as follows:
 - 1) Perform 10 tests for the first 1000 ft. (300 m) of joint length for each kind of sealant and joint substrate.
 - 2) Perform one test for each 1000 ft. (300 m) of joint length thereafter or one test per each floor per elevation.
 - b. Test Method: Test joint sealants in accordance with Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - c. Inspect tested joints and report on the following:
 - 1) Whether sealants filled joint cavities and are free of voids.
 - 2) Whether sealant dimensions and configurations comply with specified requirements.
 - 3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
 - d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether

joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

- e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
 - 2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
- B. Prepare test and inspection reports.

END OF SECTION

SECTION 07 92 16
INTERIOR JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Interior Joint Sealants, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C510 Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants
 - 2. ASTM C711 Standard Test Method for Low-Temperature Flexibility and Tenacity of One-Part, Elastomeric, Solvent-Release Type Sealants
 - 3. ASTM C719 Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement
 - 4. ASTM C792 Standard Test Method for Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants
 - 5. ASTM C793 Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants
 - 6. ASTM C910 Standard Test Method for Bond and Cohesion of One-Part Elastomeric Solvent Release-Type Sealants
 - 7. ASTM C920 Standard Specification for Elastomeric Joint Sealants
 - 8. ASTM C1193 Standard Guide for Use of Joint Sealants
- B. South Coast Air Quality Management District (SCAQMD), Rule #1168.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Sealant Schedule with the following information:
 - a. Generally describe locations requiring sealants (i.e. GWB to Aluminum Window).
 - b. List type of sealant and name of product proposed for each location.
 - c. Include a blank Color Column on schedule for selection.
 - d. Architect to complete Color Column upon selection from submitted samples.
- B. Product Data:
 - 1. Performance characteristics and limitations.
 - 2. Recommended installation.
- C. Samples:
 - 1. Submit cured sample of each color with Sealant Schedule.
- D. Contract Closeout Information:
 - 1. Warranty.

1.4 QUALITY ASSURANCE

- A. Definitions:
 - 1. Caulk and Caulking are synonymous with sealant work.

2. Interior Wet Areas includes toilets, showers, kitchens, and similar areas where sealant is subject to moisture.
- B. Seal joints which permit penetration of moisture or air, unless sealant work is specifically required under other sections.
- C. Provide sealants at the following:
 1. Masonry control joints and between masonry and other materials.
 2. Flooring joints.
 3. Isolation joints.
 4. Joints at penetrations of walls, floors, and decks by piping and other services and equipment not requiring firestopping.
 5. Perimeters of door and window frames, louvers, grilles, etc.
 6. Between cabinets, casework, countertops, and back splashes where adjacent to walls.
 7. Joints between dissimilar materials, to provide visually acceptable closures.
 8. Other joints where caulking, or sealant is indicated.

1.5 WARRANTY

- A. Provide written warranty that sealant work will remain free of defects for a period of three (3) years from Date of Substantial Completion:
 1. Failure of water or air tightness constitutes defect.
 2. Loss of adhesion, cohesion, or failure to cure constitutes defect.
 3. Remove defective work and materials and replace with new work and materials.
 4. Repair other work damaged by defective sealant work at no additional expense to Owner.
 5. Non- prorated warranty to include labor and material.
 6. Warranty signed by Installer, Contractor, or both.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Polyurethane Sealants:
 1. Base:
 - a. Pecora
 2. Optional:
 - a. Bondaflex
 - b. Master Builders Solutions
 - c. Sika
 - d. Tremco
- B. Silane-Modified Polymer (STPU, STPE, or Polyurea) Sealants:
 1. Base:
 - a. Pecora
 2. Optional:
 - a. Master Builders Solutions
 - b. Tremco
- C. Silicone Sealants:
 1. Base:
 - a. As noted for individual items.
 2. Optional:

- a. Color Rite
- b. Pecora
- c. Dow
- d. GE Silicones
- e. Tremco

D. Acoustical Sealant:

- 1. Base:
 - a. Pecora
- 2. Optional:
 - a. Grabber
 - b. Hilti
 - c. STI
 - d. 3M

E. Clean Zone Sealant:

- 1. Base:
 - a. Sika Corporation
- 2. Optional:
 - a. Dow.
 - b. Other manufacturers whose sealant products comply with the following requirements:
 - 1) Total mass loss (TML) shall not exceed 1.0 percent of initial mass, when tested in accordance with ASTM E595 Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment.
 - 2) Collected Volatile Condensable Material (CVCM or VCM) shall not exceed 0.20 percent of initial mass when tested in accordance with ASTM E595.

F. Other Sealants:

- 1. Base: As indicated.

G. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Volatile Organic Compounds (VOC):

- 1. Comply with South Coast Air Quality Management District (SCAQMD), Rule 1168.
 - a. Sealants: 250 g/L.
 - b. Sealant Primers for Nonporous Substrates: 250 g/L.
 - c. Sealant Primers for Porous Substrates: 775 g/L

B. Elastomeric Sealants:

- 1. Refer to Sealant Selection Guide for types required.
- 2. Silicone and Hybrid sealants: ASTM C920 Type S or M, Grade-NS, minimum Class as scheduled.
- 3. Latex sealants: ASTM C834, Type OP, Grade -18 degrees Celsius.
- 4. Non-staining sealant complying with ASTM C1248.
- 5. Where sealant is not exposed to view, use manufacturer's standard color which has best performance.
- 6. Use non-sag sealant in vertical joints.

7. Use self-leveling or non-sag sealant in horizontal joints.
 8. Before use of sealant, investigate its compatibility with surfaces, fillers, and other materials in joint system.
- C. Casework Sealant:
1. 100 percent silicone.
 2. Colors:
 - a. Colors to match Plastic Laminate, Stone, Wood, Solid Surfacing, and other materials specified for casework bodies, countertops, and splashes.
 - b. Architect to select from no less than 400 standard color choices.
 - c. Number of different colors for project shall not be limited.
 3. Base Product:
 - a. Solid Colors: Color-Sil by Color Rite; 100 percent Silicone, no suspended partials.
 - b. Architect to select final colors and locations during submittals phase.
- D. Acoustical Sealant:
1. Flexible, non-hardening.
 2. UL listed.
 3. Seal construction joints and through-penetration openings in non-fire-rated acoustic barriers and smoke partitions.
 4. Seal perimeter of sound rated partitions.
 5. Seal perimeter and cover outside faces of electrical boxes and similar utilities in sound rated partitions.
 6. Base Products: Pecora AIS-919 (gun and airless spray).
- E. Joint Cleaner, Primer, Bond Breaker:
1. As recommended by sealant manufacturer.
- F. Backer Rod:
1. Polyethylene, polyethylene jacketed polyurethane foam, flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not proceed with installation of joint sealants under following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F 4.4 deg C.
 2. When joint substrates are wet.
- B. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Apply only to joints free of material which may inhibit bond.
- D. Apply to cementitious materials only when thoroughly cured and dry.

3.2 PREPARATION

- A. Clean joints and prime as required by sealant manufacturer.
- B. Install sealant after finish coating or covering is scheduled to be applied.
- C. Limit application to surfaces to receive sealants and mask edges of joints to protect adjacent surfaces.

3.3 INSTALLATION

- A. Install sealant backings to support sealants during application.
 - 1. Control joint depth.
 - 2. Break bond of sealant at bottom of joint.
 - 3. Provide proper shape of sealant.
 - 4. Do not leave gaps between ends of sealant backings.
 - 5. Do not stretch, twist, puncture, or tear sealant backings.
 - 6. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- B. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- C. Install sealants using proven techniques that comply with the following and at same time backings are installed:
 - 1. Place sealants to directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths allowing optimum sealant movement capability.
- D. Prime joint surfaces as recommended by sealant manufacturer for conditions:
 - 1. Limit application to surfaces to receive sealants.
 - 2. Mask off adjacent surfaces.
- E. Sub-caulk joints without suitable backstop, to proper depth.
- F. Tool sealants using sufficient pressure to fill voids.
- G. Remove excess sealant adjacent to joints.
- H. Hollow Metal Frames:
 - 1. Seal frames to wall.
 - 2. Seal frames to floor substrates and hard floor finishes.
 - 3. Do not seal frames to previously installed carpet and similar finishes.
 - 4. Seal hairline gaps where stops and rabbets of frame members intersect.
- I. Acoustical Sealant:
 - 1. General:
 - a. Apply acoustical sealant at joints, voids, and penetrations through wallboard to maximize sound control.
 - 1) Seal wallboard edges to adjacent construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant.
 - 2) Install acoustical sealant at both faces of partitions at perimeters and through penetrations.
 - 3) Comply with ASTM C919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
 - b. Refer to Section 07 84 00 for firestopping of through-wall penetrations and fire resistive joints.
 - 1) Provide firestop sealant where required in fire-rated assemblies.
 - 2. Base of walls:
 - a. Apply acoustical sealant to bottom edge of gypsum wallboard at floor.
 - 3. Head of walls:

- a. Apply acoustical sealant to top edge of gypsum wallboard at building structure.

3.4 SEALANT USAGE GUIDELINES

Guide to Sealant Types - Interior				
Location	Materials	Sealant Type	Base Product	Remarks / Exceptions
Interior (General)	Window Sills and Stools	100 percent silicone	Color-Sil Poly-Sil Pecora 898NST	Do not use in areas subject to abrasion or physical abuse
	Cabinets and Casework to wall			
	Countertops and Backsplashes			
	Sinks in Countertops			
	Fixtures and Casework to floor			
	Interior Alum Doors and Window Frame Perimeters	One-part neutral curing silane-modified polyurethane (STPU)	Pecora Dynatrol I-XL Hybrid	Paintable
	Non-rated wall, floor, and deck penetrations.			
	Interior joints at exterior wall.			
	Hollow Metal Door and Window Frames	Siliconized Acrylic Latex (paintable)	Tremco Tremflex 834 Pecora AC-20+ Silicone	Exception: Where sealant will not be painted and white color will not be visually compatible with adjacent finishes use Dynatrol I-XL Hybrid of matching color.
	Acoustical Sealant Joints at top and bottom terminations of Interior Non-rated Walls.	Water-based acrylic; paintable	Pecora AC-20 FTR or AIS-919	
		Water-based acrylic spray	Hilti CP 572 Pecora AIS-919	
	Acoustical Sealant Joints at top and bottom terminations of Interior Fire-Rated Walls and Building Perimeter Gaps between slabs and facades.	Acrylic	Pecora AC-20 FTR	Coordinate with 07 84 00 and 07 84 53.
		Silicone	Pecora 864NST	
Interior Flatwork	Control Joints in Concrete Floors in Mechanical Rooms and other unfinished spaces	Multi-part Polyurethane	Pecora DynaTred	DynaTred may be subjected to continual water immersion.
	Stone and Precast Flooring			For resistance to high heel traffic, use Pecora Dynaflex or Dynaflex SC
Interior Wet Areas	Porcelain, Ceramic Tile, Metals, and surfaces with Epoxy Paints	Silicone; Air cure	Pecora 860 (acid cure) or Pecora 898NST	--
Detention Facility Secure Areas such as: Cells, Day Rooms, Inmate side of Visiting, Interview Rooms and other areas exposed to	Detention Furnishings and Toilet Accessories	Epoxy	Sikadur 31 Pecora DynaPoxy EP-1200	Use at Interior Construction Joints from finished floor to 10 feet AFF.
	Cabinets and Casework			Use around perimeter of items fastened to walls and ceilings when 10 feet AFF or less.
	Countertops and Backsplashes			
	Plumbing and Electrical Fixtures and Fixed Equipment			

Guide to Sealant Types - Interior				
Location	Materials	Sealant Type	Base Product	Remarks / Exceptions
Persons in Custody.	Porcelain, Ceramic Tile, Metals, and surfaces with Epoxy Paints			DO NOT USE at joints where movement is expected.
	Door and Window Frame Perimeters	Flexible Epoxy	Sikadur 51 Pecora Dynaflex	Use at listed locations both interior and exterior.
	Control Joints in Concrete or other Hard Surface Floors			Do not use at expansion joints or joints covered by another material.
	Vertical Control Joints in Concrete and Masonry Walls and where each type intersects the other			Use 10 feet AFF and above for all locations where Epoxy is listed above.
	Other Locations in Secure Areas not listed above			
Laboratories, biocontainment facilities, and cGMP cleanrooms	Sanitary seal at joints between ceramic and prefinished surfaces	Sanitary Silicone	Tremco Tremsil 200 Pecora 860 (acid cure) or Pecora 898NST	White only
	Sanitary seal at joints between epoxy painted and prefinished surfaces	Sanitary Silicone	Pecora 898NST	White only
	Airtight seal at openings in walls and ceilings	Structural Silicone	Pecora 895NST	Includes electrical conduits
		Heat Shrink Polyolefin Tubing	NP-700md	
Microelectronics & Aeronautics Clean Zone / Cleanrooms	Cleanroom Sealant	Polyurethane	Sikaflex-1A	White only

Notes

1. The above is intended to be an overall guide. Additional conditions and materials may be required. Notify Architect if additional Guidance is required to select unlisted items.
2. Optional sealant products shall offer same number of color choices as the Base Product listed.
3. All conditions and materials listed may not apply to subject project.
4. Not all project conditions may be addressed on above table; Refer also to other specification sections and install sealants where called for by other sections.
5. Materials and Conditions conventionally occurring on Exterior but used on Interior (e.g. Brick Masonry on interior) may not be listed on this Table. Refer to Exterior Guide (Section 07 92 13) for appropriate sealant type.

END OF SECTION



DIVISION 08

OPENINGS



SECTION 08 06 71
DOOR HARDWARE SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Door Hardware, as indicated, in accordance with provisions of Contract Documents.
- B. Notify Architect of items which will not operate properly, attain the required fire label, or where components are physically or functionally incompatible.
- C. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Builders Hardware Manufacturers Association, BHMA:
 - 1. ANSI/BHMA 1301 Materials and Finishes.
 - 2. ANSI/BHMA 156 Series Standards.
- B. Door and Hardware Institute: Architectural; Hardware Consultant Certification.
- C. ICC/ANSI 117.1 Accessible and Usable Building and Facilities.
- D. National Fire Protection Association, NFPA:
 - 1. NFPA 70 National Electrical Code.
 - 2. NFPA 80 Standard for Fire Doors and Other Opening Protectives.
 - 3. NFPA 101 Life Safety Code.
 - 4. NFPA252 Standard Methods of Fire Tests of Door Assemblies.
- E. United Laboratories, LLC, UL Solutions:
 - 1. UL 10B Standard for Safety-Fire Tests of Door Assemblies.
 - 2. UL 10C Standard for Positive Pressure Fire Tests of Door Assemblies.
 - 3. UL 1784 Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives.
- F. U.S. Department of Justice: 2010 ADA Standards for Accessible Design.

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Complete Hardware Schedule by door.
 - a. Complete list of products including model numbers and cut sheets.
 - b. Use Heading Numbers logically derived from Architect's Hardware Set numbers.
 - c. Hardware Sets shall follow the guidelines established in Door and Hardware Institute Handbook (DHI) Sequence and Format for the Hardware Schedule.
 - d. Notify Architect of items which will not operate properly, attain the required fire label, and where components are physically or functionally incompatible.
 - 2. Diagrammatic Elevations and Point-to-Point Wiring Diagrams of openings scheduled to receive electrified hardware and electronic access control devices.
 - a. Provide detailed wiring diagrams showing connections for signaling, control and locking functions and notes pertinent to programming, operation, etc.

- b. When door hardware sets include automatic operators and locking or latching hardware on the same doors, provide detailed wiring diagrams.
 - c. Submit with Hardware Schedule.
- C. Project Information:
 - 1. Certification that items bear UL label where required.
 - 2. Meeting minutes from Pre-Installation Meeting.
- D. Contract Closeout Information:
 - 1. Schedule of components installed as hardware sets for each opening.
 - 2. Operating and maintenance data.
 - a. Parts catalog for each product furnished.
 - b. Keying records.
 - 3. Owner instruction report.
 - 4. Letter stating extra material has been delivered.

1.4 QUALITY ASSURANCE

- A. Hardware Supplier Qualifications:
 - 1. Architectural door hardware supplier with warehousing facilities.
 - 2. Operating in the project's vicinity for a period of not less than 2 years.
 - 3. Certified Architectural Hardware Consultant (AHC) available throughout construction.
- B. Electrified Hardware Supplier Qualifications:
 - 1. Experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this project and acceptable to manufacturer of materials.
 - 2. Prepare data for electrified door hardware based on testing and engineering analysis of manufacturer's assemblies similar to those in this project.
- C. Fire Rated Door Assemblies:
 - 1. Provide door hardware rated for use in assemblies complying with NFPA 80.
 - 2. Include listed and labeled hardware from a qualified testing agency, for fire protection ratings indicated,
 - 3. Comply with Positive Pressure Requirements UL-10C, Category A or NFPA 252.
- D. Smoke and Draft Control Assemblies:
 - 1. Maximum Leakage: 3 cfm/SF of door face area when tested at pressure of 0.10 inches water per UL 1784.
 - 2. Applicability:
 - a. Doors in Smoke Partitions, Smoke Barriers, and Corridor walls.
 - b. Doors forming part of an Elevator Lobby enclosure.
 - 3. Provide S-Labels where required.
- E. Finish designations and standards: Builders Hardware Manufacturers Association (ANSI/BHMA) Standard 1301.
- F. Regulatory Requirements:
 - 1. Barrier free design requirements of the local jurisdiction and Americans with Disabilities Act (ADA).
 - 2. Listing requirements of the local jurisdiction and UL listing where applicable by type.
- G. Preinstallation Conference:

1. Prior to installation of hardware, Contractor to conduct on-site meeting to instruct hardware installer personnel in the proper installation of hardware and related electronics.
 - a. Manufacturer's Reps for Locksets, Closers, Exit Devices, and other major hardware devices shall be present and direct instruction of installers.
 - b. Require attendance of affected parties, not limited to: Contractor, hardware installer, electrical installer, door and frame installers and security installer, where applicable, and installer working with low voltage wiring of electromechanical hardware.
 - c. Discuss installation sequence of components, point-to-point wiring diagrams, and address questions raised by installers.

1.5 SPECIAL WARRANTY

- A. Written warranty in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within 3 years from date of Substantial Completion, or 25 years from date of Substantial Completion in the case of manual surface closers.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

1.6 MAINTENANCE

- A. Extra Materials:
 1. Provide special tools as supplied by hardware manufacturer, for each different or special hardware component.

PART 2 -PRODUCTS

2.1 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

2.2 MANUFACTURERS

- A. Manufacturers listed in Related Sections:
 1. 08 71 00 - Door Hardware

2.3 HARDWARE SETS – EXTERIOR

- A. SEE ELECTRIFIED SETS.

2.4 HARDWARE SETS – INTERIOR

- A. HWE-201: SEE ELECTRIFIED SETS.
- B. HW-202: Single, Privacy with Indicator
 1. Hinges
 2. Mortise Lockset
 - a. Privacy with Occupancy Indicator
 3. Cylinder
 4. Strike
 5. Closer
 - a. With Stops
- C. HW-203: Multi-stall Restroom
 1. Hinges

- 2. Closer
 - a. With Stops
- 3. Architectural Pull
- 4. Architectural Pull
- D. HW-204: Single, Classroom
 - 1. Hinges
 - 2. Mortise Lockset
 - a. Classroom
 - 3. Cylinder
 - 4. Strike
 - 5. Closer
 - a. With Holds and Stops
- E. HW-205: Single door, Exit Device, Passage
 - 1. Hinges
 - 2. Exit Device
 - a. Mortise
 - b. Lever Trim
 - c. Passage
 - 3. Strike
 - 4. Closer
 - a. With Stops
- F. HW-206: Single, Office with Closer
 - 1. Hinges
 - 2. Mortise Lockset
 - a. Office
 - 3. Cylinder
 - 4. Strike
 - 5. Closer
 - a. With Holds and Stops
- G. HWE-207: SEE ELECTRIFIED SETS.
- H. HW-208: Single with Exit Device, Classroom, and Closer
 - 1. Hinges
 - 2. Exit Device
 - a. Mortise
 - b. Lever Trim
 - c. Classroom
 - 3. Strike
 - 4. Closer
 - a. With Stops
 - 5. Cylinder
- I. HWE-209: SEE ELECTRIFIED SETS.
- J. HW-210: Sliding Door
 - 1. Fascia
 - 2. Concealed floor guide

3. 2 Pulls Rockwood 860
 4. 6 Silencers Ives SR66
- K. HARDWARE SETS – ELECTRIFIED
- L. HWE-101: CW Exterior, Double, with Auto-Operator and Card Reader
1. SDO Operator
 2. Continuous Hinges
 3. Architectural Exit Devices
 - a. Mortise
 - b. Full Height Straight Pull
 - c. Night Latch
 4. Cylinder
 5. Closers
 - a. With Stops
 6. Electric Strikes
 - a. Latch bolt Monitor Switch (wired as request-to-exit switch to shunt alarm)
 7. Weatherstripping and Sweeps
 8. Threshold
 9. Door Position Switch by Security System Installer.
 10. Power Supply as required by Security System Installer.
 11. Power Transfer
 12. Low voltage Power supplied by Security System.
 13. Access Device:
 - a. Card Reader (by Security System Installer).
 14. Actuation Devices:
 - a. Daytime Ingress: Touchless Wall Switch (TWS).
 - b. Nighttime Ingress: Card Reader (by Security System Installer).
 - c. Egress: Touchless Wall Switch (TWS).
 15. Functional Description:
 - a. Daytime:
 - 1) Building Staff unlocks Exit Device: Free ingress via Pull.
 - 2) Loss of Power or Fire Alarm: No change to daytime operation.
 - b. Nighttime:
 - 1) Ingress by Card Reader
 - a) Card Reader momentarily releases electric strike.
 - 2) Free egress by panic bar (both leaves); REX switch to shunt alarm
 - 3) Loss of Power: door remains locked; ingress via key in trim.
 - 4) Fire Alarm: No change to operation.
- M. HWE-102: Single with Card Reader
1. Hinges
 2. Closer
 - a. With Stops
 3. Weatherstripping and Sweeps
 4. Threshold
 5. Head Drip
 6. Mortise Lockset

- a. Storeroom
 - 7. Cylinder
 - 8. Electric Strike
 - a. Fail Safe
 - b. Latch bolt Monitor Switch (wired as request-to-exit switch to shunt alarm)
 - 9. Low voltage Power supplied by Security System.
 - 10. Door Position Switch by Security System Installer.
 - 11. Access Device:
 - a. Card Reader (by Security System Installer).
 - 12. Functional Description:
 - a. Door normally locked.
 - b. In by Card Reader or override by key in latchset.
 - c. Free egress by inside trim; REX switch in lever to shunt alarm.
 - d. Loss of Power (EL):
 - 1) Fail Secure (FSE), door remains locked; ingress via key in trim. Free egress via Exit Device.
 - e. Fire Alarm (EL):
 - 1) Fail Secure (FSE), door remains locked; ingress via key in trim. Free egress via Exit Device.
- N. HWE-103: CW Exterior (vestibule), Double, with Auto-Operator
- 1. SDO Operator
 - 2. Continuous Hinges
 - 3. Architectural Exit Devices
 - a. Mortise
 - b. Full Height Straight Pull
 - c. Passage
 - 4. Closers
 - a. With Stops
 - 5. Electric Strikes
 - 6. Power Supply as required by Security System Installer.
 - 7. Power Transfer
 - 8. Low voltage Power supplied by Security System.
 - 9. Actuation Devices:
 - a. Daytime Ingress: Touchless Wall Switch (TWS).
 - b. Nighttime Ingress: Free Ingress.
 - c. Egress: Touchless Wall Switch (TWS).
 - 10. Functional Description:
 - a. Always unlocked, ingress via Pull or TWS.
 - b. Free egress by panic bar or TWS.
- O. HWE-104: HM Exterior, Single with Exit Device and Card Reader
- 1. Hinges
 - 2. Closer
 - a. With Stops
 - 3. Weatherstripping and Sweeps
 - 4. Threshold
 - 5. Head Drip

6. Electrified Exit Device
 - a. Mortise
 - b. Lever trim
 - c. Electric latch retraction
 - d. REX switch in rail
 - e. Storeroom
 7. Cylinder
 8. Strike
 9. Power Transfer
 10. Low voltage Power supplied by Security System.
 11. Door Position Switch by Security System Installer.
 12. Access Device:
 - a. Card Reader by Security System Installer.
 13. Functional Description:
 - a. Door normally locked.
 - b. In by Card Reader or override by key in latchset.
 - c. Free egress by Exit Device; REX switch in rail to shunt alarm.
 - d. Loss of Power (EL):
 - 1) Fail Secure (FSE), door remains locked; ingress via key in trim. Free egress via Exit Device.
 - e. Fire Alarm (EL):
 - 1) Fail Secure (FSE), door remains locked; ingress via key in trim. Free egress via Exit Device.
- P. HWE-201: Interior Single door, Card Reader
1. Hinges
 2. Mortise Lockset
 - a. Storeroom
 - b. Lever trim
 3. Electric Strike
 4. Closers
 - a. With Stops
 5. Cylinder
 6. Low voltage Power supplied by Security System.
 7. Door Position Switch by Security System Installer.
 8. Access Device:
 - a. Card Reader by Security System Installer.
 9. Functional Description:
 - a. Door normally locked.
 - b. In by Card Reader or override by key in latchset.
 - c. Free egress by Lever; REX switch in latchset to shunt alarm.
 - d. Loss of Power (EL):
 - 1) Fail Secure (FSE), door remains locked; ingress via key in trim. Free egress via Lever.
 - e. Fire Alarm (EL):
 - 1) Fail Secure (FSE), door remains locked; ingress via key in trim. Free egress via Lever.

Q. HWE-207: Interior Single door, Exit Device with Card Reader

1. Hinges
2. Closer
 - a. With Stops
3. Exit Device
 - a. Mortise
 - b. Lever trim
 - c. Storeroom
4. Cylinder
5. Electric Strike
6. Low voltage Power supplied by Security System.
7. Door Position Switch by Security System Installer.
8. Access Device:
 - a. Card Reader by Security System Installer.
9. Functional Description:
 - a. Door normally locked.
 - b. In by Card Reader or override by key in latchset.
 - c. Free egress by Exit Device; REX switch in rail to shunt alarm.
 - d. Loss of Power (EL): Release strike (unlock)
 - e. Fire Alarm (EL): Release strike (unlock)

R. HWE-209: Interior Double door, Card Reader

1. Hinges
2. Constant Latching Flushbolts (inactive leaf)
3. Dustproof strike
4. Electrified Mortise Lockset
 - a. Storeroom
 - b. Lever trim
 - c. Electric latch retraction
5. Strike
6. Closers
 - a. With and Stops
7. Coordinator
8. Astragal
9. Cylinder
10. Power Transfer
11. Remote Lock Release button
12. Low voltage Power supplied by Security System.
13. Door Position Switch by Security System Installer.
14. Access Device:
 - a. Card Reader by Security System Installer.
15. Functional Description:
 - a. Door normally locked.
 - b. In by Card Reader or override by key in latchset.
 - c. Free egress by Lever; REX switch in latchset to shunt alarm.
 - d. Loss of Power (EL):

- 1) Fail Secure (FSE), door remains locked; ingress via key in trim. Free egress via Lever.
- e. Fire Alarm (EL):
 - 1) Fail Secure (FSE), door remains locked; ingress via key in trim. Free egress via Lever.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Coordinate reinforcement or other preparation of doors and frames.
- C. Installation constitutes responsibility for performance.
- D. Coordinate installation power supply and communication wiring to electrically operated devices.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions, supervised or inspected by an AHC.
- B. Furnish items of hardware for proper door swing.
- C. Permanently install hardware after finishing operations are complete.
- D. Protect finishes by temporary coverings as required.
- E. Mounting Heights:

Mounting Heights of Hardware	
Item	Height ^{1,2} (To Item Centerline)
Mortise Locksets	40-5/16 inches AFF to CL of Strike 3
Cylindrical Locksets	
Patient Latches	
Exit Devices	
Door Pulls	42 inches AFF to CL of Pull
Pushplates	45 inches AFF to CL of Plate
Auxiliary Deadbolts	48 inches AFF to CL of Strike
Butt Hinges (and Pivots)	Top Hinge: Not more than 11-3/4 inches down from frame
	Bottom Hinge: Not more than 13 inches above floor
	Equally spaced between Top and Bottom Hinges. Refer to Part 2 for quantity required.
Other Items	Comply with SDI and DHI Recommendations
Footnotes/Additional Requirements: <ol style="list-style-type: none"> 1. Mounting Heights shall also comply with ADA and ICC/ANSI 117.1 2. Mounting Heights shall also comply with Building Code and Fire Codes. 3. Deviation from listed height will be allowed up to + 1-1/2 inches provided it does not cause a conflict between the lock and lite cutouts. 	

- F. Install hardware with fasteners concealed where not required by code to be exposed.

- G. Coordinate installation of electric access control hardware.
 - 1. Hardware installer to be responsible for coordination with electrical installer for low voltage installations.
- H. Door Position Switches (DPS):
 - 1. Coordinate door and frame preparations with door and frame suppliers, and Security System installer as appropriate.
 - 2. Locate in frame head approximately 4 inches from latching door edge, unless otherwise instructed.

3.3 ADJUST AND CLEAN

- A. Adjust and check each operating item of hardware to ensure proper operation or function.
 - 1. Lubricate moving parts with lubricant recommended by manufacturer.
 - 2. Replace units which cannot be adjusted and lubricated to operate smoothly.

3.4 CLOSEOUT

- A. Conversion of Construction Keying to Permanent (by Contractor):
 - 1. Convert cylinders from Construction to Permanent configuration at time of Substantial Completion.
 - 2. Demonstrate conversion method to Owner's facility personnel, making certain Owner's team understands methodology.
- B. Conversion of Construction Keying to Permanent (by Owner):
 - 1. Demonstrate conversion method to Owner's facility personnel, making certain Owner's team understands methodology required to convert cylinders from Construction to Permanent configuration.
 - 2. Ensure that Owner has proper instruction and tools needed to convert keying to final configuration.
- C. Approximately six months after substantial completion, check and readjust to assure proper function of doors and hardware.
 - 1. Clean and lubricate operational items.
 - 2. Replace items which have deteriorated or failed.
 - 3. Prepare a written report of current and predictable problems in operation of hardware.
 - 4. Report visit and furnish copy of report to Owner with copy to Architect.
- D. When hardware is installed more than one month prior to final acceptance or occupancy, during week prior to acceptance or occupancy, make a final check and adjustment of hardware items.
 - 1. Remove temporary coverings.
 - 2. Clean and lubricate for proper function and finish.
 - 3. Adjust door control devices to compensate for operation of heating and ventilating equipment.
- E. Instruct Owner's personnel:
 - 1. Operating and maintenance procedures.
 - 2. Key control system.
 - 3. Methodology used to re-key cylinders from Construction to Permanent configuration.
- F. Prior to substantial completion instruct Owner's personnel in systems operation.
 - 1. Standard system operation and maintenance.
 - 2. Modification of codes.
 - 3. Acquisition, monitoring, and scheduling of ID cards.

4. Instruction in software applications.

END OF SECTION

SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Hollow Metal Doors and Frames in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM A568 Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled
- B. Hollow Door and Frame Standards:
 - 1. ANSI A250.4 Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors
 - 2. ANSI A250.8 / SDI 100 Recommended Specifications for Standard Steel Doors and Frames
 - 3. ANSI A250.11 Recommended Erection Instructions for Steel Frames
- C. Fire Rated Doors and Frames:
 - 1. Label and list for ratings indicated by ITS – Warnock Hersey, UL or other testing and inspection agency acceptable to authorities having jurisdiction.
 - 2. Affix physical label or approved marking to fire door or fire door frame at an authorized facility as evidence of compliance with procedures of labeling agency.
 - 3. Where pairs of doors require fire rating (90 minute maximum), doors shall have passed appropriate test without the use of astragals.
 - 4. Positive Pressure:
 - a. Comply with Positive Pressure Requirements UL 10C, Category A or NFPA 252.
- D. Smoke and Draft Control Assemblies:
 - 1. Maximum Leakage: 3 cfm per square foot of door face area when tested at pressure of 0.10 inches water per UL 1784.
 - 2. Applicability:
 - a. Doors in Smoke Barriers and fire-rated Corridor walls.
 - b. Doors forming part of an Elevator Lobby enclosure.
 - 3. Provide S-Labels on smoke and draft control openings.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Use same reference numbers for openings as those in Door and Frame Schedule in Drawings.
 - 2. Indicate door elevations, gauges; frame configuration; anchor types and spacing; location of reinforcement and preparations for hardware, including items recessed within door edges; details of moldings, removable stops, glazing and louvers; details of conduit and preparations for power, signal, and control systems.
- B. Product Data:
 - 1. Include construction details, material descriptions, core descriptions, fire resistance rating and finishes.

2. Shop primer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Hollow Metal Doors and Frames:

1. Base:
 - a. Ceco Door Products
2. Optional:
 - a. Curries
 - b. Philipp Manufacturing Company
 - c. Republic Doors and Frames
 - d. Steelcraft Manufacturing

B. Galvanizing Repair Coating:

1. Base:
 - a. Tnemec
2. Optional:
 - a. ZRC Worldwide
 - b. Sherwin Williams

C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Steel Sheet and Strip:

1. Comply with ASTM A568.

B. Corrosion Resistant Coating:

1. Hot dip galvanized: A60 per ASTM A653.
2. Minimum zinc-iron alloy coating: 0.6 oz/FT² 183 g/m².
3. Provide corrosion resistant coating at door and frame components where used at wet and humid locations as defined by the following:
 - a. Openings located in an exterior wall.
 - b. Interior openings:
 - 1) Rooms with showers, tubs, or pools.
 - 2) Loading docks, trash collection and compacting areas.

C. Primer:

1. Shop prime.
2. Clean and phosphatize doors and frames.
3. One coat of baked-on rust inhibiting primer paint in accordance with ANSI A250.10.
4. Suitable and compatible as base for specified finish paints.

D. Galvanizing Repair Coating:

1. Galvanized coating repair.
2. VOC 250 g/L maximum.

E. Hollow Metal Doors:

1. Comply with ANSI/SDI A250.8.

2. Determination of performance level for each door:
 - a. Use level of HM door indicated for its location, size, and other listed criteria.

Schedule of HM Door Levels			
Location	Additional Criteria	HMMA Level	Notes
Exterior Doors ¹ (flush)	Openings where each leaf is less than 47 inches	Level 3 (Extra Heavy duty)	Galvanized / galvanized Thermally Insulated
	Openings where one or more of the leaves exceeds 47 inches	Level 4 (Maximum-duty)	
Exterior Doors ¹ (stile and rail)	All	Level 3 (Extra Heavy duty)	Galvanized / galvanized Thermally Insulated
Interior Doors	Non-fire rated	Level 2 (Heavy duty)	--
	Fire rated	Level 2 (Heavy duty)	Labeled as indicated (w/out astragal wherever possible)
	Wet / Humid Areas ²	Level 3 (Extra Heavy duty)	Galvanized / galvanized Moisture-resistant core Fire-resistant were required
Interior Doors	Non-fire rated	Level 3 (Extra Heavy duty)	--
	Fire rated	Level 3 (Extra Heavy duty)	Labeled as indicated (w/out astragal wherever possible)
	Wet / Humid Areas ²	Level 3 (Extra Heavy duty)	Galvanized / galvanized Moisture-resistant core Fire resistant were required

Notes

Refer to Door Schedule for indication of the Door Type (i.e. Width, Fire Rating, Flush vs. Stile & Rail, etc.)

Refer to Plans for door location (Exterior vs. Interior).

Where Hurricane or Tornado resistant openings are specified: Refer to ADDITIONAL REQUIREMENTS for appropriate door/frame construction.

Not all items included in table may apply to subject project.

Footnotes

1. Refer to Part 2.2 MATERIALS for definition of Exterior locations.
2. Refer to Part 2.2 MATERIALS for definition of Wet/Humid locations.

3. Door Thickness: 1-3/4 inches 45 mm.
4. ANSI A250.8 Level 4, Maximum duty, physical performance Level A.
 - a. Face Sheet Thickness: 0.067 inches (14 GA) 1.7 mm.
5. ANSI A250.8 Level 3, Extra Heavy duty, physical performance Level A.
 - a. Face Sheet Thickness: 0.053 inches (16 GA) 1.3 mm.
6. ANSI A250.8 Model 2, Seamless.
7. End closures at top and bottom of door:
 - a. Top: Flush closure top cap. Minimum Sheet thickness: 0.032 inches (20 GA) 0.8 mm.
 - b. Bottom: Flush closure. Minimum Sheet thickness: 0.032 inches (20 GA) 0.8 mm.
 - c. Bottom: Inverted channel. Minimum Sheet thickness: 0.053 inches (16 GA) 1.3 mm.
8. Vertical door edges:
 - a. Lock Stile Edges: Beveled 1/8 inches 3 mm per 2 inches 50 mm.
 - 1) Exception for inactive leaves: Fabricate inactive leaves with a square edge at the lock stile edge. Active leaves to be beveled per above.
 - 2) Hinge Stiles Edge: Beveled 1/8 inches 3 mm per 2 inches 50 mm.
 - 3) Exceptions for Double Acting Doors: Provide convex, radiused edges at lock stiles and hinge stiles.
9. Hardware Reinforcement (doors):

- a. Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as door face sheets.
 - b. Minimum thickness: As prescribed in ANSI/SDI A250.6; Upgrade as necessary for conditions such as door weight, size, frequency, etc. and as follows:
 - c. Butt Hinges: 0.167 inches (7 GA) 4 mm plate reinforcement or continuous 0.104 inches (12 GA) 2.6 mm channel engineered for equal strength.
 - d. Continuous hinges: Reinforce with 0.067 inches (14 GA) 4 mm thick x 1-1/4 inches 32 mm wide strapping extending full height and welded to hinge edge of door.
 - e. Closers and Overhead Stops: 0.067 inches (14 GA) 4 mm.
10. Cores:
- a. Steel stiffeners where structurally required.
 - b. Exterior Doors:
 - 1) Thermally insulated core.
 - a) 1.0 pounds per cubic foot 16 kg/M3 Polystyrene.
 - b) Minimum R-value: 2.0 when tested according to ASTM C1363.
 - c. Interior doors:
 - 1) Non-rated doors: Kraft honeycomb laminated to face sheets.
 - 2) Rated doors: Fire resistant core as required by label.
 - 3) Sound control doors: Sound core to achieve specified rating.
 - 4) Wet/humid Areas: Moisture resistant materials, fire resistant where applicable.
 - d. Specific materials used for above listed core types: Manufacturer's option.
 - e. Reinforce for Hardware.

F. Lites:

- 1. General:
 - a. Locate bottom of glazed panel 43 inches maximum above finish floor.
 - b. Locate fixed stop at exterior face integral to door.
 - c. Locate removable stop on interior face.
 - d. Snap-in stops or stops secured with countersunk Phillips head machine screws.
- 2. Fire rated doors:
 - a. Provide lite kits and fire rated glass tested as part of door assembly and labeled for intended opening.
 - b. See Section 08 81 26 Interior Glass and Glazing for materials.
 - c. Provide label as required for opening.
- 3. Non-fire rated doors:
 - a. Lite kit of same material and finish as door.
 - b. See Section 08 81 26 Interior Glass and Glazing for materials.

G. Hollow Metal (HM) Frames:

- 1. Comply with ANSI/SDI A250.8 and with details indicated for type and profile in accordance with SDI 111.
- 2. Fabricate frames with mitered or coped corners and 1/2 inches 13 mm nominal backbend.
 - a. Touch-up galvanized/galvannealed frames with zinc-rich primer.
- 3. Fabricate frames as Face Welded (modified ANSI definition):
 - a. Face Joints: Continuously back weld face joints (weld on concealed side).
 - 1) Fill and finish exposed sides to be free of visible seams.
 - b. Intersections of Rabbets, Stops and Soffit Joints: Fabricate to hairline joints. Stitch weld on concealed side.
 - c. Split type frames and knock down type frames are not acceptable.

- d. Fasteners which are exposed to view are not acceptable.
4. Provide minimum steel gauge as indicated for its location, size, and other listed criteria per following schedule.

Schedule of HM Frames			
Location	Criteria	Minimum Thickness	Miscellaneous
Exterior Frames ¹	Standard and Thermally Enhanced	0.067 inches (14 GA) 1.7 mm	Galvanized / galvanized
Interior Frames ¹	Non-fire rated	0.053 inches (16 GA) 1.3 mm	--
	Fire rated	0.053 inches (16 GA) 1.3 mm	--
	Frames for doors with automatic openers	0.067 inches (14 GA) 1.7 mm	--
	Wet / Humid Areas ²	0.053 inches (16 GA) 1.3 mm	Galvanized / galvanized

Notes

Gauge of frame listed is the minimum. Use heavier gauge as required due to size, physical configuration or if required to meet fire label requirements.

Refer to Door Schedule for indication of the Frame Type (I.e. Width, Single vs. Pair; Fire Rating, etc.)

Refer to Plans for door location (Exterior vs. Interior).

Where Hurricane or Tornado resistant openings are specified: Refer to ADDITIONAL REQUIREMENTS for appropriate door/frame construction.

Some items listed may not apply to subject project.

Footnotes

1. Refer to Part 2.2 for definition of Exterior locations.
2. Refer to Part 2.2 for definition of Wet/Humid locations.

H. Sidelite Kits:

1. Glaze in same manner as door lites.
2. Label for intended opening.
3. Fixed Stop:
 - a. Locate at exterior face.
 - b. Integral to door/frame.
4. Removable Stop:
 - a. Locate on interior face.
 - b. Snap-in stops or stops secured with countersunk Phillips head machine screws.

I. Silencers:

1. ANSI/BHMA 156.16
 - a. Diameter: 1/2 inches.
 - b. Projection: 1/8 inches.
 - c. Tamper-proof.
 - d. Base Product – Steel Frames: SR64 by Ives.
 - e. Base Product – Wood Frames: SR65 by Ives.
2. Quantity:
 - a. Three on strike jamb of single frames.
 - b. Two per door for pair doors. Locate at head.
3. Space per manufacturer's recommendations.

J. Hardware Reinforcement:

1. Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.
2. Minimum thickness: As prescribed in ANSI/SDI A250.6; upgrade as necessary for conditions such as door weight, size, frequency, etc. and as follows:
 - a. Butt Hinges: 7 GA.
 - b. Continuous hinges: Reinforce with 0.067 inches (14 GA) 1.7 mm thick x 1-1/4 inches 32 mm wide strapping extending full height and welded to hinge jamb door rabbet of frame.
 - c. Closers and Overhead Stops: 0.093 inches (12 GA) 2.4 mm thick x 12 inches 305 mm long strapping welded to vertical flange of frame.

K. Head Stiffeners:

1. Provide at double egress frames:
2. Position stiffeners at mid span of frame opening.

L. Junction Boxes:

1. Sheet metal enclosure:
 - a. Provide to facilitate pulling of wires and making electrical connections.
 - b. Weld to back side of frames.
2. Material: 0.032 inches (20 GA) 0.80 mm sheet steel.
3. Size and shape: As required by hardware device.
4. Include knockout to receive 1/2 inches 13 mm conduit.
5. Locate Junction Boxes in frames scheduled to receive electrified security, door hardware devices, or both.

M. Jamb Anchors:

1. ASTM A879 Commercial Steel, 4 oz/SF coating; mill phosphatized.
 - a. Frames in exterior walls:
 - 1) Steel sheet complying with ASTM A1008 or ASTM A1011, hot-dip galvanized according to ASTM A153, Class B.
2. Provide anchors in accordance with manufacturer's recommendations on fire rated doors.
3. Provide minimum number as indicated in following table:

Minimum Quantity of Jamb Anchors	
Nominal Frame Height	Minimum Quantity per Jamb
Less than 60 inches 1.5 m	2
60 inches to 90 inches 1.5 m to 2.3 m	3
90 inches to 120 inches 2.3 m to 3 m	4
120 inches to 150 inches 3 m to 3.8 m	5
Greater than 150 inches 3.8 m	Add 1 additional for each 30 inches 760 mm increase in height thereafter

- a. Jamb anchors for stud framed walls:
 - 1) Z-shaped clips, welded to inside of frames; not less than 0.042 inches (18 GA) 1 mm thick, or compression anchors to suit frame size.
 - 2) Attach anchors to studs with screws.
- b. Jamb anchors for masonry walls:
 - 1) Adjustable strap-and-stirrup or T-shaped anchors to suit frame size.
 - 2) Minimum 0.042 inches (18 GA) 1 mm.
 - 3) Corrugated or perforated straps:

- a) Minimum 2 inches 50 mm wide by 10 inches 254 mm long.
- 4) Wire anchors:
 - a) Minimum 0.184 inches (6 GA) 5 mm thick.
- 5) Embed long leg into masonry wall as units are placed.
- 6) Post installed expansion type for in place concrete or masonry:
 - a) Minimum 3/8 inches 10 mm countersunk, flat head expansion bolts with expansion shields or inserts.
 - b) Include pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
 - c) Minimum embedment length: 1-3/4 inches 45 mm.
- c. Floor Anchors:
 - 1) Same for Jamb Anchors but not less than 0.053 inches (12 GA) 2.4 mm thick.
 - a) Anchors built into exterior walls:
 - (1) Steel sheet complying with ASTM A1008 or ASTM A1011, hot-dip galvanized according to ASTM A153, Class B.
 - b) Monolithic concrete slabs:
 - (1) Clip type anchors, with two holes to receive fasteners.
 - c) Topped slabs:
 - (1) Adjustable anchors with extension clips allowing not less than 2 inches 50 mm height adjustment. Terminate bottom of frames at finish floor surface.
 - 2) Include concealed fasteners.
 - 3) Provide anchors in accordance with manufacturer's recommendations at fire rated openings.
- d. Head Anchors for Double Egress Frames:
 - 1) Provide two head frame anchors for Double Egress frames.
 - 2) Locate at third points of span.
- 4. Spreaders:
 - a. Provide removable spreaders at bottom of door frames.
- 5. Inserts, bolts, and fasteners:
 - a. Manufacturer's standard units
 - b. Galvanize items built into exterior walls ASTM A153, Class C or D as applicable.

2.3 FABRICATION

- A. Factory fit doors to frame openings with uniform clearances in accordance with:
 - 1. National Fire Protection Association NFPA 80 for fire rated doors.
 - 2. National Fire Protection Association NFPA 105 for smoke control doors.
 - 3. American National Standards Institute ANSI A250.8.
 - 4. Locally adopted Building Code.
 - 5. Steel Door Institute SDI 117.

Door To Frame Clearances		
Location		Clearance
Door to Frame at top and sides		1/8 inches 3 mm
Meeting Stiles at Pair Doors		1/8 inches 3 mm
Face of door to face of Stop		1/8 inches 3 mm
Door Bottom to Floor / Flooring	Typical; all floor covering types	Up to 1/2 inches 13 mm
	At non-combustible sills	3/8 inches 9.5 mm
	Bare floors- No flooring or sills	Up to 3/4 inches 19 mm

B. Hardware Preparation:

1. Factory-prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to Door Hardware Schedule and templates furnished as specified in Section 08 71 00.
2. Locate hardware indicated, or if not indicated, according to ANSI/SDI A250.8.
3. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
4. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
5. Coordinate locations of conduit and wiring boxes for electrical connections.
6. Remove mill scale and foreign materials, touch up damaged galvanized or galvanized surfaces.

C. Hollow Metal Doors:

1. Exterior:
 - a. Provide weep openings in bottom of exterior doors.
 - b. Seal joints in top edges of doors against water penetration.
2. Glazed lites:
 - a. Factory cut openings in doors.
 - b. Locate bottom of glazed panel 43 inches maximum above finish floor.
3. Astragals:
 - a. Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire performance rating or where indicated.

D. Fire Labels:

1. Affix permanent labels to fire rated units in accordance with testing agency requirements.
2. Where labels are stamped or embossed directly into frame, ensure label will remain legible upon application of finishes.
3. At openings where continuous hinges or other items conceal fire label, locate labels on alternative locations as allowed by listing agency and local authorities.

E. Door Position Switches (DPS):

1. Coordinate locations with Security System provider.
2. Locate DPS frame head approximately 4 inches 100 mm from latching door edge.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine structure, substrates, and conditions under which work is to be installed for conditions detrimental to correct and timely completion.
- B. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

A. Frames:

1. Place frames before construction of adjacent walls.
 - a. Where adjacent walls are cast in place concrete, set frames after wall is constructed.
2. Adjust hollow metal door frames for square, alignment, twist, and plumb to following tolerances:
 - a. Plumb: Plus or minus 1/16 inches 1.5 mm, measured at jambs at floor.
 - b. Level: Plus or minus 1/16 inches 1.5 mm per leaf, measured across width of header.

- c. Square: Plus or minus 1/16 inches 1.5 mm, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - d. Alignment: Plus or minus 1/16 inches 1.5 mm, measured at jambs on horizontal line parallel to plane of wall.
 - e. Twist: Plus or minus 1/16 inches 1.5 mm, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 3. Do not remove spreaders until surrounding wall construction is complete.
 4. After surrounding walls have been constructed, verify frames remain in alignment.
 - a. Re-check for level, plumb, square, twist and issues that will prevent proper fitting of doors.
 - b. Correct deficiencies before allowing surrounding construction to proceed.
 - c. Coordinate with other trades to correct alignment problems.
 5. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
 6. Verify frame alignment, and correct deficiencies prior to hanging doors.
 7. Install frames with removable glazing stops located on secure side of opening.
 8. Provide anchor type specified for wall condition.
 9. Align anchors at hinge centers on hinge jamb and at corresponding heights on strike jamb.
 10. Secure frame to wall per manufacturer's instructions.
- B. Prime Coat Touchup:
1. Immediately after erection, sand smooth rusted or damaged areas of primer coat.
 2. Touch up primer coat with compatible air drying primer.
 3. Leave surfaces smooth for finish painting.
- C. Field Painting of HM Frames and Doors:
1. Painting of Exterior openings: Specified in Section 09 91 13.
 2. Painting of Interior openings: Specified in Section 09 91 23.
- D. Install Sealants:
1. Seal frames to walls.
 2. Seal frames to floor slabs and hard floor finishes.
 3. Hairline gap at intersections of head and jamb frames intersections of rabbets and stops:
 - a. Fill exposed seam with painter's caulk.
 4. Sealants:
 - a. Exterior: See Section 07 92 13.
 - b. Interior: See Section 07 92 16.
- E. Install silencers.

3.3 ADJUSTING AND CLEANING

- A. Verify frames remain in proper alignment.
- B. Correct deficiencies before proceeding with surrounding construction.
- C. Remove protective wrappings from doors and frames.
- D. Verify fire labels are intact, and readily visible.

END OF SECTION

STASECTION 08 14 16
FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Flush Wood Doors, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Obtain flush wood doors through one source from a single manufacturer.
- B. Window and Door Manufacturer's Association (WDMA):
 - 1. I.S. 1A Industry Standard for Architectural Wood Flush Doors
- C. American National Standards Institute (ANSI):
 - 1. ANSI A115. W Series, Wood Door Hardware Standards.
- D. Fire Rated Door Standards:
 - 1. Label and list for ratings indicated by ITS – Warnock Hersey, UL or other testing and inspection agency acceptable to authorities having jurisdiction.
 - 2. Factory-apply physical label or approved marking to fire door or fire door frame.
 - 3. Positive pressure:
 - a. Comply with UL 10C Category A or NFPA 252.
 - b. Use concealed intumescent or other tested method.
 - c. Category B applied intumescent seals are not allowed.
- E. Smoke and Draft Control Assemblies:
 - 1. Maximum air leakage rate of door assembly:
 - a. 3.0 cubic feet per minute per square foot of door opening at 0.10 inches of water in accordance with UL 1784.
 - 2. Applications:
 - a. Doors in smoke barriers with fire ratings and fire rated corridor walls.
 - b. Doors forming part of an elevator lobby or doors placed at elevator hoistway openings.
 - 3. Provide S-Labels on smoke and draft control openings.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Include details of construction for each type of door.
 - 2. Include factory finishing specifications.
 - 3. Provide manufacturer's technical data for each type of door including details of core and edge construction, trim for openings and factory finishing specifications.
- B. Shop Drawings:
 - 1. Indicate location, size, and hand of each door; elevation of each kind of door; location and extent of hardware blocking.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate requirements for veneer matching.

4. Describe factory finish and finish requirements.
 5. Indicate fire ratings for fire doors.
- C. Samples:
1. Factory finishes applied to actual door face materials for each material and finish.
 - a. Provide one piece of specified finished work for each wood species and finish.
 - b. Minimum Size: 8 by 10 inches indicating finish.
- D. Contract Closeout Information:
1. Warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Flush Wood Doors:
1. Base:
 - a. Masonite Architectural.
 2. Optional:
 - a. Oshkosh Door Company.
 - b. VT Industries.
- B. Integral Blind Assemblies:
1. Base:
 - a. IE; Blinds.
 2. Optional:
 - a. OEM Shades
 - b. Privacy Glass Solutions.
 - c. Window Accessory Company, Inc.
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Wood Door Manufacturers Association (WDMA):
1. Performance: WDMA I.S.1A-11- Extra Heavy Duty.
 - a. Meet specified performance level without use of additional hardware blocking and without use of through bolts.
 2. Aesthetic Grade: WDMA I.S.1A-11, - Premium Grade except as modified.
- B. Thickness:
1. 1-3/4 inches unless noted otherwise.

2.3 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Veneer:
1. Veneer thickness: 1/50-inch at 12 percent moisture content.
 2. Veneer grade: HPVA Grade A.
 3. Veneer Species (both faces):
 - a. White Oak.
 4. Veneer cut:
 - a. Rift Cut.

5. Veneer leaf match:
 - a. Book match
 6. Face assembly match:
 - a. Balance
 7. Pair and Set match:
 - a. Balance match
 8. Door vertical edges: Veneer edge banding, same species as face, no joints.
- B. Core:
1. Select core types which comply with label for scheduled ratings, sizes, and hardware devices.
 2. Bond cores to stiles and rails; drop-in, unbonded cores are not acceptable.
 3. Non-Fire Rated Doors:
 - a. PC-5, Extra Heavy Duty Wood Particleboard Core.
 4. Fire-rated doors - 20 minutes:
 - a. Core type indicated above for non-rated doors.
 5. Fire-rated doors - 45, 60, and 90 minutes:
 - a. Manufacturer's standard Fire Resistant Mineral Core construction as required by label and hardware schedule.
 - b. Provide manufacturers standard edge to meet required fire rating.
 - c. Include blocking as needed for surface applied hardware.
 6. Sound Control Doors:
 - a. High Density Particleboard and Insulation as required to achieve sound rating listed in Door and Frame Schedule.
 7. Stiles:
 - a. Provide manufacturers standard edge to meet required fire rating.
 - b. Fire rated doors: Fabricate stiles from fire retardant material as allowed by label.
 - c. Meeting stiles where concealed vertical rod (CVR) exit devices are scheduled.
 - 1) Avoid use of applied metal channels where label allows fire retardant material as an alternative.
- C. Rails:
1. Solid hardwood or structural composite lumber (SCL).
- D. Cross-banding:
1. Engineered wood or wood-based composite, securely bonded to core.
 2. Medium density fiberboard (MDF) not acceptable.
- E. Adhesives:
1. Face adhesive per WDMA TM-6.
 2. Utilize waterproof adhesives for doors indicated near potentially wet conditions.
- F. Lites:
1. General:
 - a. Locate bottom of glazed panel 43 inches maximum above finish floor.
 - b. Locate fixed stop at exterior face integral to door.
 - c. Locate removable stop on interior face.
 2. Glazing:
 - a. Glass specified in Section 08 81 26.
 - 1) Non-Fire Rated Openings: 6 mm (1/4-inch nominal) Tempered Safety Glass.

- 2) Radiation Resistant Openings: Safety rated glazing with radiation resistance equivalent to door and adjacent walls.
 - 3) Fire Rated Openings: Fire-rated, safety rated glazing of type required for rating indicated.
 - 4) Glass in fire rated doors and sound control doors to be factory installed by wood door manufacturer.
3. Glazing stops:
- a. Snap-in stops or stops secured with countersunk Phillips head machine screws.
 - b. Select assemblies certified for fire ratings indicated and physically compatible with glazing type indicated.
 - c. Fire rated doors:
 - 1) Veneer of same species as door facing.
 - 2) Metal vision frames with wood veneer wrap.
 - d. Non-fire rated doors:
 - 1) Same species or compatible species with door facing.
 - 2) Solid hardwood.
- G. Accessories:
1. Metal stile channels:
 - a. Nominal 5 inches metal edge channels at fire rated pairs equipped scheduled to receive concealed vertical rod (CVR) exit devices.
 - b. Use only where fire retardant wood stiles alone are insufficient to satisfy label.
 - c. Material and Finish: Stainless Steel. No. 4 Satin Brushed.
 - d. Concealed intumescent seals: Include where required by fire label.
 - e. Include overlapping metal astragal lip where opening is part of a smoke barrier.
 2. Overlapping astragals:
 - a. Provide approved overlapping astragals where required by label but not provided in Section 08 71 00 - Door Hardware.

2.4 FABRICATION

- A. Factory fit doors to suit frame openings with most stringent criteria for uniform clearances in accordance with:
1. National Fire Protection Association NFPA 80 for fire rated doors.
 2. National Fire Protection Association NFPA 105 for smoke control doors.
 3. American National Standards Institute ANSI A250.8.
 4. Locally adopted Building Code.
 5. Wood Door Manufacturers Association (WDMA) pre-fit clearances for factory fit doors.

Door To Frame Clearances		
Location		Clearance
Door to Frame at top and sides		1/8 inches
Meeting Stiles at Pair Doors		1/8 inches
Face of door to face of Stop		1/8 inches
Door Bottom to Floor / Flooring	Typical; all floor covering types	Up to 1/2 inches
	At non-combustible sills	3/8 inches
	Bare floors- No flooring or sills	Up to 3/4 inches

- B. Factory machine doors for hardware that is not surface applied.

1. Comply with final hardware schedules, shop drawings, and hardware templates.
 2. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 3. Factory pre-drill pilot holes for surface applied items.
- C. Hardware Preparation:
1. Make cutouts accurately and neatly.
 2. Glazed lites:
 - a. Factory cut openings in doors.
 - b. Locate bottom of glazed panel 43 inches maximum above finish floor.
 - c. Do not exceed area allowed by code for rated assemblies.
 3. Provide two sets of glazing stop moldings for openings to completely cover cut edges.
 - a. Neatly miter stops at corners.
 4. Cut and trim openings through doors to comply with applicable requirements of referenced standard for kinds of doors required.
 5. Finish as appropriate for material and type:
 - a. Veneer wrapped stops: Finish to match face veneer on doors.
 - b. Solid wood stops: Finish to match face veneer on doors.
 6. Fill nail holes in wood stops.
- D. Top and Bottom Edges:
1. Render top and bottom edges smooth, non-absorptive and readily cleanable.
 2. SCL rail finish: Make smooth with the application of veneer tape, plastic laminate, or clear sealer to finish rough or porous edges.
- E. Fire Labels:
1. Affix permanent labels to fire rated units in accordance with agency requirements.
 2. On openings where continuous hinges or other items would conceal label, place label in alternate location allowed by listing agency and authorities having jurisdiction.
- F. Finishes:
1. Comply with WDMA finish requirements.
 2. Completely finish doors at factory.
 3. Stain (STN):
 - a. Type: Manufacturer's standard type.
 - b. Stain color:
 - 1) To be selected by Architect from manufacturer's standard line.
 4. Transparent Finish:
 - a. System WDMA TR-6 catalyzed polyurethane.
 - b. Sheen: 30 to 40.
- G. Vertical Door Edges:
1. Lock stile edges: Beveled 1/8 inches per 2 inches.
 - a. Fabricate inactive leaves with a square edge at lock stile edge.
 - 1) Active leaves to be beveled per above.
 2. Hinge stiles edge: Beveled 1/8 inches per 2 inches.
 3. Double acting doors:
 - a. Provide convex, radiused edges at lock stiles and hinge stiles.
 - b. Kerf for privacy gaskets.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify suitability of openings to accept installation.
- B. Verify frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
- C. Reject doors with defects prior to hanging.
- D. Normalize wood doors to ambient conditions and to temperature and humidity levels recommended by manufacturer.
- E. Do not hang doors in frames set out of plumb, out of square, or out of parallel.
- F. Work with frame installer and wall installer to correct misalignment issues.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.
- H. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. Comply with door manufacturer's written instructions, referenced quality standard, and as indicated.
- B. Drill pilot holes for screws attaching hinges, closers, lock hardware and other devices to stile or face of door.
 - 1. Diameter of pilot hole shall not exceed 90 percent of the root diameter of the screw.
- C. Fit doors to frames and machine for hardware, to extent not previously worked at factory.
- D. Hardware: For installation, see Section 08 71 00, Door Hardware.

3.3 ADJUSTING

- A. Adjust and check doors for proper fit function and uniform clearance at each edge to swing and operate freely.
- B. Leave work complete and in proper operating condition.
- C. Ensure fire labels are intact, and readily visible.

END OF SECTION

SECTION 08 31 13
ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Access doors and frames.
 - 2. Fire-rated access doors and frames.
- B. Furnish labor, materials, tools, equipment, and services for Access Panels and Doors, as indicated, in accordance with provisions of Contract Documents.
 - 1. Provide where indicated on Drawings.
 - 2. Where not indicated on Drawings, provide access panels or doors at walls and inaccessible ceilings as required to permit access to equipment, devices, and piping requiring service, adjustment, or inspection.
- C. Related Requirements:
 - 1. Section 07 72 33 - Roof Hatches.
 - 2. Section 08 31 23 - Floor Hatches for doors installed in floors.
 - 3. Section 23 31 13 - Air Distribution System for HVAC duct access doors.

1.2 REFERENCES

- A. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM A36/A36M, Standard Specification for Carbon Structural Steel
 - b. ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - c. ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
 - d. ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
 - e. ASTM A879/A879M, Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
 - f. ASTM A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
 - g. ASTM F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
 - 2. International Code Council (ICC):
 - a. International Building Code (IBC).

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of product.
 - a. Include construction details, fire ratings material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

B. Samples:

1. For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches 150 by 150 mm in size.

C. Project Information:

1. Qualification Data: For testing and inspecting agency.
 - a. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
 - b. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

D. Contract Closeout Information:

1. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

1.4 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies meets the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.5 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace access doors and frame and hardware components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures, including cracks, warping, bends, and out-of-square.
 - b. Faulty operation of hardware including smoke or sound seals and gaskets.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.
- B. Gasketed Access Doors: Provide where required by Facilities Guidelines Institute for healthcare applications.

2.2 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges:
1. Base Product: Subject to compliance with requirements provide Flush Access Doors by one of the following:
 - a. Acudor.
 - b. Activar.
 - c. Babcock Davis.
 - d. Cendrex.
 - e. Karp.
 - f. Milcor.
 - g. Nystrom.
 2. Description: Face of door flush with frame, with exposed flange and concealed hinge.

3. Locations: Wall and ceiling @ Employee-ONLY areas.
 4. Uncoated Steel Sheet for Door: Nominal 0.060 inch 1.52 mm, 16 gauge, factory primed.
 5. Frame Material: Same material, thickness, and finish as door.
 6. Latch and Lock: Cam latch, screwdriver operated
- B. Flush Access Doors with Concealed Flanges:
1. Base Product: Subject to compliance with requirements provide Flush Access Doors by one of the following:
 - a. Acudor.
 - b. Activar.
 - c. Babcock Davis.
 - d. Cendrex.
 - e. Karp.
 - f. Milcor.
 - g. Nystrom.
 2. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
 3. Optional Features: Piano hinges
 4. Locations: Wall and ceiling
 5. Uncoated Steel Sheet for Door: Nominal 0.060 inch 1.52 mm, 16 gauge, factory primed.
 6. Frame Material: Same material and thickness as door.
 7. Latch and Lock: Prepared for mortise cylinder.
- C. Recessed Access Doors with Concealed Flanges:
1. Base Product: Subject to compliance with requirements provide Recessed Access Doors by one of the following:
 - a. Acudor.
 - b. Activar.
 - c. Babcock Davis.
 - d. Cendrex.
 - e. Karp.
 - f. Milcor.
 - g. Nystrom.
 2. Description: Door face recessed 5/8 inch 16 mm for gypsum board infill; with concealed flange for gypsum board installation and concealed hinge.
 3. Locations: Wall @ Access Door locations in tile walls. Align access door opening with tile pattern.
 4. Uncoated Steel Sheet for Door: Nominal 0.060 inch 1.52 mm, 16 gauge, factory primed.
 5. Latch and Lock: Prepared for mortise cylinder.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

- A. Fire-Rated, Flush Access Doors with Exposed Flanges:
1. Base Product: Subject to compliance with requirements provide Fire-Rated Access Doors by one of the following:
 - a. Acudor.
 - b. Babcock Davis.
 - c. Cendrex.
 - d. J. L. Industries, Inc., a division of Activar Construction Products Group, Inc.
 - e. Karp.

- f. Milcor.
- g. Nystrom.
- 2. Description: Door face flush with frame,; with exposed flange, self-closing door, and concealed hinge.
- 3. Locations: Wall
- 4. Fire-Resistance Rating: Not less than that of adjacent construction
- 5. Temperature-Rise Rating: 250 deg F 139 deg C at the end of 30 minutes.
- 6. Uncoated Steel Sheet for Door: Nominal 0.036 inch 0.91 mm, 20 gauge, factory primed.
- 7. Frame Material: Same material, thickness, and finish as door.
- 8. Latch and Lock: Self-latching door hardware, prepared for mortise cylinder

2.4 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 Z180 or A60 ZF180 metallic coating.
- D. Frame Anchors: Same material as door face.
- E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel, according to ASTM A153/A153M or ASTM F2329 or stainless steel.

2.5 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 - 1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
 - 2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.
 - 1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.
- E. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - 2. Keys: Furnish two keys per lock and key all locks alike.
 - 3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in Section 08 71 00 - Door Hardware.
- F. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.6 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
 - 2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil 0.025 mm for topcoat.
- E. Stainless Steel Finishes:
 - 1. Surface Preparation: Remove tool marks, die marks, and stretch lines, or blend into finish.
 - 2. Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 3. Bright, Cold-Rolled, Unpolished Finish: ASTM A480/A480M No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- A. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
- B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.
- C. Avoid locating access panels within animal holding rooms, procedure rooms, BSL-3 and BSL-4 laboratories and equipment rooms. Locate access panels in corridors, air locks, storage rooms or gowning rooms, if possible.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 - 1. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, Section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated access door indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 ADJUSTING AND CLEANING

- A. Adjust access panels to operate easily without binding. Verify that integral locking devices operate properly.
- B. Remove panels and frames that are warped, bowed, or otherwise damaged, and replace with new components.
- C. On completion of access panel installation, clean interior and exterior surfaces as recommended by manufacturer.

END OF SECTION

SECTION 08 41 14
MID-RISE ALUMINUM STOREFRONT

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Mid-Rise Aluminum Storefront, as indicated, in accordance with provisions of Contract Documents. This section includes aluminum door frames, aluminum sidelights, and aluminum framed glass doors for interior use.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer product literature.
- B. Shop Drawings:
 - 1. Prepared and signed by, or reviewed and approved by, Storefront manufacturer.
 - 2. Elevations, sections, and details for review of design intent and anchorage to building frame.
 - 3. Indicate member type, location, spacing, size of members, and method of attachment to support structure.
 - 4. Indicate supplemental bracing, strapping, splices, bridging, accessories, and details.
- C. Samples:
 - 1. Range samples of aluminum finishes.
- D. Project Information:
 - 1. Engineering calculations indicating design moments, shears, and other forces sealed by Specialty Structural Engineer.
 - a. Submit concurrent with Shop Drawings.
 - 2. Communicate special requirements, changes, or modifications to storefront and interface between storefront support system and building structural frame.
 - 3. Sample of Special Warranty demonstrating compliance with specified requirements.
 - 4. Meeting minutes from Preinstallation Conference.
 - 5. Installer Qualifications per Quality Control, above.
 - 6. Certified independent laboratory test reports verifying compliance with performance characteristics.
- E. Contract Closeout Information:
 - 1. Special Warranty.
 - a. See Section 01 78 36.
 - 2. Maintenance data.
 - a. See Section 01 78 43.
 - 3. Warrantable report by manufacturer's field service representative stating storefront systems have been installed in accordance with manufacturer's published specifications, drawings, details, and project design requirements.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Capable of providing field service representation during construction, approving acceptable installer, and approving application method.

- B. Installer Qualifications:
 - 1. Experienced to perform work specified.
 - 2. Specialized in the installation of work similar to that required for this project.
 - 3. Acceptable to product manufacturer.
- C. Welding and Welders:
 - 1. Utilize skilled and qualified welders, licensed where required in accordance with local building regulations.
 - 2. Perform welding in conformance with AWS code.
- D. Fabrication, erection and finishing standards: Applicable standards of AA, AAMA, and AWS.
- E. Provide Mid-Rise Aluminum Storefront engineered to support dead, live, lateral, wind or seismic, loads indicated.
 - 1. Comply with Section 01 71 21, Specialty Engineering Requirements.
 - 2. Include headers and reinforcing members around openings.
 - 3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Mid-Rise Aluminum Storefront:
 - 1. Base:
 - 2. Optional:
 - a. Wausau Window and Wall Systems
 - b. EFCO Corporation
 - c. Kawneer
 - d. Oldcastle Building Envelope
 - e. Schuco USA LLLP
 - f. Tubelite
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Design and fabricate storefront systems under responsibility of one manufacturer, with components sized for ease of shipping, distribution, and erection.
- B. Movements of Building Structure:
 - 1. Live load deflection of the supporting members.
 - a. L/360 maximum.
- C. Thermal Expansion and Structural Movement:
 - 1. Expansion and contraction, caused by changes in surface temperature equal to delta T.
 - a. Delta T for this project: 200 deg F.
 - b. Thermal contraction/expansion in this range shall not cause buckling, stresses on glass, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other detrimental effects over this temperature range.
 - c. Operating windows and doors shall function normally over this temperature range.

2.3 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Extruded Aluminum:

1. ASTM B221, alloy 6063-T6 for extrusions ASTM B209, alloy 5005-H16 for sheets.
2. Member wall thickness: Each framing member shall provide structural strength to meet specified performance requirements.
3. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal and in compliance with AA Aluminum Standards and Data.

B. Framing System:

1. RACO Solutions II 500 Series.
2. Position of glass in frame:
 - a. Center Plane.
3. Size of framing members: 1 1/2 inches x 5 inches plus face trims
4. Provide system to receive 1/2 inch heat strengthened tempered glass.
5. Provide strike boxes at openings in framing system.
6. Provide adaptors, sill flashing, and thermal pocket fillers as required for installation.

C. Internal Reinforcing:

1. ASTM A36 for carbon steel.
2. Shapes and sizes to suit installation.
3. Steel components factory coated with alkyd type zinc chromate primer complying with FS TT-P-645.

D. Doors:

1. Fabricate of extruded sections assembled with tension rods, or welded corners.
2. Dimensions:
 - a. Member Wall Thickness: 0.125 inches (minimum).
 - b. Stiles and Top Rail:
 - 1) Wide:
 - a) 5 inches 127 mm.
 - b) Base Product: RACO Series 550 wide stile.
 - c. Bottom Rail: 10 inches 254 mm.
3. Hinges: Specified in Section 08 71 00.
4. Prepare and reinforce doors to receive additional hardware specified in Section 08 71 00 and Section 08 71 13.

E. Anchorage Devices:

1. Manufacturer's standard formed or fabricated steel or aluminum assemblies of shapes, plates, bars, and tubes.
2. Hot-dip galvanize steel assemblies per ASTM A123: 2.0 ounce minimum coating.

F. Fasteners:

1. Anodized aluminum or non-magnetic 300 series stainless steel which will not cause electrolytic action or corrosion.
2. Provide Phillips flat head screws where exposed.
3. Finish exposed aluminum fasteners to match aluminum finish.

G. Sealants:

1. See Section 07 92 13.
2. Use exposed sealants of color to match aluminum finish.
3. Include sealants and caulking required within and around storefront.

- H. Glass:
 - 1. See Section 08 81 23 for glass to be installed under this section.
- I. Brackets, anchors, and reinforcements:
 - 1. Aluminum wherever possible.
 - 2. Where steel is used: Include dissimilar metals protection to prevent galvanic action.
- J. Sill Receiver:
 - 1. Continuous, extruded aluminum finished to match frames.
 - 2. Thermal break for improved performance.
 - 3. Seal seams and dam ends per manufacturer's instructions.
- K. Flashings:
 - 1. Manufacturer standard at sill or as indicated.
 - 2. Minimum 0.040 inches aluminum.
 - 3. Finish to match storefront if exposed.
 - 4. Mill finish if concealed.
- L. PVDF Finish Coating:
 - 1. Comply with AAMA 2605.
 - 2. Exterior: 70 percent PVDF resin.
 - 3. Pre-treatment process: Manufacturer's standard.
 - 4. Factory-applied, oven-baked.
 - 5. Specular Gloss per ASTM D523: 30 +/-5 measured at 60-degree meter setting.
 - 6. Primer:
 - a. Compatible with substrate and topcoat.
 - 7. Color coat:
 - a. DFT: 1.0 to 1.3 mils.
 - b. Color:
 - 1) Custom color:
 - a) From manufacturer's full range, including metallics, by Architect.

2.4 FABRICATION

- A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly.
- B. Accommodate expansion and structural movement of adjacent materials.
- C. Fit and assemble work at shop to maximum extent possible.
 - 1. Accurately fit and secure joints and corners.
 - 2. Make joints flush, hairline and weatherproof.
 - 3. Weld by methods recommended by manufacturer and AWS to avoid discoloration.
 - 4. Grind exposed welds smooth and restore finish.
 - 5. Ease corners of cut edges to radius of 1/64 inches.
 - 6. Reinforce work as necessary to withstand wind loadings and to support system.
 - 7. Separate dissimilar metals with bituminous paint or separators to prevent corrosion.
 - 8. Separate metal surfaces at moving joints with plastic inserts or other non-abrasive concealed inserts to prevent joint freeze-up.
- D. Arrange fasteners and attachments to conceal from view.

- E. Fully degrease and clean members prior to assembly or application of sealing compound or protective coatings.
- F. Reinforce frames and doors for hardware.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify building substrates permit installation of Mid-rise Aluminum Storefront according to manufacturer's instructions, approved shop drawings, calculations, and contract documents.
- B. Do not install storefront until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Set units plumb, level and true to line, without warp or rack of frame.
 - 1. Erection tolerances:
 - a. 1/8 inches in 10 feet 3 mm in 3 M vertically.
 - b. 1/8 inches in 20 feet 3 mm in 6 M horizontally.
 - 2. Limit variations from theoretical locations: 1/4 inches 6 mm for any member at any location.
 - 3. Limit offsets in theoretical end-to-end and edge-to-edge alignment: 1/16 inches 1.5 mm from flush surfaces not more than 2 inches 50 mm apart or out-of-flush by more than 1/4 inches 6 mm.
- B. Separate dissimilar materials at contact points, including metal in contact with masonry, concrete, bituminous paint, or pre-formed separators.
- C. Allow for required movement, including expansion and contraction.
- D. Anchor interior side of frame to insulated construction.
- E. Install doors and hardware in accordance with manufacturer's instructions.
- F. Sealant:
 - 1. Set sill members in full bed of sealant.
 - 2. Place members with internal sealants and baffles in accordance with manufacturer's instructions.
 - 3. Install perimeter sealant and backing materials between assemblies and adjacent construction.
 - 4. See Section 07 92 13.
- G. Glazing:
 - 1. See 08 81 23.

3.3 PROTECTION AND CLEANING

- A. Protection:
 - 1. Protect finish surfaces from damage during construction.
 - 2. Protect from damage of grinding, polishing, plaster, lime, acid, cement, and other harmful contaminants.
- B. Cleaning:
 - 1. Repair or replace damaged components.
 - 2. Clean in accordance with manufacturer's instructions.
 - 3. Remove construction debris and legally dispose offsite.

END OF SECTION

SECTION 08 44 13

CURTAIN WALL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Curtain Wall System (CWS), as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer product literature.
- B. Shop Drawings:
 - 1. Prepared and signed by or reviewed and approved by curtainwall manufacturer.
 - 2. Elevations, sections, and details for review of design intent and anchorage to building frame.
 - 3. Indicate member type, location, spacing, size, and method of attachment to support structure.
 - 4. Indicate supplemental bracing, strapping, splices, bridging, accessories, and details.
- C. Samples:
 - 1. Manufacturer's standard line of PVDF finishes for color selection.
- D. Project Information:
 - 1. Engineering calculations indicating design moments, shears, and other forces sealed by Specialty Structural Engineer.
 - a. Submit concurrent with Shop Drawings.
 - 2. Communicate special requirements, changes, or modifications to curtain wall and interface between curtain wall support system and building structural frame.
 - 3. Sample of Special Warranty demonstrating compliance with specified requirements.
 - 4. Meeting minutes from Preinstallation Conference
 - 5. Installer Qualifications per Quality Control
 - 6. Certified independent laboratory test reports verifying compliance with performance characteristics.
- E. Contract Closeout Information:
 - 1. Special Warranty.
 - a. See Section 01 78 36.
 - 2. Maintenance data
 - a. See Section 01 78 43.
 - 3. Warrantable report by manufacturer's field service representative stating curtain wall systems have been installed in accordance with manufacturer's published specifications, drawings, details, and project design requirements.

1.3 QUALITY ASSURANCE

- A. Provide Curtain Wall System engineered by specialty structural engineer to support superimposed loads indicated.
 - 1. Comply with Section 01 71 21, Specialty Engineering Requirements.
 - 2. Include headers and reinforcing members around openings.

3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.
- B. Installer Qualifications:
1. Firm with not less than ten years successful experience in erection and installation of curtain wall systems similar in design and scale of systems proposed for this project.
 2. Submit a minimum of five references of projects similar in size and scope.
 3. Submit results of monthly onsite inspections conducted by manufacturer's field service representative, to assure proper installation, to Architect.
 4. Upon completion of project, submit report from manufacturer's field service representative.
 - a. See Submittals, Contract Closeout Information, below.
- C. Welding and Welders:
1. Utilize skilled and qualified welders, licensed where required in accordance with local building regulations.
 2. Perform welding in conformance with AWS structural welding code.
- D. ASTM International (ASTM):
1. ASTM E1332 Standard Classification for Rating Outdoor-Indoor Sound Attenuation
- E. Preinstallation Conference:
1. See Section 01 31 19.
- F. Mock-up:
1. Erect mock-up wall 2 bays wide and 2 stories high.
 2. Install complete with glass, glazing, insulation, spandrels, anchors, and other components required to create entire assembly.
 3. Mock-up wall may be retained in place as a permanent part of building.
 4. If constructed separate from building, mock-up wall shall remain intact during balance of curtain wall installation and used for comparative purposes.

1.4 WARRANTY

- A. Special Assembly Warranty: Installer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory applied finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Curtain Wall System:
 - 1. Base:
 - a. Oldcastle Building Envelope
 - 2. Optional:
 - a. EFCO Corporation
 - b. Wausau Window and Wall Systems
 - c. Schuco USA
 - d. Tubelite
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Design and fabricate Curtain Wall Systems under responsibility of one manufacturer, with components sized for ease of shipping, distribution, and erection.
- B. Movements of Building Structure:
 - 1. Inter-story drift caused by wind or earthquake forces.
 - a. $h/400$ maximum.
 - 2. Live load deflection of the supporting members.
 - a. $L/360$ maximum.
- C. Design Wind Loads - Allowable Stress Design (ASD):
 - 1. Use most restrictive of following:
 - a. Wind pressures as required per local building code based on wind speed, exposure factor and importance factor noted in the Structural Drawings.
 - b. Wind Pressures defined by Building Code as locally adopted and amended.
 - c. Deflection values: Use the most restrictive of the following:
 - 1) Limit deflection to values specified for Uniform Design Load Test.
 - 2) Limit deflection to comply with Building Code as locally adopted and amended.
 - 3) Limit deflection to $L/175$ for spans up to 13 feet 6 inches or $L/240$ plus 1/4 inch for spans greater than 13 feet 6 inches.
 - 2. Design structural components, including transoms, mullions, and anchors, complying with deflection and stress requirements.
- D. Thermal Expansion and Structural Movement:
 - 1. Expansion and contraction, caused by changes in surface temperature equal to ΔT .
 - a. ΔT for this project: 200 deg F.
 - b. Thermal contraction/expansion in this range shall not cause buckling, stresses on glass, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other detrimental effects over this temperature range.
 - c. Operating windows and doors shall function normally over this temperature range.

2.3 PERFORMANCE REQUIREMENTS

- A. Air, Water, and Structural Performance:
 - 1. Air Infiltration:
 - a. Test in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, NFRC 400, or ASTM E283, as applicable.
 - b. Maximum Air Infiltration:

- 1) Fixed wall areas:
 - a) 0.06 cfm/SF 0.0003 M3/S/M2 when tested at 6.24 psf 300 Pa.
- 2) Swinging doors:
 - a) Air infiltration: Not more than 0.30 cfm/LF 0.00015 M3/S /305 mm at 1.60 psf 77 Pa static air pressure differential, when tested in accordance with ASTM E283.
 - b) Water Leakage: No uncontrolled water entry at 0 psf 0 Pa test pressure per ASTM E331.
 - c) Structural Performance: Structural performance per ASTM E330 shall be based on an actual deflection of 0.02 inches 0.051 mm at test pressure of 20 psf 958 Pa.
 - d) Thermal Transmittance:
 - (1) Thermal transmittance due to conduction (U_c) shall not be greater than 0.651 btu/HR/FT²/deg F 3.696 W/M² K per AAMA 1503.
 - (2) Condensation resistance factor (CRF) shall not be less than 56 per AAMA 1503.
 - e) Pairs:
 - (1) Less than 1.0 cfm/SF 0.00508 M3/S/M2 of perimeter crack, when tested at 1.56 psf 75 Pa.
2. Water Infiltration under Static Pressure:
 - a. Test in accordance with ASTM E331.
 - b. No uncontrolled water penetration through area of wall.
 - c. Differential static pressure 20 percent of inward acting design wind load pressure specified but not less than 15 psf 720 Pa.
3. Structural Performance:
 - a. Uniform Load Deflection Test:
 - 1) Conduct at Design Test Pressure both positive and negative in accordance with ASTM E330.
 - 2) Apply inward and outward test pressures equal to design wind pressures.
 - 3) Deflection of framing member in direction normal to plane of wall not exceeding $L/175$ for span under 13 feet - 6 inches 4.1 M and $L/240 + 1/4$ inches 6 mm for span over 13 feet - 6 inches 4.1 M.
 - 4) Maximum deflection at cantilevers not to exceed $2L/175$.
 - 5) No air and water infiltration, no glass breakage, no damage to fasteners, or anchors and main members, or disengagement.
 - 6) Deflection of thin metal panel walls not exceeding $1/60$ of span.
 - 7) Measure deflection from gauges located on vertical mullions and horizontal members.
 - 8) Deflection of member in direction parallel to plane of wall, when carrying full dead load, not exceeding an amount which will reduce glass bite below 75 percent of design dimension.
 - 9) Provide minimum $1/8$ inches 3 mm clearance between member and top of fixed panel, glass, or other fixed part immediately below.
 - 10) Clearance between member and door or operable window, minimum $1/16$ inches 1.5 mm.
 - b. Uniform Load Structural Test:
 - 1) Conduct at 1.5 x Design Test Pressure both positive and negative, acting normal to plane of wall in accordance with ASTM E330.

- 2) No glass breakage; permanent damage to fasteners, hardware parts, or anchors; damage to make curtain wall insert vents inoperable; or permanent deformation of main frame member in excess of 0.2 percent of its clear span.
- c. Vertical Inter-Story Movement:
 - 1) No air and water infiltration, no glass breakage, no damage to fasteners, or anchors and main members, or disengagement resulting from vertical displacement of intermediate level support in the plane of the main wall 1/2 inches 13 mm up and down six complete cycles in accordance with AAMA 501.7.
- d. Dynamic Lateral Racking – Parallel to Wall:
 - 1) No air and water infiltration in excess of primary performance requirements, no breakage, no damage, or disengagement resulting from lateral displacement of the intermediate level support in plane of the main wall at +/-0.5 percent of story height for three complete cycles in accordance with AAMA 501.6.
- e. Static Lateral Racking – Parallel to Wall:
 - 1) No glass breakage, framing member or trim disengagement, catastrophic failure or fall-out resulting from lateral displacement of intermediate level support in plane of main wall at +/-1.5 percent of story height for three complete cycles in accordance with AAMA 501.4.
- f. Thermal Cycling:
 - 1) No air and water infiltration in excess of primary performance requirements, no breakage, no damage, or disengagement resulting from three thermal cycles of -10 deg F -23 deg C exterior ambient temperature to +180 deg F +82 deg C exterior surface temperature, each held for a two-hour period after equilibrium has been reached.
 - a) Interior ambient air temperature controlled at 70 deg F +/-5 deg F 21 deg C +/- 15 deg C during cold and hot cycles, respectively.
 - b) Test in accordance with AAMA 501.5.
- B. Condensation Resistance and Thermal Transmittance Performance:
 1. Perform thermal tests in accordance with NFRC 102 and/or AAMA 1503 or provide finite element computer thermal modeling and calculations per NFRC 100, NFRC 705 or AAMA 507, using DOE/LBL THERM, WINDOW, and/or CMAST software.
 - a. Thermal Transmittance (U-Factor) for overall window area:
 - 1) 0.30 maximum.
 - b. Solar Heat Gain Coefficient (SHGC) for overall window area:
 - 1) 0.17 maximum.
 - c. Condensation Resistance Factor (CRF) requirements:
 - 1) Frame: 80 minimum.
 - 2) Glass: 72 minimum.
- C. Acoustic Performance:
 1. Perform acoustical tests in accordance with ASTM E90 and ASTM E1425 on glass type specified in Section 08 81 23, rigidly supported in aluminum framing of same type.
 2. Glass-only test results are not acceptable.
 3. Sound Transmission Class (STC): Not less than 31.
 4. Outdoor-Indoor Transmission Class (OITC): Not less than 25.

2.4 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Reliance TC LT Curtain Wall System by Captured and/or structurally glazed as indicated on Drawings.

B. Aluminum Framing and Components:

1. Extruded aluminum, ASTM B221, 6063-T5 alloy and temper.
2. Sizes, shapes, and profiles as indicated.
3. Provide framing member wall thickness to meet specified structural performance requirements.
4. Thermal Break:
 - a. Silicone compatible elastomer extrusion.
 - b. Reliance TC LT Curtain Wall System by Oldcastle Building Systems. 2-1/2 inches x 7-1/2 inches
5. Vertical mullions:
 - a. Captured and/or structurally glazed as indicated on Drawings.
6. Horizontal intermediate framing members:
 - a. Captured and/or structurally glazed as indicated on Drawings.
7. Kiss mullions:
 - a. As indicated on Drawings.
8. Provide exterior accent trim at locations indicated on Drawings.
 - a. Snap-on covers:
 - 1) FRP pressure plate
 - 2) Manufacturer standard profile between expansion joints.

C. Steel:

1. Smooth and free from surface blemishes.
2. Structural Shapes, Plates, and Bars: ASTM A36.
3. Cold Formed Hollow Structural Sections: ASTM A500, structural tubing
4. Cold Rolled Sheet and Strip: ASTM A1008.
5. Hot Rolled Sheet and Strip: ASTM A1011.
6. Provide steel reinforcement to meet performance requirements.
7. Finish exposed reinforcing steel to match the glazing system.

D. Brackets and Reinforcements:

1. Manufacturer's high strength aluminum units or,
2. Nonmagnetic stainless steel or,
3. Hot-dip galvanized steel.
 - a. Comply with ASTM A386.
4. 1/4 inches thick minimum stainless steel plates at threaded fasteners.
5. Non-staining, nonferrous shims.

E. Embedments:

1. Adjustable connections between curtain wall and building structure:
 - a. Toothed channel with toothed tee-bolts where channel direction is parallel to primary gravity or wind forces.
 - b. ASTM A283 Grade D hot-rolled channel sections with hot-rolled anchors.
 - c. Comply with ASTM A123 or ASTM A153.
 - d. Design as required for project specific conditions.

F. Fasteners:

1. Screws and bolts connecting aluminum parts:
 - a. ASTM A666 type 300 series, non-magnetic stainless steel.
2. Tee bolts, steel parts, or aluminum and steel parts connecting to embedment:

- a. ISO 898 Grade 4.6 minimum hot dip galvanized steel.
 - 3. Remaining fasteners and connection parts:
 - a. ASTM A666 type 304 or 316 stainless steel.
 - 4. Fastener alloys and coatings:
 - a. Compatible with adjacent materials to prevent galvanic action and corrosion.
 - b. Restrict use of self-drilling screw fasteners to connections where access cannot be arranged to place a bolt.
 - 5. Use exposed fasteners only where unavoidable for application of hardware.
 - a. Match finish of adjoining metal.
 - b. Countersink flat head machine screws for exposed fasteners.
 - 6. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 7. Reinforce members as required to receive fastener threads.
 - 8. Jacket fasteners to prevent thermal shorts.
- G. Glazing Gaskets:
- 1. Comply with ASTM C864.
 - 2. Extruded EPDM rubber.
 - 3. Silicone compatible.
- H. Perimeter Anchors:
- 1. Aluminum.
 - 2. Provide dissimilar metals protection between steel and aluminum material.
- I. Back Pans:
- 1. 0.050 inches 1.27 mm minimum, aluminum sheet.
 - a. PVDF Coating.
 - 2. Finish: Prefinished to match curtain wall frames.
 - 3. 0.036 inches 20 GA 0.91 mm galvanized steel.
 - a. Paint exposed pans.
 - 4. Color: Prefinished to match curtain wall frames.
 - 5. Welded or soldered joints with integral flanges.
 - 6. Depth: 4 inches 100 mm.
 - 7. Profile: Coordinate with application.
 - 8. Reinforcing: Integral stiffeners at 12 inches 300 mm O.C. for units exceeding 25 square feet 2.32 M2.
 - 9. Spandrel insulation:
 - a. 4 inches 100 mm mineral wool.
 - b. R-value: 4.2 per inch 0.74 per 25 mm.
 - c. 4.0 pcf 64 kg/M3 density.
 - d. Insulation adhesive as recommended by insulation manufacturer.
 - e. Provide where indicated.
 - f. Base product: Firespan 40 by Thermafiber.
 - g. Optional product: Curtainrock 40 by Rockwool.
- J. Interior Stools:
- 1. Aluminum extrusions and associated clips and fasteners.
 - 2. Prefinished to match curtain wall frames.
 - 3. Profiles indicated.

K. Doors:

1. Fabricate of extruded sections assembled with tension rods, aluminum lugs and lock nuts.
 - a. Wall thickness: 0.125 inches 3 mm minimum.
2. Thermal:
 - a. Depth:
 - 1) 2-1/4 inches 57 mm.
 - b. Stiles and top rail:
 - 1) Wide: 5 inches 127 mm.
 - c. Bottom rail:
 - 1) 10 inches 250 mm.
 - d. Base product: WS-500TC Thermal Entrance Series by Oldcastle Building Systems.
3. Offset pivots: Specified in Section 08 71 00.
4. Provide manufacturer's standard weatherstripping at edges and door bottom.
5. Prepare and reinforce doors to receive additional hardware specified in Section 08 71 00 and Section 08 71 13.

L. Thermal Break:

1. Continuous extruded 3/8 inches 10 mm EPDM spacer.
2. Sponge neoprene zone dams.

M. Weatherstripping:

1. Dual durometer PVC, polypropylene, TPE, EPDM, neoprene, or silicone as approved by curtain wall manufacturer.
2. Fin-type weather-strip at interlocking vertical mullion members to provide isolation for horizontal movement.

N. Glass:

1. See Section 08 81 23.

O. Sealant:

1. See Section 07 92 13.
2. Match color of aluminum.

P. Perimeter Fire Containment System:

1. See Section 07 84 53.

2.5 FINISHES

A. PVDF Finish Coating:

1. Comply with AAMA 2605.
2. Exterior: 70 percent PVDF resin.
3. Pre-treatment process: Manufacturer's standard.
4. Factory-applied, oven-baked.
5. Specular Gloss per ASTM D523: 30 +/-5 measured at 60 degree meter setting.
6. Primer:
 - a. Compatible with substrate and topcoat.
7. Color coat:
 - a. DFT: 1.0 to 1.3 mils.
 - b. Color:
 - 1) Custom color:

- a) As selected by the Architect from Sherwin Williams coil coatings range: Basis of Design color is a dark bronze metallic.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify building substrates permit installation of curtain wall according to manufacturer's instructions, approved shop drawings, calculations, and contract documents.
- B. Do not install curtain wall until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Design to accommodate total of plus or minus 1/2 inches 50 mm interstory vertical movement, including fabrication tolerance, without damage.
 - 1. Fully pressure-equalized at interior plane of glazing pocket.
 - 2. Compartmentalize glazing pocket at each glass lite.
- B. Allow thermal movement of materials from -10 deg F 23 deg C exterior ambient temperature to +180 deg F 82 deg C exterior surface temperature.
- C. Install in accordance with manufacturer approved shop drawings, installation instructions, specifications, and AAMA MCWM-1 Metal Curtain Wall Manual.
- D. Install plumb, level, and true to line to 1 in 1000 tolerance, without warp or rack of frames in accordance with manufacturer tolerances.
- E. Provide interlocking male/female type vertical mullion stack joints at adjacent frame members.
- F. Provide separation of aluminum materials from sources of corrosion or electrolytic action at contact points and nylon or neoprene washers to allow thermal movement and at points of attachment to structure.
- G. Conceal fasteners at vertical to horizontal main framing connections and trim except as otherwise required and approved.
- H. Install flashing and sealants within and at perimeter with splices and end dams designed and installed to insure weathertight installation.
- I. Back Pans:
 - 1. Install in spandrel glazing pocket inboard of glass unit and seal to frame with silicone sealant.
- J. Water Drainage:
 - 1. Compartmentalize each light of glass using joint plugs and silicone sealant to divert water to horizontal weep locations.
 - 2. Locate weep holes in horizontal pressure plates and covers to divert water to exterior of building.
 - 3. Provide weep holes or drainage slots within glazing pockets to drain any condensation or accumulating water within system to exterior.

3.3 FIELD TESTING

- A. Architect shall select curtain wall to be tested when representative portion of curtain wall has been installed, glazed, perimeter caulked and cured.
- B. Test for water penetration in accordance with AAMA 501.2, Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems.
- C. Where test results do not meet requirements: Correct deficiencies and implement improved installation procedures for completing balance of curtain wall system.
- D. Submit results of tests to Architect.

3.4 PROTECTION AND CLEANING

A. Protection:

1. Protect finish surfaces from damage during construction.
2. Repair or replace damaged components.
3. Clean in accordance with manufacturer's instructions.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Door Hardware, as indicated, in accordance with provisions of Contract Documents.
- B. Notify Architect of items which will not operate properly, attain the required fire label, or where components are physically or functionally incompatible.
- C. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Complete Hardware Schedule by door.
 - a. Complete list of products including model numbers and cut sheets.
 - b. Use Heading Numbers logically derived from Architect's Hardware Set numbers.
 - c. Hardware Sets shall follow the guidelines established in Door and Hardware Institute Handbook (DHI) Sequence and Format for the Hardware Schedule.
 - d. Notify Architect of items which will not operate properly, attain the required fire label, and where components are physically or functionally incompatible.
 - 2. Diagrammatic Elevations and Point-to-Point Wiring Diagrams of openings scheduled to receive electrified hardware and electronic access control devices.
 - a. Provide detailed wiring diagrams showing connections for signaling, control and locking functions and notes pertinent to programming, operation, etc.
 - b. When door hardware sets include automatic operators and locking or latching hardware on the same doors, provide detailed wiring diagrams.
 - c. Submit with Hardware Schedule.
- C. Project Information:
 - 1. Certification that items bear UL label where required.
 - 2. Meeting minutes from Pre-Installation Meeting.
 - 3. Names of supplier's certified AHCs active on project.
- D. Contract Closeout Information:
 - 1. Schedule of components installed as hardware sets for each opening.
 - 2. Operating and maintenance data.
 - a. Parts catalog for each product furnished.
 - b. Keying records.
 - 3. Owner instruction report.
 - 4. Letter stating extra material has been delivered.

1.3 QUALITY ASSURANCE

- A. Hardware Supplier Qualifications:
 - 1. Architectural door hardware supplier with warehousing facilities.
 - 2. Operating in the project's vicinity for a period of not less than 2 years.
 - 3. Certified Architectural Hardware Consultant (AHC) available throughout construction.

- B. Electrified Hardware Supplier Qualifications:
 - 1. Experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this project and acceptable to manufacturer of materials.
 - 2. Prepare data for electrified door hardware based on testing and engineering analysis of manufacturer's assemblies similar to those in this project.
- C. Fire Rated Door Assemblies:
 - 1. Provide door hardware rated for use in assemblies complying with NFPA 80.
 - 2. Include listed and labeled hardware from a qualified testing agency, for fire protection ratings indicated,
 - 3. Comply with Positive Pressure Requirements UL-10C, Category A or NFPA 252.
- D. Smoke and Draft Control Assemblies:
 - 1. Provide S-Labels where required.
 - 2. Applicability:
 - a. Fire-rated doors (20 minute or higher) in Smoke Barriers and Corridor walls.
 - b. Doors forming part of an Elevator Lobby enclosure, including doors in non-rated Smoke Partitions.
 - 3. Maximum Leakage: 3 cfm/SF of door face area when tested at pressure of 0.10 inches water per UL 1784.
- E. Radiation Resistant Doors:
 - 1. On doors indicated with (LL) hardware, provide either lead lining or lead wrapping of case and thru-bolts as applicable to type of hardware to assure shielding integrity.
- F. Finish designations and standards: Builders Hardware Manufacturers Association (ANSI/BHMA) Standard 1301.
- G. Regulatory Requirements:
 - 1. Barrier free design requirements of the local jurisdiction and Americans with Disabilities Act (ADA).
 - 2. Listing requirements of the local jurisdiction and UL listing where applicable by type.
- H. Preinstallation Conference:
 - 1. Prior to installation of hardware, Contractor conduct an on-site meeting to instruct hardware installer personnel in the proper installation of hardware and related electronics.
 - a. Manufacturer's Reps for Locksets, Closers, Exit Devices, and other major hardware devices shall be present and direct instruction of installers.
 - b. Require attendance of affected parties, not limited to: Contractor, Hardware Installer, Electrical Installer, Door and Frame Installers and Security Installer, where applicable, and installer working with low voltage wiring of electromechanical hardware.
 - c. Discuss installation sequence of components, point-to-point wiring diagrams, and address questions raised by installers.

1.4 SPECIAL WARRANTY

- A. Written warranty in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within three years from date of Substantial Completion, or 25 years from date of Substantial Completion in the case of manual surface closers.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of door hardware.

- c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

1.5 MAINTENANCE

A. Extra Materials:

- 1. Provide special tools as supplied by hardware manufacturer, for each different or special hardware component.

PART 2 -PRODUCTS

2.1 MANUFACTURERS

A. Hinges:

- 1. Base:
 - a. Hager Hinge
- 2. Optional:
 - a. Stanley Hardware
 - b. McKinney
 - c. Ives

B. Continuous Geared Hinges:

- 1. Base:
 - a. Ives
- 2. Optional:
 - a. Hager
 - b. Pemko
 - c. Zero
 - d. McKinney
 - e. Stanley

C. Power Transfer Devices:

- 1. Base:
 - a. Von Duprin
- 2. Optional:
 - a. Securitron.
 - b. Security Door Controls.
 - c. ABH Manufacturing

D. Flushbolts and Coordinators:

- 1. Base:
 - a. Ives
- 2. Optional:
 - a. Door Controls
 - b. Rockwood
 - c. Hager Hinge
 - d. ABH Manufacturing

E. Cylinders:

- 1. Base:
 - a. Same manufacturer as listed for Locks, Latches and Deadbolts.

F. Locks, Latches, and Deadbolts:

1. Base:
 - a. Schlage Lock
 2. Optional:
 - a. Sargent Manufacturing
 - b. Stanley Security Solutions/Best Access Systems
- G. Exit Devices:
1. Base:
 - a. Von Duprin
 2. Optional:
 - a. Sargent Manufacturing
 - b. Precision Hardware
- H. Architectural Exit Devices:
1. Base:
 - a. Rockwood
 2. Optional:
 - a. CR Laurence
- I. Electric Strikes:
1. Base:
 - a. Von Duprin
 2. Optional:
 - a. HES
 - b. Securitron
- J. Door Pulls, Pushplates, and Pushbars:
1. Base:
 - a. Trimco
 2. Optional:
 - a. Hager Hinge
 - b. Burns Manufacturing
 - c. Ives
 - d. Rockwood Manufacturing
- K. Architectural Minimal Pulls:
1. Base:
 - a. Rockwood
- L. Overhead Stops and Door Holders:
1. Base:
 - a. Glynn-Johnson
 2. Optional:
 - a. Sargent Manufacturing
 - b. Rixson
 - c. Rockwood
 - d. Dorma
 - e. ABH Manufacturing
- M. Door Closers:

1. Base:
 - a. LCN
 2. Optional:
 - a. Sargent Manufacturing
 - b. Stanley
- N. Kickplates:
1. Base:
 - a. Trimco
 2. Optional:
 - a. Hager Hinge
 - b. Burns Manufacturing
 - c. Ives
 - d. Rockwood Manufacturing
 - e. ABH Manufacturing
- O. Door Stops:
1. Base:
 - a. Ives
 2. Optional:
 - a. Sargent Manufacturing
 - b. Corbin Russwin Architectural Hardware
 - c. Hager Hinge
 - d. Trimco
- P. Thresholds, Head Drips, Weatherstripping, and Smoke Gaskets:
1. Base:
 - a. Reese Enterprises
 2. Optional:
 - a. National Guard Products
 - b. Pemko Manufacturing
 - c. Zero International
- Q. Access Control Devices:
1. Provided by Security System Installer.
- R. Door Position Switches (DPS):
1. Provided by Security System Installer.
- S. Other materials:
1. Base: As indicated.
- T. Other manufacturers desiring approval comply with Section 01 61 00 and submit samples of both specified item and proposed item for comparison.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Finishes and Fasteners:
1. Finishes:

Hardware Finishes				
Hardware Component	Satin Chrome Series			
	Base Metal	ANSI / BHMA	Finish Description	US Equiv.
Locksets and Latchsets	Brass/Bronze	626	Satin Chromium plated over nickel	US26D
Door Pulls, Pushbars, and Pushplates	Stainless Steel	630	Satin Stainless Steel	US32D
Kickplates and Armplates	Stainless Steel	630	Satin Stainless Steel	US32D
Exit Devices	Brass/Bronze	626	Satin Chromium plated over nickel	US26D
Hinges	Stainless Steel	630	Satin Stainless Steel	US32D
	Steel	652	Satin Chromium plated over nickel	US26D
Thresholds, Weatherstripping, Head Drips	Aluminum	719	Mill finish aluminum	US27
Door stops, holders, pivots, door edging and other unlisted items	Brass/Bronze	626	Satin Chromium plated over nickel	US26D
Patient Latches	Stainless Steel	630	Satin Stainless Steel	US32D
Exposed arms and covers of closers:	Any	689	Powder Coated, Aluminum Color	US20A

- a. Tactile Warning:
 - 1) Etched, milled, or knurled surface treatment.
 - 2) Provide on corridor-side levers of doors to loading platforms, boiler and mechanical rooms, communications and electrical closets, stages, utility stairs, and roof access.
 2. Fasteners:
 - a. Manufacture hardware to conform to templates.
 - b. Prepare for Phillips oval head machine screw installation unless directed otherwise.
 - c. Exposed screws to match hardware finish or, if exposed in surfaces of other work, to match finish of other work as closely as possible.
 - d. Fasteners in mineral core doors:
 - 1) Attachment of hinges:
 - a) Use screws, which are fully threaded (from tip to head).
 - b) For mineral core doors, use thru-bolted half surface hinges.
 - 2) Attachment of Closers:
 - a) Use through-bolts at mineral core doors.
 - b) Use fully threaded screws at doors with solid wood blocking.
 - e. Provide concealed fasteners (unless thru bolted).
 - f. Provide non-corrosive fasteners.
 3. Templates:
 - a. Provide templates to door and frame suppliers.
 - b. List template numbers on Hardware Schedule submittal for use by fabricators.
 - c. Provide copies of approved Hardware Schedule to related suppliers, fabricators, and installers.
- B. Hinges:
1. Butt Hinges:
 - a. Butts and Hinges: ANSI/BHMA A156.1
 - b. Template Hinge Dimensions: ANSI/BHMA A156.7
 - c. Self-Closing Hinges: ANSI/BHMA A156.17.
 - d. Full mortise, unless noted otherwise.
 - 1) Non-rising, flat button tips.
 - 2) Hospital tips: Psychiatric patient areas.
 - 3) Hospital tips: Inmate areas.

- 4) Non-removable pins (NRP): Provide at out-swinging exterior doors and where specifically indicated.
- e. Following table refers to manufacturer's numbers that are considered equal:

Definition of Hinge Types						
Type	Manufacturer				Description	
	Hager	Stanley	Ives	McKinney	ANSI	Remarks
1	BB1199	FB1199	5BB1HW	T4B3386 or T4A3386	A5111	Stainless Steel, Heavy Weight, 5-knuckle, 4 Ball Bearing, Non-ferrous for wet/exterior usage.
2	BB1168	FB1168	5BB1HW	T4B3786 or T4A3786	A8111	Heavy Weight, 5-knuckle, 4 Ball Bearing, Steel with Steel Pin.
3	BB1279	FB1179	5BB1	TB2714 or TA2714	A8112	Standard Weight, 5-knuckle, 2 Ball Bearing, Steel with Steel Pin
4	BB1263	FB268/78	5BB1SCHW	T4B3795 or T4A3795	A8121	Swing Clear Hinge, Heavy Weight, 5-knuckle, 4 Ball Bearing, Steel with Steel Pin
5	1250	2060R	3SP1	1552	K81071F	Spring Hinge, (single-acting), Steel, Use two Type 5 (Spring Hinges) in combination with Type 2 (Heavy Weight Ball Bearing) hinges
NOTES: Use Type where indicated. It is possible that not all Types will be needed on subject project. On openings with unequally sized pairs: Utilize same hinge model on both leaves; Hinge type listed for the larger/heavier leaf shall govern. Use the appropriate variations of the above listed Model Numbers for actual door edge style specified (i.e. Bevel or Square Edge Doors). Where Type 4 (Swing Clear) or Type 5 (Spring) hinges are called for at Exterior or wet areas: Use the Stainless Steel variations of the above listed Model Numbers.						

- f. Hinge Types according to door location and width:
- 1) Type 1 - Stainless Steel, Heavy Weight, Ball Bearing Hinge:
 - a) Exterior out-swinging doors with non-removable pins (NRP) option.
 - b) Exterior in-swinging doors.
 - c) Interior in-swinging doors to wet areas (showers, kitchens, etc.).
 - 2) Type-2 - Steel, Heavy Weight, Ball Bearing Hinge:
 - a) Interior greater than 36 inches wide.
 - 3) Type-3 - Steel, Normal Weight, Ball Bearing Hinge:
 - a) Interior less than or equal to 36 inches.
 - 4) Type-4 - Swing Clear, Steel, Heavy Weight, Ball Bearing:
 - a) Use on openings where specifically indicated or scheduled.
 - b) Upgrade to Stainless Steel for exterior and interior wet areas.
 - 5) Type 5 - Spring Hinges, Steel, Heavy Weight.
 - a) Where specifically indicated or scheduled.
 - b) Use on steel gates in stairs.
 - c) Upgrade to Stainless Steel for exterior and interior wet areas.
 - 6) Type 6 - Double-acting spring Hinges, Steel, Heavy Weight.
 - a) Where specifically indicated or scheduled.
 - b) Upgrade to Stainless Steel for exterior and interior wet areas.
- g. Hinge quantities per door leaf:
- 1) Leaves up to 60 inches: 2 hinges.
 - 2) Leaves between 61 inches and 90 inches: 3 hinges
 - 3) Leaves between 91 inches and 120 inches: 4 hinges

- 4) Leaves between 121 inches and 150 inches: 5 hinges
 - 5) Leaves taller than 151 inches: add 1 hinge for each 30 inches increase in leaf height thereafter.
- h. Hinge sizes:

Guide to Minimum Sizes of Hinges			
Door Thickness	Door Width	Minimum Hinge Height	Minimum Hinge Width
1-3/8 inches	Up to 32 inches	3-1/2 inches	3-1/2 inches
	From 32 inches to 36 inches	4 inches	
	Greater than 37 inches	4-1/2 inches	
1-3/4 inches	Up to 36 inches	4-1/2 inches	4-1/2 inches
	From 37 inches to 48 inches	5 inches	
	Over 48 inches	6 inches	
2 to 2-1/2 inches	Up to 42 inches	5 inches Heavy Weight	5 inches
	Over 43 inches	6 inches Heavy Weight	

NOTES:

1. The above is a guide to minimum sizes. Consider the actual weight of door leaf being supported and its anticipated frequency of use when determining the actual hinge height.
2. Do not exceed parameters recommended by Hinge manufacturer.
3. Unequal Pairs: Utilize same hinge size for both leaves; Hinge height stipulated for the wider leaf shall govern.
4. Increase the hinge width as required to clear door trim where used. Ensure that door, when opened 180 Degrees will not contact the applied trim.

- i. Current Conducting Butt Hinges (Electric Hinges):
 - 1) Provide where specifically scheduled.
 - 2) Do not use as a substitute method where Power Transfer devices are scheduled.
 - 3) Minimum current-carrying capacity: 3.5 amp (continuous), 16 amp (impulse).
 - 4) Number of Conductors: As required for devices served.
 - 5) Current-Conducting Butt Hinges by same manufacturer supplying non-electric butts.
 - 6) Base Product: Hager products listed above with ETW option.
2. Continuous Geared Hinges:
 - a. Provide where specifically scheduled by Hardware Sets.
 - b. ANSI/BHMA A156.26.
 - c. Heavy duty hinge (HD) assembly of three interlocking extrusions applied to full height of the door and frame without mortising.
 - d. Door leaf and jamb leaf shall be geared together for the entire length of the hinge and joined by a channel.
 - e. Mounting: Concealed (non-surface mounted) with door edge protector lip.
 - f. Hinge knuckle: Monolithic appearance. Piano hinges visible knuckle separations are not considered equivalent.
 - g. Designed to carry vertical door loads on minimum 3/4 inches acetal bearings through a full 180 degrees.
 - 1) Minimum of 32 bearings for a 7 foot length.
 - h. Template screw locations at door leaf and jamb leaf to simplify replacement.
 - i. Base Products: 224HD by Ives.

- j. Optional Products:
 - 1) FMHD by Pemko
 - 2) MCK-25HD by McKinney
 - 3) 780-224HD by Hager.
 - 4) 662HD by Stanley.
 - k. Openings with electrified hardware:
 - 1) Utilize transfer methods specified in individual Hardware Sets.
 - 2) Where Power Transfer devices are scheduled:
 - a) Factory machine cut-outs in hinge leaves to accommodate electric Power Transfer (EPT) devices.
 - 3) Where Continuous Geared Electric Hinges are scheduled:
 - a) Supply continuous hinges as described above and additionally having integral, through-wire conductors.
 - b) Minimum current-carrying capacity: 3.5 amp (continuous), 16 amp (impulse).
 - c) Number of Conductors: As required for devices served.
 - d) Base Product: 224HD-TW by Ives.
- C. Power Transfer:
- 1. Concealed: Mortised into edge of door and frame.
 - a. UL listed.
 - b. 18 gauge conductors.
 - c. Determine number of conductors as required by application.
 - 2. Finish: Match finishes indicated for hinges.
 - 3. Base Product:
 - a. CEPT-10 by Securitron.
- D. Automatic Flushbolts (AFB):
- 1. Include Rub/Strike Plate on active door leaf.
 - 2. Include Dustproof Strikes with bottom rod.
 - 3. Base Products:
 - a. FB31P at metal doors.
 - b. FB41P at wood doors.
- E. Constant Latching Flushbolts (CLFB):
- 1. Include Rub/Strike Plate on active door leaf.
 - 2. Include Dustproof Strike.
- F. Manual Flushbolts (MFB):
- 1. Include Dustproof Strikes.
- G. Dustproof Strikes:
- 1. Base: Ives DP2.
 - 2. Include with Flushbolts.
- H. Door Coordinators:
- 1. Base: Ives, COR Series.
 - 2. Optional: Door Controls, 600 Series.
 - 3. Provide where indicated.
 - 4. Provide where Astragals are used.
 - a. Exceptions:

- 1) Coordinators are not required at double egress pairs.
 - 2) Coordinators are not required where Manual Flushbolts are used.
 - b. Provide where Automatic and Constant Latching Flushbolts are used.
 5. If coordinator is provided for door which has stop which lacks enough surface area to allow proper mounting, provide mounting accessories.
 6. Provide solid shim or other fascia piece that will result in surface being flush with edge of coordinator.
 7. Provide filler sections as required to finish opening.
- I. Cylinders:
1. ANSI/BHMA A156.5 Grade 1.
 2. Material: Brass or bronze, stainless steel, or nickel silver.
 3. Finish: Match lock mechanism to which cylinders are installed.
 4. Cylinder Type: Interchangeable cores.
 5. IC Format: Small Format Interchangeable Cores (SFIC) matching Best, Falcon, etc.
 6. Cylinder Mechanism:
 - a. Top row consisting of 6-pin tumblers plus additional side biting.
 7. Key Control:
 - a. Restrictive.
 8. Determine key type required to suit locking mechanism. Include appropriate trim rings, cams, tail pieces, and adaptors.
 9. Patented cylinders and keys to protect against unauthorized manufacture.
 10. Provide cylinders for all locking mechanisms scheduled.
 11. Base Product (proprietary to match existing facility):
 - a. Coordinate with City of Lincoln.
- J. Keys:
1. Material: Nickel silver
 2. Stamping: Permanently inscribe each key with a control number and the following: DO NOT DUPLICATE.
 3. Quantity: In addition to one extra blank key for each lock, provide the following:
 - a. Cylinder Change Keys: 3
 - b. Master Keys: 6
 - c. Grand Master Keys: 6
 - d. Great-Grand Master Keys: 6
- K. Mortise Locks and Latches:
1. ANSI/BHMA-A156.13, Series 1000, Operational and Security Grade-1.
 2. Mortise with antifriction latch bolt with 3/4 inch throw and deadbolt with 1 inch throw.
 3. Sectional trim.
 4. Sectional trim unless otherwise specified.
 5. Full escutcheon trim unless otherwise specified.
 6. Backset: 2-3/4 inches.
 7. Base Product: L Series by Schlage.
 8. Optional Products:
 - a. 8200 Lever Lock by Sargent Manufacturing
 - b. 40H by Best
 9. Lever Style: 06 design
 10. Functions as indicated in Hardware Sets and in accordance with ANSI/BHMA-A156.13.

L. Cylindrical Locks and Latches:

1. ANSI/BHMA-A156.2, Series 4000, Grade 1.
2. Heavy duty cylindrical with latch bolt throw as follows:
 - a. Single doors: 1/2 inches minimum, or as otherwise required by fire label.
 - b. Pair doors: 3/4 inches minimum, or as otherwise required by fire label.
 - c. Backset: 2-3/4 inches.
3. Base Product: ND Series by Schlage.
4. Optional Products:
 - a. 10-Line by Sargent Manufacturing
 - b. 9K by Best
5. Lever Design: Rhodes lever.
6. Functions as indicated in Hardware Sets and accordance with ANSI/BHMA-A156.2.

M. Electrified Locksets:

1. Furnish from the same manufacturer as mechanical locks and latch sets.
2. Match trim style and finish of mechanical locks and latch sets.
3. Furnish electrical lock function and associated electrical components to perform as indicated in the operational description for each electrified hardware set.
 - a. Electrified Mortise Locksets:
 - 1) Base Product: L9080 by Schlage.
 - 2) Optional Products: 8200 Series by Sargent Manufacturing; 47HW Series by Best.
 - b. Electrified Cylindrical Locksets:
 - 1) Base Product: ND96 by Schlage.

N. Auxiliary Deadbolts:

1. ANSI/BHMA A156.5, Grade 1.
2. Lock Throw: 1 inch minimum, or as otherwise required by fire label.
3. Backset: 2-3/4 inches (unless otherwise indicated).
4. Classroom Function: Keyed on one side, thumbturn on the other can only retract bolt.
5. Function ANSI F16: Keyed on both sides.
6. Function ANSI F17: Keyed on one side, thumbturn on the other.
7. Function ANSI F18: Keyed on one side, no trim on the other.
8. Door Bolt Function: Thumbturn on one side, no trim on the other.
9. Privacy Function: ANSI F17 with OCCUPIED indicator.
10. Base Product: B600/700/800 Series Commercial Grade Auxiliary Locks by Schlage.

O. Exit Devices:

1. ANSI/BHMA-A156.3, Grade 1
2. Include cylinders at lockable exit devices.
3. Lever Trim: Match lever style specified for Locks and Latches.
4. Offset Pull Style: 1 inch diameter; 8190-0 by Ives/Von Duprin.
5. Fire Rated Openings:
 - a. Use fire rated exit devices.
6. Non-rated Openings:
 - a. Use doggable devices UL-listed for accident hazard.
 - 1) Exception 1: Omit dogging or use fire rated devices at Smoke Partitions.
 - 2) Exception 2: Omit dogging or use fire rated devices where openings include Card Readers and dogging could compromise ability to secure the opening.

7. Vertical Rod Exit Devices:
 - a. Exterior Openings:
 - 1) Include bottom rods and floor strikes.
 - b. Interior Openings greater than 90 minutes:
 - 1) Include bottom rods and floor strikes.
 - c. Interior Openings 90 minutes or less:
 - 1) Provide LBR (Less Bottom Rod) devices where allowed by fire label.
 - 2) Include thermal pins, as required by fire label for LBR devices.
 - d. Where exposed bottom rods are required: Protect rods with rod and latch guards.
 - 1) Base product: RG-27 by Von Duprin.
 8. Electrified devices:
 - a. Include concealed Power Transfer devices where electrified Exit devices are scheduled.
 - 1) Select Power Transfer models having required number of conductors and conductors of the wire gauge recommended for the device served.
 - b. Include Power Supply as required.
 9. Base Products - Push Pad type (smooth-case): 98 Series by Von Duprin; Except 35 Series for narrow stile doors.
 - a. Optional Products: 88-Series by Sargent Manufacturing; Apex 2000 Series by Precision.
 10. Base Products - Push Pad type (grooved-case): 99 Series by Von Duprin; Except 33 Series for narrow stile doors.
 - a. Optional Products: 88-Series by Sargent Manufacturing; Apex 2000 Series by Precision.
 11. Architectural Exit Devices
 - a. Base Product:
 - 1) PDU 8500 by Rockwood
 - a) ANSI/BHMA A156.3, Grade 1
 - b) ANSI/BHMA A156.41
 - c) CAN/ULC-S132
 - 2) Finish: US 32DMS
 - a) Infill: Black Gloss paint
- P. Strikes:
1. Provide manufacturer's standard strike for each latching/locking mechanism.
 - a. Finish: Match latch/lock device.
 2. Standards:
 - a. Strikes for Bored Locks and Latches: ANSI/BHMA A156.2.
 - b. Strikes for Mortise Locks and Latches: ANSI/BHMA A156.13.
 - c. Strikes for Auxiliary Deadlocks: ANSI/BHMA A156.5.
 3. Strike Lip:
 - a. Curved lip extended to protect frame.
 - b. Locks with 3-piece antifriction latch bolts: Flat-Lip Strikes.
 - c. Locks used on frames with applied wood casing trim: Extra-Long-Lip Strikes.
 4. Provide manufacturer's standard Wrought Strike Box for each latching/locking mechanism.
 5. Provide specially fabricated Strike Boxes where set in aluminum framing.
- Q. Electric Strikes:
1. ANSI/BHMA A156.31 Grade 1.

2. UL listed for continuous duty.
 3. Field selectable voltage: 12/24 VDC.
 4. Field selectable operation: Fail Safe (FS)/Fail Secure (FSE).
 5. Latch bolt Monitor Switch where indicated.
 6. Coordinate model number with door and frame configuration and lock type.
 7. Base Product:
 - a. 6200 Series by Von Duprin.
 8. Optional Product:
 - a. 1006 Series by HES.
 - b. ES-4 & ES-5 by Stanley
- R. Door Pulls, Pushplates and Pushbars:
1. ANSI/BHMA A156.6.
 2. Door Pull (straight):
 - a. Tubular metal; 1.25 inch diameter
 - b. Size: 16 inches (CTC)
 - c. Base Product: Rockwood RM3701
 3. Architectural Pull:
 - a. Tubular metal; 1.25 inch diameter
 - b. Size: 30 inches (CTC)
 - c. Base Product: Rockwood RM3701
 4. Pushplate:
 - a. Flat metal plate; 1/16 inches thick.
 - b. Size: 3-1/2 X 15 inches.
 - c. Base Product: Trimco 1001-2.
 - d. Optional Product: Ives 8200.
 - e. Provide cutouts as required for cylinders, deadbolts, etc.
 5. Pushplate (half circular):
 - a. Flat metal plate; 1/16 inches thick.
 - b. Size: 8 X 16 inches.
 - c. Base Product: Trimco 1041-4.
 6. Pushbar:
 - a. Tubular metal; 1.25 inch Diameter.
 - b. Size: Length as required by door width.
 - c. Base Product: Rockwood RM3701
- S. Architectural Minimal Pull
1. Base Product: Rockwood RM751
 - a. Finish: US32D
- T. Door Closers (surface applied):
1. General:
 - a. ANSI/BHMA A156.4, Grade 1.
 - b. UL listed for use on fire doors.
 - c. Body Material: Cast iron.
 - d. Size door closers to comply with manufacturer's recommendations for door sizes, locations, and accessibility requirements for opening force.
 - e. Adjust closer to meet accessibility requirements for opening force and closing speed.

- f. Supply arms, brackets, and plates, as required.
 - g. Mount closers on room side of corridor doors unless conditions prohibit such mounting.
 - h. Integral back checks.
 - i. Include limiting cushion stop at exterior, out-swinging doors.
- 2. Base Products:
 - a. Models 4011 and 4111 by LCN.
 - b. Models 4041 and 4041XP by LCN.
- 3. Optional Products:
 - a. 281 Series by Sargent Manufacturing.
 - b. QDC100 Series by Stanley.
 - c. 9500 Series by Norton.
- U. Door closers for Section 08 17 00 integrated doors.
 - 1. Base Product: LCN 3030 or 4040.
 - 2. Other closer manufacturers submit templates to manufacturer for machining.
- V. Automatic Doors:
 - 1. Swinging Doors:
 - a. Automatic Operators, Motion Sensors, Wall Switches, Presence Sensors for Automatic Swinging Doors: Specified in Section 08 71 13.
 - b. Balance of Hardware specified in this Section and scheduled in Section 08 06 71.
 - 2. Sliding Doors:
 - a. Aluminum Frames, Door Panels, Tracks, Operators, Motion Sensors, Wall Switches, Presence Sensors, Electric Locking Mechanisms, Exit Devices, and other elements of automatic sliding door package units: Specified in Section 08 42 29.
 - b. Balance of Hardware specified in this Section and scheduled in Section 08 06 71.
- W. Door Trim and Protectives:
 - 1. Kickplates and Armorplates:
 - a. ANSI/BHMA A156.6, Type J100.
 - b. Material: Stainless Steel; 0.050 inches thick.
 - c. Material: Plastic Laminate, 1/8 inches thick, color as selected.
 - d. Height:
 - 1) Kickplates: 8 inches high.
 - 2) Armorplates: 34 inches high.
 - e. Width:
 - 1) Single Doors: 2 inches less door width (LDW).
 - 2) Pair Doors: 1 inch less door width (LDW).
 - f. Bevel edge on top and sides of plates.
 - g. Coordinate installation of plates with locks and other hardware items
 - 1) Cutouts where required.
 - 2. Door Edging:
 - a. Material: Stainless Steel.
 - b. Minimum Thickness: 0.050 inches thick.
 - c. Provide where indicated in HW sets.
 - 1) Provide 1 at hinge edge and 1 at latch edge of door.
 - 2) Exception: Omit from hinge edge where continuous geared hinges are scheduled.
 - d. Height: 34 inches

- e. Provide cut-outs for hinges and similar items.
- f. Install with supplied screws.
- g. Base Product: KE31-1 by Trimco.

X. Door Holders and Stops:

1. General:
 - a. Provide Door Stop at each door leaf.
 - b. Use type as indicated in Hardware Set.
 - c. If no type is indicated, use criteria listed below.
2. Wall-mounted Door Stops:
 - a. Provide where door encounters a wall when opened 110 degrees or less.
 - 1) Wall stop is not required for times when door is used in rescue mode.
 - b. Except provide overhead type:
 - 1) Where door encounters a tile or glass wall.
 - 2) Where door encounters casework, railings, or obstructions other than a wall.
 - 3) Where door has pushbutton lockset or other hardware incompatible with wall stops.
 - c. See Sections 06 10 00 or 09 22 16 for blocking.
 - d. Base Products:
 - 1) Wood Screw, plastic anchor: WS406CCV by Ives
 - 2) Screw, drywall anchor: WS407CCV by Ives
3. Overhead Door Stops:
 - a. Provide where door could swing more than 110 degrees without encountering a wall or where door meets an exception preventing use of a wall stop.
 - b. Base Products:
4. Doors up to 45 inches wide: 450 series by Glynn Johnson
5. Doors over 45 inches wide: 90 series by Glynn Johnson
 - a. Exterior doors without a closer: 90 series by Glynn Johnson
 - b. Exterior doors with a closer: 100 series by Glynn Johnson
 - c. Lead lined doors: 90 series by Glynn Johnson
 - d. Double-acting door has no wall adjacent: 100 series by Glynn Johnson
6. Floor Stops:
 - a. Where double-acting door has no wall adjacent: FS-13 by Glynn Johnson
7. Magnetic Door Hold Open devices (MHO):
 - a. Specified with Fire Alarm System in Section 28 31 00.
 - b. MHOs are indicated in HW sets for coordination purposes.
 - c. Base Product: SEM 7830 by LCN

Y. Perimeter Seals:

1. Where door or frame is extruded aluminum, refer to Aluminum Door/Frame specifications for Perimeter Gasket products.
2. Thresholds:
 - a. ANSI/BHMA A156.6.
 - b. Material: Aluminum.
 - c. UL and ADA compliant.
 - d. Size for frame depth.
 - e. Provide required bolt cutouts.
 - f. Base Products are meant to describe design intent. Contractor to verify that models indicated are appropriate for sill conditions and finishes.

- 1) Choose from Base Product models wherever possible.
- 2) Include elevators and other adaptors where required.
- g. Base Products:
 - 1) Saddle Thresholds: S404 or S405 by Reese.
 - 2) Saddle Thresholds with Thermal-break: S282, S471 or S473 by Reese.
 - 3) Half Saddle Thresholds for offset conditions: S814, S439 or S514 by Reese.
 - 4) Panic Threshold: S248 with pile insert by Reese.
 - 5) Bumper Seal Thresholds with Thermal break: 273x292 FGPK by Pemko.
 - 6) Carpet-to-carpet conditions: S565 by Reese.
3. Weatherstripping:
 - a. ANSI/BHMA A156.22; air leakage not to exceed 0.50 cubic feet per minute per linear foot of crack when tested to ASTM E 283.
 - b. Head and Jamb Stops:
 - 1) Surface mounted, adjustable, screwed to frame stops.
 - 2) Base Product: 775 by Reese.
 - c. Sweeps:
 - 1) Base Product: 810 by Reese.
 - d. Meeting stiles of door pairs:
 - 1) Base Product: M35 by Reese.
4. Head Drip:
 - a. Provide on exterior doors other than main entrance doors.
 - b. Bed flange in sealant and screw to head of frame using non-corrosive fasteners.
 - c. Base Product: R201 by Reese.
5. Fire and Smoke Seals:
 - a. Provide approved seals to achieve the fire/smoke labels indicated for the opening.
 - b. Provide at other locations indicated to control sound, air, and light infiltration.
 - c. Performance:
 - 1) Fire Door Assemblies (other than openings also requiring smoke control):
 - a) ANSI/BHMA A156.22; air leakage not to exceed 0.50 cubic feet per minute per linear foot of crack when tested to ASTM E 283.
 - 2) Smoke- and Draft-Control Door Assemblies:
 - a) Where smoke- and draft-control door assemblies are required, provide seals that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 - b) Air Leakage Rate: Maximum air leakage of 3 cubic feet per minute per square foot at the tested pressure differential of 0.1 inches of water.
 - d. Intumescent seal (surface-applied):
 - 1) At head and jambs of openings: Pemko HSS2000.
 - e. Perimeter Gaskets:
 - 1) Base Product – Frame perimeter seals at jambs and heads:
 - a) 797 by Reese; S88 by Pemko.
 - 2) Base Product - Meeting Stiles:
 - a) 93 by Reese; 355_S by Pemko.
 - f. Astragal:
 - 1) Provide where indicated.
 - 2) Where not indicated:
 - a) Provide as required to obtain fire label.

- b) Provide on pair doors located on exterior wall.
 - c) Provide on pairs of radiation resistant doors.
 - 3) Fire Rated Openings:
 - a) Flat steel:
 - b) UL listed for labeled doors.
 - 4) Exterior Openings:
 - a) Aluminum with weatherstripping gaskets.
- 6. Isolation Seals:
 - a. Normal Duty:
 - 1) Jambs and Heads: Reese 99 or 399.
 - 2) Door Bottom: Reese 330, automatic door bottom.
 - 3) Meeting Stiles: Reese 87.
 - b. High Acoustical Performance:
 - 1) Jambs and Heads: Reese 599.
 - 2) Door Bottom: Reese 521, automatic door bottom.
 - 3) Meeting Stiles: Reese 87.
- Z. Silencers:
 - 1. Silencers are listed in Section 08 11 13 but are required as described in this Article.
 - 2. Provide Silencers at openings except those receiving perimeter gaskets such as weather, fire, fire/smoke, and sound gaskets.
- AA. Controlled Access Accessory Items
 - 1. Card Readers (OF/CI):
 - a. Furnished by Owner and installed by Contractor.
 - 2. Exit Button (EB):
 - a. Wall mounted, single gang box lock release button for emergency egress.
 - b. Momentary contacts.
 - c. Locate EB where indicated in Drawings.
 - d. Base Product: 623-RD-EX by Schlage.
 - 3. Remote Lock Release (RLR) Button:
 - a. Wall mounted, single gang box activation device.
 - b. Convenience releasing device, located remotely from opening, to release an electrified locking mechanism.
 - 1) Where used with Automatic Doors: RLR shall also activate operator to open.
 - c. Momentary contacts.
 - d. Base Product: 623-GR by Schlage.
 - 4. Remote Lock Activation (RLA) Button:
 - a. Wall mounted, single gang box activation device.
 - b. Crisis lock Actuation Device located remotely from opening, to activate and hold an electrified locking mechanism in the event of threat to facility or occupants.
 - 1) Where used with Automatic Doors: RLA shall also disable other Actuation Devices on the unsecured side.
 - c. Alternate action/Maintained contacts.
 - d. Base Product: 623-GR-AA-DP by Schlage.
 - 5. Door Position Switches (DPS):
 - a. Provided by Security System.
 - 6. Request-to-Exit (REX) motion sensors:

- a. Provide where necessary to shunt alarm.
 - b. Provided and installed by Security System Installer.
 - 7. Fire Alarm Relays:
 - a. Specified with Fire Alarm System in Section 28 31 00.
 - 8. Low Voltage Power (centrally supplied by Security System):
 - a. Unless otherwise noted, Owner's Security System will provide low voltage power required to power items with current draw less than 2 amp (24 VDC) including the following:
 - 1) Magnetic Locks.
 - 2) Electric Strikes.
 - 3) Electro-Mechanical Mortise Locksets.
 - 4) Electro-Mechanical Cylindrical Locksets.
 - 9. Power Supplies (PS) – Division 08 devices installed local to opening:
 - a. Provide filtered, regulated power.
 - b. Include relay modules that interface with Fire Alarm System.
 - c. Select power supply units that are:
 - 1) Same brand as primary devices being powered.
 - 2) Capable of receiving Fire Alarm Inputs.
 - 3) Capable of interfacing scheduled hardware with automatic operators.
 - 4) Include time delay modules where required for described function.
 - d. Electrified Exit Devices:
 - 1) Base Product: PS914 by Von Duprin.
 - 2) UL listed.
 - 3) Include options that interface with Fire Alarm and Automatic Operators.
 - e. Provide UL listed power supply units wherever Magnetic Locks, Electrified Locksets, Electric Strikes, and similar items are scheduled.
 - 1) Base Product (Electrified Locks): PS900 Series by Schlage.
 - 2) Base Product (Electric Strikes): PS900 Series by Von Duprin/Schlage.
 - 3) Base Product (Magnetic Locks): PS900 Series by Locknetics/Schlage.
- BB. Operation – Keying:
- 1. Establish keying system with Owner:
 - 2. Provide and set up complete visible card indexed system with key tags and control slips.
 - 3. Tag and identify keys and install in key cabinet.
 - 4. Master key and key in groups as directed.
 - a. Provide 6 master keys for each group.
 - 5. Key to existing master key system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Coordinate reinforcement or other preparation of doors and frames.
- C. Installation constitutes responsibility for performance.
- D. Coordinate installation power supply and communication wiring to electrically operated devices.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions, supervised or inspected by an AHC.
- B. Furnish items of hardware for proper door swing.
- C. Permanently install hardware after finishing operations are complete.
- D. Protect finishes by temporary coverings as required.
- E. Mounting Heights:

Mounting Heights of Hardware	
Item	Height ^{1,2} (to Item Centerline)
Mortise Locksets	40-5/16 inches AFF to Centerline of Strike ³
Cylindrical Locksets	
Patient Latches	
Exit Devices	
Door Pulls	42 inches AFF to Centerline of Pull
Pushplates	45 inches AFF to Centerline of Plate
Auxiliary Deadbolts	48 inches AFF to Centerline of Strike
Butt Hinges (and Pivots)	Top Hinge: Not more than 11-3/4 inches down from frame
	Bottom Hinge: Not more than 13 inches above floor
	Equally spaced between Top and Bottom Hinges. Refer to Part 2 for quantity required.
Other Items	Comply with SDI and DHI Recommendations
Footnotes/Additional Requirements: 1. Mounting Heights shall also comply with ADA and ICC/ANSI 117.1 2. Mounting Heights shall also comply with Building Code and Fire Codes. 3. Deviation from listed height will be allowed up to + 1-1/2 inches provided this does not cause a conflict between the lock and lite cutouts.	

- F. Install hardware with fasteners concealed where not required by code to be exposed.
- G. Coordinate installation of electric access control hardware.
 - 1. Hardware installer to be responsible for coordination with electrical installer for low voltage installations.
- H. Door Position Switches (DPS):
 - 1. Coordinate door and frame preparations with door and frame suppliers, and Security System installer as appropriate.
 - 2. Locate in frame head approximately 4 inches from latching door edge, unless otherwise instructed.

3.3 ADJUST AND CLEAN

- A. Adjust and check each operating item of hardware to ensure proper operation or function.
 - 1. Lubricate moving parts with lubricant recommended by manufacturer.
 - 2. Replace units which cannot be adjusted and lubricated to operate smoothly.
- B. Conversion of Construction Keying to Permanent (by Contractor):

1. Convert cylinders from Construction to Permanent configuration at time of Substantial Completion.
 2. Demonstrate conversion method to Owner's facility personnel, making certain Owner's team understands methodology.
- C. Approximately six months after substantial completion, check and readjust to assure proper function of doors and hardware.
1. Clean and lubricate operational items.
 2. Replace items which have deteriorated or failed.
 3. Prepare a written report of current and predictable problems in operation of hardware.
 4. Report visit and furnish copy of report to Owner with copy to Architect.
- D. When hardware is installed more than one month prior to final acceptance or occupancy, during week prior to acceptance or occupancy, make a final check and adjustment of hardware items.
1. Remove temporary coverings.
 2. Clean and lubricate for proper function and finish.
 3. Adjust door control devices to compensate for operation of heating and ventilating equipment.
- E. Instruct Owner's personnel:
1. Operating and maintenance procedures.
 2. Key control system.
 3. Converting cylinders from Construction to Permanent key configuration.

END OF SECTION

SECTION 08 71 13
AUTOMATIC DOOR OPERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Automatic Door Equipment – Swinging Doors, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. American Association of Automatic Door Manufacturers (AAADM).
- B. ANSI/BHMA-A156.10 Standards for Power Operated Pedestrian Doors.
- C. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electric Code.
- D. Comply with requirements of authorities having jurisdiction for doors with automatic door operators serving as a component of a required means of egress.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic door operators, including actuation and safety devices.
 - 2. Include operating characteristics, electrical characteristics, and furnished accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other work for guide rails.
 - 2. Point to point wiring diagrams showing connections to electrified hardware devices and access control system devices.
- C. Project Information:
 - 1. UL listing data.
- D. Contract Closeout Information:
 - 1. Safety inspection report.
 - 2. Operation and Maintenance Data.
 - a. See Section 01 78 23.
- E. Refer to Section 01 81 33 - Cyber Security Requirements for required cyber security related submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Automatic Swinging Door Operators:
 - 1. Base:
 - a. ASSA ABLOY
 - 2. Optional:
 - a. Horton Automatics.
 - b. Stanley Access Technologies.
 - c. NABCO Entrances.

- d. Record.
- B. Actuation and Safety Devices:
 - 1. Base:
 - a. BEA.

C. Other manufacturers belonging to AAADM desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure, normal traffic load for type of occupancy indicated and in compliance with UL 325.
- B. Coordinate operator mechanisms with door operation, hinges, and actuation and safety devices.
- C. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
- D. Maximum Opening Force if power fails:
 - 1. Not more than 30 pounds of force to manually set door in motion.
- E. Units Scheduled on Exterior Openings:
 - 1. Wind Load Resistance:
 - a. Provide door operators on exterior doors that will open and close doors and maintain them in fully closed position when subjected to prevailing wind forces.
 - b. Adjust in field to suit localized variation in wind pressure.
- F. Operating Temperature:
 - 1. Designed to operating within temperature ranges of -22 to 122 degrees F.
- G. Operator Covers:
 - 1. Fabricated extruded or formed aluminum extending continuously over full width of door opening including door jambs.
 - a. Minimum sheet thickness: 0.156 inches.
 - 2. Include end caps, provision for maintenance access, and concealed fasteners.
- H. Brackets and Reinforcements:
 - 1. Manufacturer's standard, fabricated from aluminum with non-staining, non-ferrous shims for aligning system components.
- I. Aluminum:
 - 1. Sheet: ASTM B206.
 - 2. Extrusions: ASTM B221.
- J. Fasteners and Accessories:
 - 1. Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.

2.3 LOW ENERGY DOOR OPERATORS

- A. General: Install operators at vestibule doors in sequence on the side of the door facing into the vestibule.
 - 1. Electro-mechanical operator, powered by Minimum 1/8 hp, continuous duty.
 - a. Voltage: 110-120 VAC; less than 2 Amp.

2. Factory-assembled and sealed unit including helical gear drive transmission and interconnected rack and gear system for compression heavy duty spiral spring.
 - a. Housing enclosure: Die cast aluminum housing.
 - b. Spring: Replaceable.
 - c. Mount operator using vibration isolators.
 3. Operation:
 - a. Power-open/Spring-close.
 - b. Operate as door closer in event of power failure.
 - c. Include safe swing circuit that stops and reverses door if sensing device is activated while door is in opening cycle.
 - d. Both OPEN and CLOSE speeds adjustable.
 - e. Include clutch that permits frequent manual use of opening without detrimental wear on operator.
 4. Electronic Controls:
 - a. Self-contained, solid state integrated circuit controlling operation and switching of the operator.
 - b. Integral low voltage power supply for actuators.
 - c. Time Delay (1.5 to 30 seconds) for normal cycle, as well as the following built in features:
 - 1) Torque limiting for controlled forces on opening.
 - 2) Acceleration control for smooth starts and recycle.
 - 3) Special circuitry for reducing power to the motor when door is in HOLD-OPEN mode, extending longevity and assuring reliability.
 - d. Provide actuators and controls.
 - e. Provide automatic lock interface for single or pairs of door for electrified exit devices, delayed egress magnetic locks and door electric strike applications.
 - f. Provide additional interface options to operate door with the access control devices.
 5. Base Product: SW200i by ASSA ABLOY.
- B. Types of Low Energy Door Operators:
1. LPO Low Energy Operator:
 2. LPO/FDO Low Energy Fire Door Operator:
 - a. Operators and components complying with NFPA 80 a certified by a nationally recognized testing laboratory.
 - b. Function - Fire Alarm
 - 1) Disconnect from power source by Fire Alarm.
 - 2) Self-close and self-latch by Fire Alarm.
 - 3) Operators shall not re-open doors until Fire Alarm has been reset.
 - c. Function - Loss of Power: Self-close and self-latch upon loss of power.
 3. Power-assist Operators – PAO:
 - a. Non-rated Openings:
 - 1) Capable of sensing when user attempt to manual open door; then responding by assisting User.
 - b. Fire-rated Openings and Smoke-rated Openings:
 - 1) Capable of sensing when user attempt to manual open door; then responding by assisting User.
 - 2) Operators and components complying with NFPA 80 as certified by a nationally recognized testing laboratory.
 - 3) Function - Fire Alarm

- a) Disconnect from power source by Fire Alarm.
- b) Self-close and self-latch by Fire Alarm.
- c) Operators shall not re-open doors until Fire Alarm has been reset.
- 4) Function - Loss of Power: Self-close and self-latch upon loss of power.

2.4 OPERATOR FINISHES SCHEDULE

- A. Interior Operators:
 - 1. Finish on exposed components: Matching Door and Frame.
- B. Exterior Operators:
 - 1. Finish on exposed components: Matching Door and Frame.

2.5 ACTUATION DEVICES

- A. Touchless Wall Switch (TWS):
 - 1. Contact free, microwave technology.
 - 2. Adjustable: 4 to 24 inches.
 - 3. Face plate engraved with ADA symbol and WAVE TO OPEN text.
 - 4. Shape:
 - a. Double gang square.
 - 5. Mount center line of switch 40 inches above floor.
 - 6. Locate where indicated in drawings.
 - 7. Base Product: MS31 by BEA.
 - a. Color: Black.
- B. Wall switches (WS):
 - 1. Momentary contact type.
 - 2. Remote radio controlled.
 - 3. Face plate engraved with ADA symbol and PUSH TO OPEN text.
 - 4. 4-3/4 inches square design.
 - a. Base Product: 10PBS by BEA.
 - b. Base Product: Panther10EMS475by BEA.
 - 5. 4-3/4 inches round design.
 - a. Base Product: 10PBR by BEA.
 - b. Base Product: Panther10EMR475by BEA.
 - 6. Narrow Style for direct mount on jambs:
 - a. Base Product: 10PBJ by BEA.
 - 7. Finish: 630 brushed stainless.
 - 8. Mount center line of switch 40 inches above floor.
 - 9. Locate where indicated in drawings.
- C. Bollards with Door Controls:
 - 1. Description: Hollow pedestal in which door actuation switches and similar items can be mounted.
 - 2. Material: Extruded Aluminum, nominal 1/8 inches wall thickness.
 - a. Finish: Powder Coating.
 - 3. Size and Shape: 6 x 6 inches square.
 - 4. Mounting Type: Surface-mounted to top of slabs with anchor plate and anchor bolts.
 - 5. Height (Surface-mounted Bollards): 42 inches AFF.
 - 6. Top Cap: Flat top.

7. Devices to be installed in Bollards:
 - a. Wall Switch
 - b. Keyswitch
 - c. Refer to plans for items required at each opening.
8. Design and Fabricate custom bollards to accommodate switches indicated.
9. Base Product: by Wikk Industries.

2.6 SAFETY DEVICES

A. General:

1. Provide on all doors with automatic operators.
2. Provide additional items as required for full compliance with ANSI/BHMA-A156.10.
3. Anti-vandalism design and concealed adjustments for zone size and sensitivity.
4. Finish to match door frame.
5. Unit capable of operating from -30 degrees F for exterior doors.
6. Provide remote control units or hand gesture technology for programming.

B. Presence Sensors:

1. Capable of sensing object motionless within door swing and inhibit operation of automatic operator until object has vacated field.
2. Time-of-Flight sensing device using laser technology.
3. Ambient light and radio frequencies shall not interfere with proximity detector operation.
4. Provide compatible lock out relay.
5. Base Product: LZR Flatscan 3D by BEA.

C. Signs:

1. Signage: As required by BHMA standard for the type of operator.
2. Transparent doors: Double sided IN-OUT decals.
3. Opaque doors: Warning signs on both sides.

2.7 MISCELLANEOUS ITEMS

A. Master Control Toggle Switch:

1. 3-positions: ON / OFF / HOLD-OPEN.
2. Mount on operator housing.

2.8 FABRICATION

- A. Fabricate exterior components to drain water passing joints and condensation and moisture occurring or migrating within operator enclosure to the exterior.
- B. Form aluminum shapes before finishing.
- C. Use concealed fasteners to greatest extent possible.
 1. Where exposed fasteners are required, use countersunk flat head machine screws, finished to match operator.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrate to accept installation.
- B. Installation constitutes acceptance of conditions and responsibility for performance.

3.2 INSTALLATION

- A. Perform complete installation of automatic door control equipment.

- B. Include electrical connections between components.
- C. Coordinate control wiring with electrical installer.
- D. Apply signage on both sides of each door and sidelite as required by ANSI/BHMA regulations and manufacturer's installation instructions.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's representative shall provide technical assistance and guidance for installation.
- B. Adjust door operators, controls, and hardware for smooth and safe operation and for weather tight closure.
- C. Before placing doors into operation, AAADM certified technician shall inspect and approve doors for compliance with ANSI/BHMA regulations.

3.4 CLOSEOUT ACTIVITIES

- A. Refer to Section 01 81 33 - Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

SECTION 08 81 23
EXTERIOR GLASS GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Exterior Glass and Glazing in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Samples:
 - 1. 12 inches by 12 inches 300 mm by 300 mm piece of each specified type of glass.
- C. Contract Closeout Information:
 - 1. Warranty.

1.3 QUALITY ASSURANCE

- A. Glass Standards:
 - 1. Flat glass:
 - a. ASTM C1036 Standard Specification for Flat Glass.
 - b. Float glass: Type I, Quality q3; and Class 1 unless otherwise indicated.
 - c. Figured glass: Type II, Quality q7, Form 3; and Class 1, Finish f1 and Pattern p2 unless otherwise indicated.
 - d. Provide Class 2 or 3 for tinted or integrally colored glass.
 - 2. Flat glass, heat treated (coated/uncoated):
 - a. Tempered safety glass: Conform to ANSI Z97.1 and CPSC 16 CFR 1201.
 - b. ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
 - c. ASTM C1651 Standard Test Method for Measurement of Roll Wave Optical Distortion in Heat-Treated Flat Glass.
 - d. Heat strengthened glass: Kind HS, Type I, Quality q3, Class 1 and Condition A unless otherwise indicated.
 - e. Tempered glass: Kind FT, Type I, Quality q3, Class 1 and Condition A unless otherwise indicated.
 - f. Heat strengthened – tempered glass: Kind HS-FT, Type 1, Quality q3 and Condition A unless otherwise indicated.
 - g. Provide Class 2 or 3 for tinted or integrally colored glass.
 - h. Provide Condition B or C for coated glass.
 - i. Distortion Tolerances:
 - 1) Heat treated flat glass by horizontal, roller hearth process with inherent roller wave distortion parallel to bottom edge of glass as installed.
 - 2) Maximum peak to valley roller wave 0.003 inches 0.080 mm in central area and 0.008 inches 0.20 mm within 10-1/2 inches 267 mm of leading and trailing edge
 - 3) Roll Wave (horizontal) distortion to maximum 0.003 inches 0.080 mm at center of panel and 0.003 inches 0.080 mm at edges of panels as measured from peak to valley.

- 4) Clear or low-iron glass 1/4 inches to 3/8 inches 6 mm to 10 mm thick without ceramic frit or ink:
 - a) Maximum plus or minus 100mD millidiopters over 95% of glass surface.
 - 5) Maximum bow and warp 1/32 inches 0.79 mm per lineal foot.
 - j. Fully tempered glass:
 - 1) Provide heat soak testing in compliance with EN14179 including 2 hour dwell at 280 degrees C – 300 degrees C.
- 3. Insulating Glass Units:
 - a. Insulating Glass Certification Council (IGCC), Class CBA.
 - b. ASTM E2190 Standard Specification for Insulating Glass Unit Performance and Evaluation.
 - c. ASTM E2188 Standard Test Method for Insulating Glass Unit Performance.
 - d. ASTM E2189 Standard Test Method for Testing Resistance to Fogging in Insulating Glass Units.
- 4. NFPA 80 Standard for Fire Doors and Windows.
- 5. ANSI Z97.1 Safety Glazing Materials Used in Buildings.
- 6. CPSC 16 CFR 1201 Federal Safety Standard for Architectural Glazing Material.
- 7. NGA GANA Glazing Manual.
- B. Glazing Standards:
 - 1. NGA GANA Glazing Manual.
 - 2. Glazing Guidelines for Sealed Insulating Glass Units, by the Insulating Glass Manufacturers Alliance (IGMA).

1.4 WARRANTY

- A. Written five (5) year warranty signed by installer to cover weather tightness of installation including air and water integrity.
- B. Written warranty signed by manufacturer or fabricator of glass units against failure.
 - 1. Include costs associated with glass replacement and installation.
 - 2. Failure is defined as excessive deterioration under normal conditions, thermal failure of insulating units, or obscured vision.
 - a. Coated glass: 10 years.
 - b. Laminated glass: 5 years.
 - c. Insulating glass (vertical): 10 years.
 - d. Insulating glass (sloped): 5 years.
 - e. Reflective spandrel: 5 years.
 - f. Pyrolytic-coated, self-cleaning glass: 10 years.
 - g. Tempered glass: Heat soaked warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Insulating Glass and Insulating Spandrel Glass Fabricators:
 - 1. Base:
 - a. Viracon
 - 2. Optional:
 - a. JE Berkowitz
 - b. Oldcastle
 - c. Technoglass

d. Trulite

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Glass:

1. Comply with indicated standards.
2. See Glass Types Schedule for listing of types.
3. Materials specified in Glass Types Schedule are minimum acceptable products.
4. Provide individual glass types used in fabrication of insulating units from single manufacturer.
5. Manufacturer or fabricator determine if materials should be heat strengthened or fully tempered at non-hazardous locations that do not require safety glazing and provide accordingly.
6. Low-E coating:
 - a. Hardcoat.

B. Glazing Compounds:

1. Non-sag and non-staining.
2. Pigmented to match frame units not requiring painting.
3. Compatible with adjacent surfaces.
4. For use in setting glass: Neutral-cure Silicone sealant.
5. Sealant tape: Butyl rubber sealant tape or ribbon having a continuous neoprene shim.
6. Gaskets:
 - a. Polyvinyl chloride or neoprene.
 - b. Extruded, flexible, of profile and hardness required to receive glass and provide a watertight installation.

C. Installation Setting Blocks and Spacers:

1. EPDM or Neoprene, compatible with sealants used.
2. Setting blocks: 80-90 durometer.
3. Spacers: 40-50 durometer.
4. Compressible filler: Closed cell jacketed rod stock of synthetic rubber or plastic foam.

D. Insulating Glass Spacers:

1. 1/2 inches 13 mm thick, nominal.
2. Aluminum, desiccant filled.
 - a. Finish: Mill.

E. Shims, clips, springs, angles, beads, attachment screws and other miscellaneous items: As indicated or required.

2.3 GLASS TYPES SCHEDULE

A. Glass Type EX-1: Provide tempering in addition to heat strengthening where required by IBC or noted on the Drawings.

1. Insulating glass; two sheets of 6 mm thick glass, hermetically sealed together at edges with spacers and sealant, with 12 mm dehydrated air space.
2. Outdoor Lite: Heat-strengthened Clear float glass with Guardian SNR35 on Surface #2.
3. Interspace Content: 90% Argon.
4. Indoor Lite: Heat-strengthened Clear float glass.

5. Visible Light Transmission (VLT): 33% minimum.
6. Winter Nighttime U-Factor: 0.24 maximum.
7. Summer Daytime U-Factor: 0.21 maximum.
8. Solar Heat Gain Coefficient (SHGC): 0.17 maximum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing or glazing channel surfaces, backing, stop design, and conditions under which glazing is to be installed.
- B. Field verify glass size for each opening, within tolerances and dimensions established.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Comply with NGA GANA Glazing Manual and IGMA Glazing Guidelines for Sealed Insulating Glass Units.
- C. Do not install glass with edge damage.
- D. Install setting blocks in adhesive or sealant.
- E. Provide spacers inside and out, of proper size and spacing, for glass size, except where gaskets are used for glazing.
- F. Minimum Bite:
 1. 6 mm monolithic units: 10 mm.
 2. 25 mm insulating units: 12 mm.
 3. For other sizes: Refer to Table C of AAMA's Aluminum Curtain Wall Design Manual, Volume 6, Glass & Glazing.
- G. Sealant Depth: Equal to sealant width.
- H. Miter cut and bond gasket ends together at corners.
- I. Remove and replace damaged glass.
- J. Ensure that weep system in frames is not blocked by sealant.

3.3 CLEANING AND PROTECTION

- A. Wash and polish glass on both faces not more than 7 days prior to final completion of work.
- B. Comply with glass manufacturer's recommendations and NGA GANA 01-0300.

END OF SECTION

SECTION 08 81 26
INTERIOR GLASS GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Interior Glass and Glazing in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.

1.3 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Glass Standards:
 - a. ANSI Z97.1.
 - b. CPSC 16 CFR 1201.
 - c. NGA GANA Glazing Manual.
 - 2. Flat Glass:
 - a. ASTM C1036 Standard Specification for Flat Glass.
 - b. Float glass: Type I, Quality q3 and Class 1 unless otherwise indicated.
 - c. Figured glass: Type II, Quality q7, Form 3 and Class 1, Finish f1 and Pattern p2 unless otherwise indicated.
 - d. Mirror glass and one-way vision glass: Type I, Quality q1 or q2, Class 1 and coated for purpose.
 - 3. Flat Glass, Heat Treated, Coated and Uncoated:
 - a. ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
 - b. Heat strengthened glass: Kind HS, Type I, Quality q3, Class 1 and Condition A unless otherwise indicated.
 - c. Tempered glass: Kind FT, Type I, Quality q3, Class 1 and Condition A unless otherwise indicated.
 - d. Heat strengthened – tempered glass: Kind HS-FT, Type 1, Quality q3 and Condition A unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Glass Products:
 - 1. Base:
 - a. AGC Industries
 - 2. Optional:
 - a. Guardian Industries
 - b. Pilkington
 - c. Vitro Glass
 - d. Saint-Gobain

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Glass Materials:

1. Comply with indicated standards.
2. See Glass Types Schedule for listing of types.
3. Materials specified in Glass Types Schedules are minimum acceptable products.
4. Manufacturer or fabricator determines if materials should be heat strengthened or fully tempered at non-hazardous locations that do not require safety glazing and provide accordingly.

B. Glazing Compounds:

1. Non-sag, non-stain type.
2. Pigmented to match frame units not requiring painting.
3. Compatible with adjacent surfaces.
4. For use in setting glass: Neutral-cure Silicone sealant.
5. Sealant tape:
 - a. Butyl rubber sealant tape or ribbon having a continuous neoprene shim.
6. Gaskets:
 - a. Polyvinyl chloride or neoprene.
 - b. Extruded, flexible, of profile and hardness required to receive glass and provide a watertight installation.

C. Installation Setting Blocks and Spacers:

1. EPDM or Neoprene, compatible with sealants used.
2. Setting blocks: 80-90 durometer.
3. Spacers: 40-50 durometer.
4. Compressible filler stock: Closed cell jacketed rod stock of synthetic rubber or plastic foam.
5. Shims, clips, springs, angles, beads, attachment screws and other miscellaneous items: As indicated or required.

2.3 GLASS TYPES SCHEDULE

A. Refer to Interior Glass Types Schedule for basic description of mark numbers indicated on Drawing.

B. Refer to Drawings for depiction of unit sizes and locations.

C. Upgrade basic type conditions in accordance with following rules:

1. Heat treatment upgrade based on physical size of unit:
 - a. Heat strengthened or fully tempered units between 55 and 70 square feet 5 and 6.5 square meter.
 - b. Fully temper units exceeding 70 square feet 6.5 square meter.
 - c. Strengthen annealed glass where units exceed length or width limitations, or both as recommended by glass manufacturer.
2. Heat treatment upgrade based on locations which are potentially hazardous to occupants:
 - a. Upgrade units to fully tempered, Kind FT, glass as required by any one of the following:
 - 1) When required by local Codes.
 - 2) When specifically indicated on Drawings.
 - b. Locations requiring Safety Glass, Kind FT, by 16 CFR 1201 and ANSI Z97.1:

- 1) Units installed in doors, sash, transom, or other operable units.
 - 2) Units where any part of unit is within 18 inches 450 mm, measured vertically, above a floor line, sidewalk, paver, or other walking surface located within 3 feet 900 mm of the glass unit, measured horizontally.
 - 3) Units in sidelights and other units located adjacent to and within 48 inches 1.2 m of either jamb of door or other operable units; this includes adjacent lites that are in perpendicular plane to door.
3. Other conditions requiring heat treatment upgrades:
- a. Units which will be exposed to irregular sun or shade combinations, or both, shall be Kind HS or better.
 - b. Where glass manufacturer recommends heat treatment coatings or tints specified.
 - c. Where required to resist lateral loads.

2.4 INTERIOR GLASS TYPES SCHEDULE

- A. Type **A** - Annealed:
1. Clear float, 6 mm thick.
- B. Type **T** - Tempered:
1. Clear tempered float.
 2. Thickness: 6 mm.
- C. Type **HT** - Heat strengthened (soaked) tempered glass:
1. Clear heat strengthened tempered float.
 2. Thickness: 13 mm.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing or glazing channel surfaces, backing, stop design, and conditions under which glazing is to be installed.

3.2 INSTALLATION

- A. Do not install glass with edge damage.
- B. Contractor is responsible for correct glass size for each opening, within tolerances and dimensions established.
- C. Comply with recommendations of manufacturers, except where more stringent requirements are indicated.
- D. Comply with NGA GANA Glazing Manual.
- E. Install sealants as recommended by sealant manufacturer.
- F. Install setting blocks in adhesive or sealant.
- G. Provide spacers inside and out, of proper size and spacing, for glass size, except where gaskets are used for glazing.
- H. Minimum Bite:
1. Monolithic, 6 mm glass: 10 mm minimum bite.
 2. For other sizes: Refer to Table C of AAMA's Aluminum Curtain Wall Design Manual, Volume 6, Glass and Glazing.
- I. Sealant Depth: Equal to sealant width.
- J. Prevent sealant exudation from glazing channels.
1. Leave void at heel or install filler at jambs and head.

- 2. Do not leave void or install filler at sill.
- K. Miter cut and bond gasket ends together at corners.
- L. Immediately after installation, attach crossed streamers to framing held away from glass.
- M. Do not apply anything to surfaces of glass.
- N. Remove and replace damaged glass.

3.3 CLEANING AND PROTECTION

- A. Wash and polish glass on both faces not more than 7 days prior to final completion of work in each area.
- B. Comply with glass manufacturer's recommendations and NGA GANA 01-0300.

END OF SECTION

SECTION 08 87 33
DECORATIVE FILMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Decorative Film, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM E84 - Standard test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E 903 - Standard Test Method for Solar Absorbance, Reflectance, and Transmittance of Materials Using Integrating Spheres.

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Scale elevations showing layout, profiles, and product components, including dimensions, anchorage, and accessories.
- C. Samples:
 - 1. Standard size samples of each specified texture, color, and pattern.
- D. Project Information:
 - 1. Manufacturer's data sheets for products specified, including:
 - a. Preparation instructions and recommendations.
 - b. Storage and handling requirements and recommendations.
 - c. Installation methods.
- E. Contract Closeout Information:
 - 1. Operation and Maintenance data for installed products, including precautions against harmful cleaning materials and methods.
 - 2. Warranty.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Minimum ten years of experience in manufacture of decorative film.
- B. Installer Qualifications:
 - 1. Trained and qualified installer, specialized and experienced in work required for this project, with minimum five years of experience installing products of same type and scope as specified.
 - 2. Products specified in this section shall be installed by a single installer.

1.5 PROJECT/SITE CONDITIONS

- A. Environmental Limitations: Do not install until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and

humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

- B. Products are not recommended for interior applications where condensation consistently occurs.
- C. Confirm appropriate substrate is suitable for mounting of glass finish components prior to start of installation.
- D. Apply materials when environmental conditions are within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
 - 1. Application temperature range is 60 deg F to 100 deg F 16 deg C to 38 deg C.

1.6 WARRANTY

- A. Manufacturer's standard warranty for a period of three years against defects in material or workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Decorative Film:
 - 1. Base: As indicated on Interior Finish Legend.
 - 2. Optional:
 - a. 3M Commercial Graphics Division.
 - b. Avery Dennison.
 - c. Olee Creative.
 - d. Solyx.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Decorative Film:
 - 1. Film Type: Polyester.
 - 2. Decorative Pattern: Printed.
 - 3. Adhesive: Acrylic, Pressure Sensitive, Permanent.
 - 4. Liner: Silicone-coated Polyester.
 - 5. Thickness (Film and Adhesive without Liner): Minimum 3 mils 76 microns.
 - 6. Fire Performance, ASTM E84: Class A.
 - a. Flame Spread: 25 maximum.
 - b. Smoke Developed: 450 maximum.
 - 7. Optical Performance tested per ASTM E903.
- B. Accessories:
 - 1. Provide as required for complete installation.
 - 2. Edge Sealer, Premasking Tape, Prespacing Tape, etc. as recommended by Decorative Film manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine glazing surfaces and conditions under which decorative film is to be installed.
- B. Field verify film size for each glass panel, within tolerances and dimensions established.

- C. Do not proceed with installation until all finishing work has been completed in and around the work area.
- D. Beginning of installation indicates acceptance of conditions and responsibility for performance.

3.2 SURFACE PREPARATION

- A. Comply with all manufacturer's instructions for surface preparation.
- B. Thoroughly clean substrate of substances that could impair the overlay's bond, including mold, mildew, oil, and grease.
- C. Re-clean surfaces with appropriate surface prep solvent and remove any haze or surface contamination.

3.3 INSTALLATION

- A. Do not install on glass with edge damage.
- B. Refer to manufacturer's installation instructions.
- C. Application must be performed by qualified installer.
- D. Verify pattern prior to material acquisition.
- E. Remove liner and wet adhesive prior to installation.
- F. Form smooth, wrinkle-free, bubble-free surface for finished installation.
- G. Remove air bubbles, wrinkles, blisters, and other defects. Use approved procedures to prevent the formation of air bubbles, wrinkles, blisters, and other defects.
- H. Cut and trim film edges neatly at uniform at a distance of 1/16 inches to 1/8 inches from edge of rebate or edge of glass at jambs, corners, and joints.
 - 1. Maintain clean cut utilizing sharp blades.

3.4 CLEANING AND PROTECTION

- A. Remove left over material and debris from work area.
- B. Touch up, repair, or replace damaged panels.
- C. Protect from damage by other trades.
- D. Clean per manufacturer's recommendations.

END OF SECTION



DIVISION 09

FINISHES



SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Non-Structural Metal Framing in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. The American Iron and Steel Institute (AISI):
 - 1. AISI S220 North American Standard for Cold-Formed Steel Framing – Nonstructural Members.
- B. ASTM International (ASTM):
 - 1. ASTM C635 Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
 - 2. ASTM C645 Standard Specification for Nonstructural Steel Framing Members.
 - 3. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - 4. ASTM C754 Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - 5. ASTM A1003 Standard Specification for Steel Sheet, Carbon, Metallic and Nonmetallic-Coated for Cold-Formed Framing Members.
 - 6. ASTM A1007 Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
- C. Gypsum Association (GA):
 - 1. GA-216 Application and Finishing of Gypsum Panel Products.
 - 2. GA-234 Control Joints for Fire-Resistance Rated Systems.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications for each type of material and accessory.
 - a. Where fire resistance classification is indicated, submit copies of nationally recognized testing laboratory listings of products proposed for use.
 - 2. Where EQ coatings are used, submit copies of nationally recognized testing laboratory results showing conformance with ASTM A653 and AISI S220.
 - a. Include data required to show specification compliance.
- B. Shop Drawings:
 - 1. Sizes and spacing of typical framing members and opening framing.
 - 2. Show locations and sizes of atypical framing members, wall framing sections, and opening elevations.
 - 3. Methods of fastening framing members to each other and to supporting systems.
 - 4. Details of vertical deflection connections to structures.
 - 5. Locations and spacing of lateral bracing and structural bracing systems.
 - 6. Accessory products required for complete installation.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Member of Certified Steel Stud Association (CSSA), Steel Framing Industry Association (SFIA), or Steel Stud Manufacturers Association (SSMA).
- B. Code-Compliance Certification of Studs and Tracks:
 - 1. Provide documentation that framing members are certified according to the product-certification program of the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Non-Structural Metal Framing:
 - 1. Base:
 - a. ClarkDietrich Building Systems
 - 2. Optional:
 - a. CEMCO Steel Framing and Metal Lath
 - b. Custom Stud Inc.
 - c. Marino/WARE
 - d. MBA Metal Framing
 - e. MRI Steel Framing LLC
 - f. Telling Industries
 - g. The Steel Network
- B. Flexible Track:
 - 1. Base:
 - a. ClarkDietrich Building Systems
 - 2. Optional:
 - a. The Steel Network
 - b. Flex-Ability Concepts
- C. Isolation Strip Material:
 - 1. Base:
 - a. Reflectix, Inc.
 - 2. Optional:
 - a. Saint-Gobain
- D. Knee Wall Brace:
 - 1. Base:
 - a. Pittcon Industries
 - 2. Optional:
 - a. ClarkDietrich Building Systems
- E. Interlocking Grid Support Systems for Gypsum Board Ceilings:
 - 1. Base:
 - a. USG Corporation
 - 2. Optional:
 - a. Armstrong
 - b. Chicago Metallic

- F. Products proposed for use in fire-rated assemblies:
1. Approved by nationally recognized testing laboratory.
- G. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Select steel studs in accordance with manufacturer's standard load tables and following design pressures and maximum deflections:

Performance Criteria		
Use Condition ²	Design Pressure	Maximum Deflection
Wall enclosing stairs, elevator hoistways, and other vertical shafts	10 psf 480 Pa	L/240
Wall enclosing vestibules, ground floor lobbies, and similar spaces subject to intermittent exposure to exterior wind conditions	15 psf 720 Pa	L/240
Walls scheduled with Tile Backer Board, Moisture-Resistant, Impact-Resistant, or Abuse-Resistant Gypsum Wallboard	5 psf 240 Pa	L/360
Walls scheduled to receive Tile, lath and plaster, or veneer plaster. ¹		L/360
Typical Interior Walls/Partitions (those not listed above)	5 psf 240 Pa	L/240
Interior Ceilings, Soffits and Bulkheads	5 psf 240 Pa	L/360

Footnotes

1. Limit deflection to L/360 where wall cladding on either face is any of the following: Ceramic Tile, Stone Tile, Porcelain Tile, Thin Brick, Lath & Plaster, Simulated Masonry, Adhered Stone, Veneer Plaster, and similar brittle finishes which are prone to movement induced cracking.
2. Where elements meet multiple conditions; Use most stringent Deflection and Design Pressure values.

2.3 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Metal Studs and Floor Tracks:
1. C-shaped, roll formed studs and tracks conforming to ASTM C645.
 2. Steel design standard: 33KSI 227 MPa.
 3. Galvanized: G40 or G40EQ conforming to ASTM A653 and AISI S220.
 4. Stud and track depths: As indicated by wall type.
 5. Minimum flange width: 1-1/4-inch 6 mm.
 6. Minimum thickness: 30 mil (20 GA) 0.752, except as follows:
 - a. Increase member thickness to comply with performance criteria.
 - b. Decrease member thickness to minimum 18 mil (25 GA) 0.46 mm studs at following condition:
 - 1) Where walls do not extend to overhead structural deck and supporting diagonal bracing or horizontal stiffeners are used.
 7. In lieu of increased member thickness, design may employ diagonal braces above ceiling to reduce overall span.
 - a. Coordinate locations with building services items.
 - b. Do not employ studs with member thickness less than allowed by fire resistance rated assemblies.
 8. High strength 50 ksi 345 MPa or 70 ksi 483 MPa studs shall comply with design criteria of equivalent thickness standard 33 ksi 227 MPa studs listed.

9. At walls designated STC 40 and above, use only studs with physical characteristics of studs used in documented STC testing.
 10. Base product: ProSTUD Drywall Framing by ClarkDietrich.
- B. Flexible Track:
1. Adjustable segmented track fabricated from same material, gauge, and width as specified for straight track.
 2. Use at curved walls and soffits.
 3. Base product: 360Trak by ClarkDietrich.
- C. Head of Wall Accessories:
1. Configure to accommodate deflection of superstructure without inducing axial loading on partition wall.
 2. Maintain structural integrity, fire and smoke-resistance, and sound control as required by each wall.
 3. Slotted top deflection track:
 - a. Deep leg, vertically slotted track.
 - b. Cold-formed sheet steel; galvanized; G60.
 - c. Thickness: 30 mil (20 GA) 0.752 mm minimum.
 - d. Width: As required for stud sizes indicated.
 - e. Depth: Minimum 2-1/2-inch 63 mm down-standing legs with 1/4-inch 6 mm wide by 1-1/2-inch 38 mm high slots spaced 1 inch 25 mm on center.
 - f. Base product: MaxTrak by ClarkDietrich.
 4. Z-bars, cold formed channels, and clips:
 - a. Accommodate thickness of spray-applied fire-resistive materials.
 5. UL-listed fire-resistant components tested for compliance with requirements indicated.
 6. Firestopping Materials:
 - a. Sealants, sprays, intumescent strips and forming materials.
 - b. Coordinate with sealants specified in Section 07 84 00 and Section 07 92 16.
 - c. Intumescent applications:
 - 1) Factory or field applied.
 - d. Base product: BlazeFrame by ClarkDietrich.
- D. Shaftwall Framing:
1. C-T or C-H shaped studs with U or J shaped tracks.
 2. Material: Galvanized steel; G40 or certified equivalent.
 3. Thickness: 30 mil (20 GA) 0.752 mm minimum.
 4. Size: 2-1/2, 4, and 6 inches 63, 100, and 150 mm minimum as indicated.
 5. Structural design criteria:
 - a. Select stud with properties necessary to limit deflection to L/240 deflection at load of 10 psf 480 Pa.
 - b. Use larger size and thickness to satisfy span and deflection criteria.
 6. Shaftwall assembly with gypsum wallboard specified in Section 09 29 00:
 - a. Fire resistance tested in accordance with ASTM E119.
 - b. Sound transmission loss: Tested in accordance with ASTM E90.
 7. Base product: Shaftwall System by ClarkDietrich.
- E. Z-Bar Standoff Clips:
1. 30 mil (20 GA) 0.752 mm galvanized steel.

2. Provide Z-bars for attachment of top track to superstructure elements which are to be protected with sprayed fireproofing.
 - a. Size: 2 by 2 by 2 inch 50 mm x 50 mm x 50 mm.
 3. Length:
 - a. As required to accommodate beam and deck fireproofing.
 - 1) At structural steel member: Length equal to flange width of structural steel member.
 - 2) At steel deck: Minimum length equal to partition width, or as required to span steel deck flutes.
 - b. Extend length of Z-bar to accommodate partition offset that will not clear fireproofed steel beam.
- F. Furring Channels:
1. Hat shaped sections.
 2. Galvanized: G40 or certified equivalent.
 3. Sizes: 7/8 inch 22 mm and 1-1/2 inch 38 mm, as indicated.
 4. Minimum Thickness: 30 mil (20 GA) 0.752 mm; Use heavier gauge as dictated by conditions.
 5. Base product: Furring Channel/ Hat Channel by ClarkDietrich.
- G. Metal Backing:
1. General:
 - a. See Drawings for applications of backing types listed and further details.
 - b. Use heavier gauge as necessary for items to be supported.
 - c. Comply with manufacturer's backing requirements if capacity exceeds types listed.
 2. Flat Plate (Type A):
 - a. Flat, sheet metal stock per ASTM A1008.
 - b. G40 galvanized or certified equivalent.
 - c. Thickness: 43 mil (18 GA) 1.27 mm minimum.
 3. Metal Backing (Type B):
 - a. C-shaped modified track runners.
 - b. G40 galvanized or certified equivalent.
 - c. Backing height: 6 inches 150 mm minimum.
 - d. Flange width: 1-1/4-inch 32 mm minimum.
 - e. Thickness: 30 mil (20 GA) 0.95 mm minimum.
 - f. May be installed continuously across multiple stud spaces.
 - g. Use where no other type of backing is designated.
 4. Metal Backing (Type C):
 - a. C-shaped modified track runners.
 - b. G40 galvanized or certified equivalent.
 - c. Backing height: 8 inches 200 mm minimum.
 - d. Flange width: 1-1/4-inch 32 mm minimum.
 - e. Thickness: 54 mil (16 GA) 1.5 mm minimum.
 - f. Install at single stud space with properly oriented studs.
 5. Hospital and Laboratory casework and wall mounted medical equipment without specific backing requirements:
 - a. Type B backing as listed above with revised minimum thickness.
 - b. Thickness: 54 mil (16 GA) 1.5 mm minimum.

- 1) Use heavier gauge as necessary for items to be supported.

H. Accessory Items:

1. Wire Ties:
 - a. Minimum thickness: 43 mil (18 GA) 1.09 mm soft annealed, galvanized.
2. Track Fasteners:
 - a. Power driven type, to withstand minimum 190 pounds 86 kg shear when driven.
3. Knee Wall Brace:
 - a. Steel tube and baseplate bolted to concrete floor slab with tube projecting vertically; concealed within framed walls to provide structural stability for knee walls.
 - b. Design components compatible with wall type.
 - c. Material: Cold-rolled steel tube and base plate.
 - d. Fully welded.
 - e. Overall height: Wall height less 2 inches 50 mm.
 - f. Spacing as recommended by manufacturer.
 - g. Base product: SKB Series by Pittcon Industries.

I. Support Systems for Gypsum Ceilings:

1. Interlocking Grid Systems:
 - a. ASTM C635, direct-hung system composed of T-Shaped framing members designed to carry load of screw-applied gypsum ceiling board.
 - b. Tabs on Cross-Tees to interlock into slots in Main Runners where intersections occur.
 - c. Base Product: Drywall Suspension System by USG Corporation.
2. Track and Channel Systems:
 - a. ASTM C645 roll-formed steel with G40 galvanized coating.
 - b. Thickness: 30 mil (20 GA) 0.752 mm minimum; Use heavier gauge as dictated by conditions.
 - c. Carrying channels:
 - 1) Size: 1-1/2-inch 38 mm.
 - d. Furring channels:
 - 1) Sizes: 7/8-inch and 1-1/2-inch 22 mm x 38 mm, as indicated.
3. Stud-Framed Ceiling/Soffit Systems:
 - a. C-shaped studs or joists; roll-formed.
 - b. Galvanized: G40.
 - c. Frame member depth: 3-5/8-inch 92 mm minimum, unless otherwise indicated.
 - 1) Use wider stud sections if ceiling span and support requires.
 - d. Flange width: 1-1/4-inch 32 mm minimum.
 - e. Stud thickness: 33 mil 0.838 mm minimum.
4. Tie Wire:
 - a. ASTM A641, Class 1 zinc coating, soft temper.
 - b. Diameter, single strand: 62 mil (14 GA) 1.575 mm minimum.
 - c. Diameter, double strand: 42 mil (18 GA) 1.067 mm minimum.
5. Wire Hangers:
 - a. ASTM A641, Class 1 zinc coating, soft temper.
 - b. Diameter: 97 mils (12 GA) 2.46 mm minimum.
6. Anchors in Concrete:
 - a. Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times

- that imposed by ceiling construction, as determined by testing per ASTM E488 or ASTM E1512 as applicable.
- b. Acceptable types: Cast-in-place, post-installed expansion anchors and post-installed bonded anchors.
- c. Material: Carbon-steel components zinc plated to comply with ASTM-B633, Class Fe/Zn 5 for Class SC 1 service condition.
- 7. Powder-Actuated Fasteners in Concrete:
 - a. Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E1190.
 - b. Comply with seismic design requirements where applicable.
- 8. Other items including suspension wire, tie wire, attachment devices: As specified and indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting structure and conditions under which system will be installed.
- B. Correct conditions detrimental to proper installation.
- C. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. Layout and install metal framing accurate to dimensions indicated in drawings.
- B. Installation Standards:
 - 1. ASTM C754 and ASTM C1007, except comply with framing sizes and spacing indicated.
 - 2. Gypsum Board Assemblies: Comply with additional requirements in ASTM C840 and GA-216 relative to framing installation.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, wall stops, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.
- F. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- G. Extend framing full height to structural supports.
 - 1. Exception: Where partitions are indicated to terminate at, or just above, suspended ceilings.
 - 2. Continue framing around ducts and similar items which penetrate partitions.
- H. Position studs vertically engaging floor track and head of wall deflection track.
 - 1. Align stud knockouts to facilitate running of wires and conduit.
- I. Space studs maximum 16 inches 400 mm on center.
 - 1. Stud spacing at Shaftwall: 24 inches 610 mm on center.
- J. Provide additional studs at corners, partition intersections and terminations of partitions, and at each side of control joints.
- K. Positively anchor studs to floor tracks with self-tapping pan head screws, or stud clinching tool per ASTM C754.

- L. Anchor studs to deflection track with wafer head screws on both flanges of each stud.
 - 1. Maintain deflection gap between top of stud and top of slotted track.
 - 2. Install screws at centerline of slot and secure allowing vertical movement.
- M. Anchor fire rated partitions as required by fire resistance design, and firestopping design.
- N. Where partitions abut vertical structural elements, provide perimeter relief per Gypsum Association GA-600 Strain Relief System details.
- O. Head-of-Wall:
 - 1. Provide slotted top track for walls extended to structure.
 - 2. Configure to resist lateral loads while accommodating deflection of overhead building superstructure without inducing axial loading on partition framing.
 - 3. Secure deflection track to structure in accordance with industry standards and regulatory requirements.
 - 4. Secure at corners and at ends.
 - 5. Cut vertical studs 5/8-inch 16 mm short to create a deflection gap when installed into top track.
 - a. Secure vertical studs to top track with framing screw at each stud, screwing through track slots for positive stud connection.
 - 6. Secure Gypsum Wallboard to vertical studs; do not secure Gypsum Wallboard to top track directly.
 - 7. Where partitions attach to structural elements that are scheduled to receive Spray-applied Fire Resistive Materials (SFRM):
 - a. Install Z-bar to underside of steel beams and steel deck before application of sprayed fireproofing.
 - b. Locate Z-bars perpendicular to line of partition, spaced maximum 16 inches on center.
 - c. Attach each Z-bar with two 0.145 by 1-inch 3.7 mm x 25 mm powder-actuated fasteners located minimum 1 inch from ends of Z-bar.
 - d. After fireproofing, secure top track to Z-bars with No. 8 x 5/8-inch wafer head framing screws spaced maximum 16 inches 400 mm on center.
 - 8. Where fire-rated partitions are offset and will not clear fireproofed steel beam, extend Z-bar outrigger horizontally from bottom of beam out to minimum 2 inches 50 mm beyond width of head-of-wall.
 - a. Attach 3/4 inch 19 mm expanded metal lath continuous, width of top of Z-bar outriggers prior to fireproofing steel beam to accommodate sprayed fireproofing.
 - 9. Prepare wall for installation of seals, firestopping, or both:
 - a. Fire-rated Walls: Prepare for fire-resistive joint assemblies specified in Section 07 84 00.
 - b. Non-fire rated partitions including Smoke Partitions: Prepare for Acoustical Sealant specified in Section 07 92 16.
- P. Furring Channels:
 - 1. Attach furring channel systems directly to parent walls.
 - 2. Install channels at maximum 16 inches 400 mm OC.
 - 3. Provide additional framing at openings, cutouts, corners, and control joints.
 - 4. Space fasteners not more than 24 inches 610 mm OC, staggered on opposite flanges of furring channels.
- Q. Sound Isolation Clips:
 - 1. Install per manufacturer's instructions.
 - 2. Where electrical device, outlet, and service boxes are fastened to framing with Sound Isolation Clips:

- a. Leave a gap between the gypsum wallboard and the electrical device, outlet, or service box to avoid flanking of the Sound Isolation Clips.
 - b. Seal the gap with Acoustical Sealant.
- R. Stud Wall Isolation Strip:
 - 1. Install per manufacturer's instructions.

3.3 FRAMING AT OPENINGS

- A. Control Joints (CJ):
 - 1. Install additional stud, maximum 1/2 inch 13 mm from jamb studs.
 - 2. Do not fasten extra stud to track or jamb stud.
 - 3. Refer to specification Section 09 29 00 for control joint locations.
- B. Prefabricated headers, jambs, and sill framing systems option:
 - 1. Proprietary opening framing systems may be used as an alternative to conventionally fabricated framing.
 - 2. Pre-approved Products:
 - a. HDS Framing System by ClarkDietrich.
 - b. Quick Frame Rough Opening System by Marino/ Ware.
- C. Door Openings:
 - 1. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section for cripple studs at head and secure to jamb studs. Screw into web of jamb stud.
 - 2. Unless indicated otherwise, extend jamb studs through suspended ceilings and secure laterally to overhead structure.
 - 3. Jamb Studs:
 - a. Minimum thickness of jamb studs: 30 mil (20 GA) 0.752 mm at openings.
 - b. Install two studs at each jamb, toe-to-toe unless otherwise indicated.
 - 1) Securely attach first stud to frame.
 - 2) Fill cavity between studs with acoustic batt insulation where required by acoustical rating of wall.
 - 3) Join second stud to first stud on each face with 30 mil (20 GA) 0.752 mm screw attached steel straps at 42 inches 1070 mm on center maximum.
 - 4. Headers:
 - a. Openings less than 4 feet 6 inches 1.37 m wide:
 - 1) Cut-to-length section of floor runner above and below wall openings.
 - 2) Cut flanges and bend webs at ends.
 - 3) Overlap and screw attach jamb studs to frames.
 - b. Openings over 4 feet 6 inches 1.37 m wide:
 - 1) Cut-to-length, horizontal box beam studs above and below wall openings.
 - 2) Design for actual span and loading.
 - c. Incorporate miscellaneous steel members, specified in Section 05 50 00, and wood blocking, specified in Section 06 10 00, where indicated.
 - 5. Control Joints at head of jambs:
 - a. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch 13 mm clearance from jamb stud to allow for installation of control joint in finished assembly.
 - b. Gypsum Wallboard control joints as specified in Section 09 29 00.
- D. Other Framed Openings:

1. Frame openings other than door openings the same as required for door openings, unless otherwise indicated.
2. Cripple Studs:
 - a. Install cut-to-length intermediate vertical studs above and below openings.
 - b. Spacing: As indicated for typical full-length studs.
 - c. Match stud framing below sills of openings to framing installed above opening.
3. Incorporate miscellaneous steel members, specified in Section 05 50 00, and wood blocking, specified in Section 06 10 00, where indicated.

3.4 WALL BACKING AND BLOCKING

- A. Provide in-wall backing reinforcement where following items are mounted to interior walls and interior face of exterior walls:
 1. Crash rails, chair rails, wall bumpers, and similar wall protection devices.
 2. Wall-mounted door stops.
 3. Contractor or Owner furnished equipment indicated to be wall mounted.
 4. Toilet accessories that do not include proprietary backing devices.
 5. Toilet partitions and lockers.
 6. Markerboards, tackboards, and chalkboards.
 7. Other wall-mounted items where backing is indicated by details or specification.
- B. Metal Wall Backing requirements are described as Accessory Items in Part 2 of this section.
- C. Wood Wall Blocking may be used where allowed by Code and Manufacturer of item to be supported. Specified in Section 06 10 00.
- D. Verify metal stud framing has been installed to support wall-mounted items specified in Section 05 50 00.
- E. Coordinate mounting height, location, and coverage with item to be supported.
- F. Determine material width according to item to be supported.
- G. Provide in-wall metal wall backing material to interior metal stud walls specified herein and Exterior stud walls specified in Section 05 40 00.
- H. Attachment: Minimum 2 - #10 sheet metal screws at each stud.

3.5 CEILING FRAMING

- A. Install in compliance with manufacturer's recommendations.
- B. Provide required items to support and trim out neatly, flush or recessed mechanical and electrical items.
- C. Frame openings in ceiling support system to accommodate access panels and similar openings and penetrations.
 1. Completely frame openings with closed channel side of stud facing opening for support of recessed mechanical and electrical items.

3.6 CEILING SUPPORT SYSTEMS

- A. Install suspension system components in sizes and spacing indicated on Drawings, but not less than required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where abutting or penetrated by building structure.
- C. Suspend hangers from building structure as follows:
 1. Install hangers plumb and free from contact with insulation or other objects that are not part of supporting structural or suspension system.

- a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and secure fasteners appropriate for substrate.
 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and secure fasteners appropriate for structure and hanger.
 5. Do not attach hangers to steel roof deck.
 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Grid Suspension Systems:
1. Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces.
 2. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
 3. Install suspension systems that are level to within 1/8-inch 3 mm in 12 feet 3.66 m measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
 4. Coordinate support requirements for in-ceiling devices with capacity of ceiling grid system.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Gypsum Wallboard in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C475 Joint Compound and Joint Tape for Finishing Gypsum Board.
 - 2. ASTM C840 Application and Finishing of Gypsum Board.
 - 3. ASTM C841 Installation of Interior Lathing and Furring.
 - 4. ASTM C954 Steel Drill Screws for Application of Gypsum Panel Products or Metal Plaster Bases.
 - 5. ASTM C1002 Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases.
 - 6. ASTM C1047 Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - 7. ASTM C1396 Standard Specification for Gypsum Board.
 - 8. ASTM C1629 Abuse-Resistant Non-decorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.
 - 9. ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 - 10. ASTM E84 Surface-Burning Characteristics of Building Materials.
 - 11. ASTM E90 Sound Transmission Testing.
 - 12. ASTM E119 Fire Tests of Building Construction.
 - 13. ASTM E413 Classification for Rating Sound Insulation.
 - 14. ASTM F2547 Standard Test Method for Determining the Attenuation Properties in a Primary X-ray Beam of Materials Used to Protect Against Radiation Generated During the Use of X-ray Equipment
- B. Gypsum Association (GA):
 - 1. GA-216 Application and Finishing of Gypsum Panel Products.
 - 2. GA-234 Control Joints for Fire-Resistance Rated Systems.
 - 3. GA-238 Guidelines for Prevention of Mold Growth on Gypsum Board.
- C. Fire Resistant Rated Assemblies:
 - 1. For fire resistance rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
 - 2. Provide materials listed by UL, or other approved testing laboratory, for construction and rating type indicated.
- D. STC Rated Assemblies:
 - 1. Provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- E. Radiation Shielding Assemblies:
 - 1. National Council on Radiation Protection and Measurement (NCRP):

- a. NCRP Report No. 147 Structural Shielding and Design Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10MeV
- b. Comply with requirements of local, state, or federal regulatory agencies where building or safety standards or criteria exceed NCRP Report Numbers 49 and 147.

1.3 SUBMITTALS

- A. Product Data:
 1. Manufacturer's specifications for each type of material and accessory.
- B. Samples:
 1. Trim Accessories: Full-size Sample in 12-inch 300-mm length for each trim accessory indicated.
 2. Textured Finishes: Manufacturer's standard size sample for each textured finish indicated and on same backing indicated for Work.
- C. Project Information:
 1. Submit Certification Letter on Contractor's letter head signed by Contractor indicating that all materials incorporated into this Project comply with requirements specified in this Specification or are accepted equivalent products.

1.4 QUALITY ASSURANCE

- A. Radiation Shielding Assemblies:
 1. Fabricator-Installer Qualifications:
 - a. Not less than 10 years of experience in successful fabrication and installation of radiation protection similar to work specified.
 2. Certification:
 - a. Furnish certificate of compliance signed by Manufacturer and Fabricator-Installer stating materials are in accordance with Contract Documents and physicist shielding report.
- B. Mockups: Before beginning gypsum board installation, install mockups of at least 100 square feet 9 square meters in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Install mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
 - b. Each texture finish indicated.
 2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
 3. Simulate finished lighting conditions for review of mockups.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Gypsum Wallboard:
 1. Base:
 - a. Georgia Pacific (GP).
 2. Optional:
 - a. American Gypsum.
 - b. CertainTeed.
 - c. National Gypsum Company (NGC).
 - d. Pabco Gypsum.

- e. United States Gypsum (USG).
- B. Drywall Trim Accessories:
 - 1. Base:
 - a. United States Gypsum (USG)
 - 2. Optional:
 - a. CertainTeed.
 - b. ClarkDietrich.
 - c. Phillips Manufacturing.
 - d. Structus Building Technologies.
- C. Specialty Drywall Trim:
 - 1. Base:
 - a. Pittcon Industries.
 - 2. Optional:
 - a. Fry Reglet Corp.
 - b. Gordon, Inc.
- D. Foam Tape:
 - 1. Base:
 - a. Norseal.
 - b. Gasket Dynamics.
- E. Sound Attenuation Batts (SAB):
 - 1. Base:
 - a. Owens-Corning.
- F. Preformed Acoustical Seal for Wall Boxes:
 - 1. Base:
 - a. STC Architectural Products.
- G. Pressure Sensitive Fire Tape:
 - 1. Base:
 - a. E-Z Taping System.
- H. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Furnish in maximum available lengths, consistent with installation requirements.
 - 1. Long Edge: Tapered.
 - 2. Short Ends: Square.
- B. Upgrade listed types to fire rated equivalent products when used in fire rated assemblies.
- C. Provide listed GWB products to mold and moisture resistant types, where wallboard is installed in Electrical, Communication Rooms, Mechanical shafts, Stair Shafts, and similar locations where wallboard is installed prior to building being weathertight.
- D. Exterior Gypsum Sheathing: Specified in Section 06 16 43.
- E. Framing and suspension systems for Gypsum Board Ceilings: Specified in Section 09 22 16.
- F. Firestopping: Specified in Section 07 84 00.

- G. Thermal Insulation: Specified in Section 07 21 00 and other Division 07 sections.
- H. Interior Expansion Joint Covers: Specified in Section 07 95 13.
- I. Interior face of exterior walls and rooms where moisture or high humidity is present:
 - 1. Mold and moisture resistant gypsum panels (MRGWB).
 - 2. Gypsum panels, with glass mat facer per ASTM C1658.
 - 3. Thickness: 5/8 inches 16 mm.
 - 4. Mold resistance score: 10 per ASTM D3273.
 - 5. Apply continuously to interior face of exterior stud walls prior to framing interior partitions and ceilings.
 - 6. Where MR wallboard is scheduled in fire rated walls, provide approved fire resistive products with comparable moisture resistance.
 - 7. Base product:
 - a. DensArmor Plus Interior Panel and DensArmor Plus Fireguard Interior Panel Fireguard by Georgia Pacific.
- J. Interior Partitions and Ceilings:
 - 1. Gypsum panels - Type X:
 - a. ASTM C1396.
 - b. Thickness: 5/8 inches 16 mm.
 - c. Type X core.
 - d. Base product:
 - 1) ToughRock Fireguard X Gypsum Wallboard by Georgia Pacific.
 - 2. Tile Backer Board (TBB):
 - a. Moisture resistant treated gypsum core, glass mats on both sides, and acrylic water barrier or water-resistant gypsum coating on finished side.
 - b. Provide TBB at walls of showers, tub rooms, toilet rooms, decontamination rooms, and similar walls where tile is scheduled.
 - c. Thickness: 1/2 inches 13 mm.
 - d. Thickness: 5/8 inches 16 mm type X at rated walls.
 - e. Mold resistance score: 10 per ASTM D3273.
 - f. Base Products:
 - 1) Non-Rated Walls: DensShield Tile Backer by Georgia Pacific.
 - 2) Fire Rated Walls: DensShield Fireguard Tile Backer by Georgia Pacific.
 - g. Include Level 5 finish at non-tiled portions.
- K. Trim:
 - 1. Interior Trim:
 - a. Material: Galvanized or aluminum coated steel sheet, rolled zinc, paper faced galvanized steel sheet, or paper faced structural laminate.
 - b. Material for wet areas: Composite.
 - c. Shapes:
 - 1) Corner bead.
 - 2) LC-Bead: J-shaped; exposed long flange receives joint compound.
 - 3) L-Bead: L-shaped; exposed long flange receives joint compound.
 - 4) U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - 5) Control joint.
 - 6) Curved Edge Corner bead: With notched or flexible flanges.
 - 7) Other items as indicated.

2. Specialty trim:
 - a. Profiles and dimensions indicated.
 - b. Material: 6063-T5 Aluminum.
 - c. Finish: Factory primed for field finishing.
 - d. Finish: Class II anodic finish.
 - e. Finish: Factory painted, baked enamel finish.
 - f. Flanges to be embedded: Corrosion resistant primer compatible with joint compound and finish materials indicated.

L. Joint Treatment Materials:

1. Use product types recommended by wallboard manufacturer for each condition.
2. Materials compatible with other compounds applied previously or on successive coats.
3. Provide dust control products in occupied areas or adjacent to occupied areas.
4. Joint tape:
 - a. Paper-faced gypsum wallboard: Paper tape as recommended by panel manufacturer.
 - b. Glass-mat faced gypsum wallboard: Fiberglass mesh as recommended by panel manufacturer.
 - c. Tile backing panels: As recommended by panel manufacturer.
5. Joint compounds for interior gypsum wallboard:
 - a. Setting type joint compound:
 - 1) Filling open joints and voids.
 - 2) Embedding tape and first coat over joints, fasteners, and trim flanges.
 - b. Lightweight setting type joint compound:
 - 1) Second coat.
 - 2) Final, skim coat on surfaces receiving a Level 5 finish.
 - c. Drying type all-purpose joint compound:
 - 1) Second and third coats.
 - 2) Final, skim coat, on surfaces receiving a Level 5 finish.
 - d. Spray applied coating compound:
 - 1) Final, skim coat, on surfaces receiving a Level 5 finish.
6. Joint compounds for moisture resistant gypsum wallboard:
 - a. Setting type joint compound:
 - 1) Filling open joints and voids.
 - 2) Embedding tape and first coat over joints, fasteners, and trim flanges.
 - b. Lightweight setting type joint compound:
 - 1) Second and third coats.
 - 2) Final, skim coat on surfaces receiving a Level 5 finish.

M. Acoustical Materials:

1. Provide where indicated.
2. Minimum nominal thickness: As required to achieve STC indicated for wall systems.
3. Density: As required to achieve STC indicated for wall systems.
4. Sound attenuation batts (SAB):
 - a. Glass or mineral fiber.
 - b. Commercial sound blanket, ASTM C665, Type I, unfaced, produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - c. Surface burning characteristics per ASTM E84:

- 1) Maximum flame spread: 25.
- 2) Maximum smoke developed: 50.
- d. Fire rated assemblies: Select SAB materials and thicknesses that that are approved for use in assemblies listed.
- e. Acoustically rated assemblies: Select SAB materials and thicknesses that that are approved for use in assemblies listed.
- f. Batt insulation products shall contain no added formaldehyde, including urea formaldehyde, phenol formaldehyde, and urea-extended phenol formaldehyde.
- g. Base Products:
 - 1) Fiberglass: Sound Attenuation Batt Insulation by Owens-Corning.
 - 2) Mineral Wool: Thermafiber SAFB FF by Owens-Corning.
5. Preformed acoustical seal for wall boxes:
 - a. Box Seal by STC Sound Control
 - b. Molded neoprene, durometer A-40 complying with ASTM D2000.
 - c. Formed to fit the electrical device, outlet, and service boxes.
 - d. STC improvement: 6 dB in accordance with ASTM E90.
 6. Provide at electrical and service box penetrations in sound rated walls.
- N. Interior joint sealants, including acoustical sealants:
 1. See Section 07 92 16.
- O. Fasteners:
 1. General: Provide fasteners of size and type indicated that comply with requirements specified for material and manufacturer.
 - a. For roof and wall sheathing: Provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
 2. Nails, Brads, and Staples: ASTM F 1667.
 3. Power-Driven Fasteners: NES NER-272.
 4. Wood Screws: ASME B18.6.1.
 5. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, length recommended by sheathing manufacturer for sheathing thickness, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
 - a. For steel framing less than 0.0329 inch 0.835 mm thick, use screws complying with ASTM C 1002.
 - b. For steel framing 0.033 to 0.112 inch 0.84 to 2.84 mm thick, use screws complying with ASTM C 954.
- P. Laminating Adhesive:
 1. Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- Q. Foam Tape:
 1. PVC 1/2 by 1/4 inches 13 by 6 mm: With pressure sensitive adhesive; Norseal.
 2. EPDM 1/2 by 1/4 inches 13 by 6 mm: With pressure sensitive adhesive; Cellular rubber by Gasket Dynamics.
- R. Backing for Control Joints:
 1. Fire rated board.
- S. Support straps:

1. Galvanized steel sheet for retaining and bracing in length and width indicated or as required for adequate support of assembly.
 2. Minimum Base-Metal Thickness: 20 gauge.
- T. Sealer for Moisture Resistant Gypsum Wallboard:
1. Manufacturer's standard compound.
 2. Use at joints, cut edges, and screw penetrations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting structure and conditions prior to wallboard installation.
- B. Correct unsatisfactory conditions.
- C. Start of installation constitutes acceptance of conditions and responsibility for performance.

3.2 INSTALLATION - GENERAL

- A. Comply with ASTM C840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Remove loose materials and vacuum cavity of gypsum dust prior to enclosing stud space.
- C. Install wallboard vertically with edges over metal stud framing members and similar framing support members.
- D. Bring boards into contact but do not force into place.
- E. Stagger edge joints on opposite side of partition so they occur on different framing members.
- F. Stagger joints in multi-layer applications not less than one support from previous layer.
- G. Install wallboard over metal framing studs and similar framing support members at interior face of exterior walls full height from floor to structure above.
- H. Wallboard installation prior to building being weathertight:
 1. Replace scheduled GWB products to their mold-resistant counterparts.
 - a. Products proposed are subject to Architect approval.
 2. Exposure time shall be limited by manufacturer requirements.
- I. Sound Insulation:
 1. Install sound insulation in walls from floor to structure above, wherever sound rated walls are indicated.
 2. Install in thicknesses and densities necessary to achieve sound rating.
 3. Fill cavities where studs are installed nested or toe-to-toe.
 4. Fill void spaces inside headers and other multi-component assemblies.
 5. Pack spaces around electric boxes and other penetrations to maintain full sound rating.
 - a. Fill small voids that remain with Acoustical Sealant.
 6. Where walls either are not finished on both sides or where insulation does not fill the cavity depth, supplementary galvanized steel support straps must be provided to hold product in place at 24 inches on center or at spacing as indicated by the insulation manufacturer's written installation instructions.
- J. Preformed Acoustical Seal for Wall Boxes:
 1. Place preformed seal over exposed outlet box flush with wall surface with device protruding through preformed or precut opening in seal.
 2. Secure in place with outlet cover plate.
- K. Pressure Sensitive Fire Tape:

1. Where allowed: Install approved pressure sensitive fire tape to above-ceiling wallboard joints in fire rated walls.
 2. Exception: Utilize conventional mud and tape where fire tape is not permitted by UL wall design or by local authorities.
- L. Curved Partitions:
1. Space studs or furring to prevent flat areas between framing at curved surfaces.
- M. Wall Reveals:
1. Install reveal wall channels and/or aluminum framing as recommended by manufacturer.
- N. Screw Placement:
1. Proceed with attachment from board center toward ends and edges.
 2. Space maximum 8 inches 200 mm OC at edges and 12 inches 300 mm OC in field of board.
 - a. Use closer screw spacing if required by UL.
 - b. Fasten wallboard to each stud where multiple studs are installed at door jambs.
 3. Secure wallboard to vertical studs; do not secure to top track directly.
 - a. Follow top track manufacturer's screw pattern requirements.
 - b. Install additional framing if required.
 - c. Top track is specified in Section 09 22 16.
 4. Set screws between 3/8 inches and 1/2 inches 10 mm and 13 mm from edges.
 5. Drive screws so head rests in slight dimple without cutting face paper or fracturing core.
- O. Access Panels and Doors:
1. Locate where required by Section 23 05 00 and Section 26 00 10, or as indicated.
 2. See Section 08 31 13.

3.3 INSTALLATION - TRIM ACCESSORIES

- A. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Interior Trim:
1. Install in following locations:
 2. Corner Bead: Use at outside corners.
 3. J-Bead or LC-Bead: Use at exposed panel edges.
 4. L-Bead: Use where wallboard abuts dissimilar surfaces and where indicated.
- C. Specialty Trim:
1. Install in locations indicated.

3.4 INSTALLATION - SHAFTWALL

- A. Install shaft walls in compliance with UL and Gypsum Association description.
- B. Provide shaft wall systems permitting entire erection procedure from outside shaft.
- C. Provide special metal runner angles and channels, and studs or splines spaced per manufacturer's requirements.
- D. Comply with requirements for thickness of metal and thickness of wall, for heights of wall indicated.
- E. Use maximum practical board lengths.
- F. Projections in Elevator Hoistways:
1. Inspect elevator shafts to determine if projections greater than 4 inches 100 mm exist.

2. At projections 4 inches 100 mm and greater:
 - a. Install GWB bevels sloping 75 degrees from horizontal.
 - b. Support GWB with metal studs.

3.5 INSTALLATION - CEILING

- A. Install in compliance with manufacturer's recommendations.
- B. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. During cold or damp weather, insulate before installing gypsum board on a ceiling with a vapor barrier.

3.6 CONTROL JOINTS

- A. General:
 1. Install Control Joints in locations indicated and as described in this article and in specific locations approved by Architect for visual effect.
 2. Install suitable backing material to maintain required rating where Control Joints occur in fire or sound rated assemblies.
- B. Partitions:
 1. Extend control joints continuous full height of partition or wall.
 2. Provide vertical control joints on both wall faces which align with door frames, window frames, and similar opening as follows:
 - a. Single Doors and Cased Opening:
 - 1) Locate Control Joints at both jambs, from head of opening to top of partition.
 - b. Pair doors:
 - 1) Locate Control Joints at both jambs, from head of opening to top of partition.
 - 2) Exception: Control Joints are not required where partition forms a cross-corridor condition.
 - c. Doors with adjacent sidelights:
 - 1) Locate Control Joints at both jambs from head of opening to top of partition, and, from sill to floor at sidelight jambs.
 - d. Sliding doors:
 - 1) Locate Control Joints at both jambs, from head of opening to top of partition.
 - e. Punched windows less than 30 feet 9 M in width:
 - 1) Both jambs from head of opening to top of partition, and from sill edge to floor.
 - f. Ribbon windows greater than 30 feet 9 M in width:
 - 1) Both jambs from head of opening to top of partition, and from sill edge to floor.
 - 2) Locate additional intermediate CJ's so maximum distance between CJ's does not exceed 30 feet 9 M apart.
 3. Provide additional vertical Control Joints, spaced no more than 30 feet 9 M apart from each other, from other opening related Control Joints, or from corners.
 4. Provide horizontal control joints at partitions which are more than one story in height:
 - a. Locate horizontal Control Joints where partitions bypass each intermediate floor.
 - b. Align control joint with floor line, unless otherwise indicated.
- C. Ceilings:
 1. Use Control Joints to subdivide ceilings/soffits as indicated, and within the following limits:
 - a. Ceilings with perimeter relief:
 - 1) Subdivide so no area exceeds 2500 SQ FT 232 m², and no area has a length which exceeds 50 feet 15 M.

- a) Exception where ceiling occurs at exterior: Subdivide so that no area exceeds 900 SQ FT 83 m², and no area has a length which exceeds 30 feet.
 - b. Ceilings without perimeter relief:
 - 1) Subdivide so that no area exceeds 900 SQ FT, and no area has a length which exceeds 30 feet 9 M.
 - c. Locate control joints at transitions between areas of different shapes.
- D. Soffits:
 - 1. Use control joints to subdivide ceilings/soffits as indicated, and within the following limits:
 - a. Locate Control Joints at transitions between areas of different shapes.
 - b. Continue lines of soffit Control Joints vertically to top of fascia.
 - c. Subdivide exterior applications so no area exceeds 900 SQ FT 83 m², and no area has a length which exceeds 30 feet 9 M.

3.7 WALLBOARD FINISHING

- A. Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.
- B. Pre-fill rounded or beveled edges, open joints, voids, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Where bead abuts exterior metal window frames or other metal components, separate from other material by use of foam tape.
- E. Remove residual joint compound from adjacent surfaces.
- F. Apply Joint Compound and Tape in accordance with fire rated design.
 - 1. Apply joint treatment compound in accordance with manufacturer's directions.
 - 2. Fill joints, screw heads, and internal corners with compound.
 - 3. Extend joint system vertically from floor to extent described as follows:
 - a. Fire Walls, Barriers, and Partitions: Extend to full height of wall.
 - b. Smoke Barriers and Partitions: Extend to full height of wall.
 - c. Interior face of exterior wall (non-rated): Extend to full height of wall.
 - d. Other interior partitions (non-rated): Extend to 6 inches 150 mm above ceiling.
 - 4. Refer to Drawings for indication of partition heights.
- G. Level 4 Finish:
 - 1. After drying, sand or otherwise smooth final coat of compound as needed to eliminate high spots or excess compound to leave smooth, even, and level surface.
 - 2. Draw down final coat of compound to a smooth even plane.
 - 3. Locations:
 - a. Wallboard scheduled to be finished with Gloss Level 1 (flat), Level 2 (velvet), or Level 3 (eggshell) paint, glazed coating, textured coating, or wall covering.
 - b. Where above listed surfaces are to be finished with textured decorative treatments, wall covering, paneling, or wall guard.
 - c. Remaining locations, unless noted otherwise.
- H. Level 5 Finish:
 - 1. Trowel skim coat of joint compound leaving a thin film covering the entire surface, in accordance with manufacturer's recommendations.
 - 2. Make surfaces free of tool marks and ridges.

- 3. Locations:
 - a. Exposed ceiling, soffit, or wall areas abutting window mullions, skylights, or receiving direct indoor lighting.
 - b. Hallways or corridors more than 20 feet 6 M long and unbroken by doorways or windows.
 - c. Atriums, Lobbies, Auditoriums, and similar large spaces.
 - d. Multi-story spaces.
 - e. Wall board scheduled to be finished with Gloss Level 4 (satin), Level 5 (semi-gloss), Level 6 (gloss), Level 7 (high gloss), paint, glazed coating, textured coating, or wall covering.
 - f. Surfaces using MRGWB or other wallboard types with a glass mat facer on finished side.
- I. Glass Mat, Water Resistant Backing Panels:
 - 1. Finish according to manufacturer's written instructions.
- J. Cementitious Backer Units:
 - 1. Finish according to manufacturer's written instructions.
- K. Repairs:
 - 1. After painter has applied primer to wallboard surfaces, repair and refinish defective areas.
 - 2. If wallboard is damaged, or surfaces are roughened, repair or replace.

3.8 FIRE AND SMOKE WALL IDENTIFICATION

- A. Identify walls indicated on Drawings as having a required fire or smoke rating.
 - 1. Follow guidelines set in applicable Building Code.
 - 2. Permanently identify rating and type of barrier with stencil and paint in contrasting, 3 inches 75 mm high letters in a manner acceptable to authority having jurisdiction.
 - 3. Text for fire and smoke barriers: "x HOUR FIRE AND/OR SMOKE BARRIER—PROTECT ALL OPENINGS."

3.9 FIELD QUALITY CONTROL

- A. Radiation Shielding Testing:
 - 1. Owner's registered radiation physicist will test radiation shielding.
 - 2. Notify Owner's radiation physicist when shielding installation is complete to perform a visual inspection.
 - 3. Upon completion of radiology equipment installation, perform tests and radiation survey.
 - a. Comply with requirements of ASTM F2547.
 - b. Conduct leakage tests under direction of Owner's radiation physicist.
 - c. Test elements forming radiation shielding.
- B. Testing Results:
 - 1. Exposure levels shall not exceed those specified in Radiation Shielding Report.
- C. Perform corrective work that inspection reports indicate does not comply with specified requirements.
- D. Retest locations where system is found to be deficient following repair.
- E. Submit certified reports to Owner.

3.10 PROTECTION

- A. Protect installed wallboard from water damage during construction.

- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
- D. Prior to finishing, walls shall be inspected for visible mold growth.
 - 1. Replace affected portions.

END OF SECTION

SECTION 09 30 00

TILING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Tile, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Tile Council of North America (TCNA):
 - 1. Handbook for Ceramic, Glass and Stone Tile Installation, latest edition.
- B. Ceramic Tile Institute of America (CTIOA).
- C. ASTM International (ASTM):
 - 1. ASTM C373 Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products
 - 2. ASTM C485 Standard Test Method for Measuring Warpage of Ceramic Tile
 - 3. ASTM C627 Standard Test Method for Evaluating Ceramic Floor Tile Installation Systems Using Robinson-Type Floor Tester
 - 4. ASTM C630 Standard Test Method for Resistance of Ceramic Tile to Chemical Substances
 - 5. ASTM C648 Standard Test Method for Breaking Strength of Ceramic Tile
 - 6. ASTM C1026 Standard Test Method for Measuring the Resistance of Ceramic and Glass Tile to Freeze-Thaw Cycling
 - 7. ASTM C1027 Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile
 - 8. ASTM C1378 Standard Test Method for Determination of Resistance to Staining
- D. American National Standards Institute (ANSI):
 - 1. ANSI A108.5 Installation of Ceramic tile with Dry-Set Portland Cement or Latex-Portland Cement.
 - 2. ANSI A108.10 Installation of Grout in Tilework.
 - 3. ANSI A108.13 Installation of Membranes for Thin-Set Ceramic Tile.
 - 4. ANSI A108.17 Installation of Crack Isolation Membranes for Thin-set Ceramic Tile and Dimension Stone.
 - 5. ANSI A118.1 Standard Dry-Set Cement Mortars.
 - 6. ANSI A118.3 Chemical Resistant, Water-Cleanable, Tile-Setting and-Grouting Epoxy and Water-Cleanable Tile-Setting Epoxy Adhesive.
 - 7. ANSI A118.4 Modified Dry-Set Cement Mortar.
 - 8. ANSI A118.7 High Performance Cement Grouts.
 - 9. ANSI A118.12 Crack Isolation Membranes for Thin-set Ceramic Tile and Dimension Stone Installation.
 - 10. ANSI A118.15 Improved Modified Dry-Set Cement Mortars.
 - 11. ANSI A137.1 Standard Specification for Ceramic Tile.

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.

B. Shop Drawings:

1. Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, movement joints, thresholds, ceramic accessories, and setting methods and details.

C. Samples:

1. One full size sample of each tile specified in Drawing Finish Schedule.
2. Grout: Submit manufacturer's full range of standard and designated color samples for each type for Architect's selection.

D. Project Information:

1. Installation methods.
2. Manufacturer's Certificate: For each shipment, type and composition of tile provide a Master Grade Certificate signed by manufacturer and installer certifying products meet or exceed specified requirements of ANSI A137.1.

E. Contract Closeout Information:

1. Maintenance Data:
 - a. Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.
 - b. See Section 01 78 23.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Minimum 10 years of experience in manufacture of tile, setting and grout materials.

B. Installer Qualifications:

1. Specializing in tile work, having minimum of 5 years' successful documented experience with work comparable to that required for this Project.

C. Single Source Responsibility:

1. Obtain each type and color tile material required from single source.
2. Provide compatible materials for tile system.

D. Certifications:

1. Submit Master Grade Certificate for each type of ceramic, quarry, and paver tile in accordance with requirements of ANSI A137.1.
2. Submit manufacturer's certifications that mortars, adhesives, and grouts are suitable for intended use.

PART 2 - PRODUCTS

2.1 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS.

2.2 MANUFACTURERS

A. Ceramic Tile:

1. Base:
 - a. See Drawing Finish Schedule.
 - b. As specified in Drawing, Interior Notes and Finish Legend.

B. Porcelain Tile:

1. Base:

- a. See Drawing Finish Schedule.
- C. Accessories:
 - 1. Base:
 - a. Schluter Systems.
 - 2. Option:
 - a. Profilitec.
 - b. Blanke Corporation
- D. Other manufacturers desiring approval comply with Section 01 61 00.

2.3 DESIGN CRITERIA

- A. Tile:
 - 1. Ceramic Tile: Comply with ANSI A137.1 American National Standard Specifications for Ceramic Tile for types, compositions, and grades of tile indicated.
 - 2. Porcelain Tile: Comply with ANSI A137.3 American National Tile Standard Specifications for Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs for types, compositions, and grades of tile indicated.
 - 3. Furnish tile complying with Standard Grade requirements unless otherwise indicated.
 - 4. ANSI Standard for Tile Installation Materials: Comply with ANSI standard referenced with products and materials indicated for setting and grouting.
- B. Colors, Textures, and Patterns:
 - 1. Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with following requirements:
 - a. As specified in the Drawing Finish Schedule.
- C. Factory Mounting:
 - 1. Provide back face or edge mounted tile assemblies as standard with manufacturer unless another mounting method is indicated.
 - 2. Do not use back mounted or edge mounted tile assemblies for swimming pools, exterior applications, or wet areas.
- D. Grout Release:
 - 1. Factory applied temporary protective coating.
 - 2. Provide where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by pre-coating with a continuous film of petroleum paraffin wax, applied hot.
 - 3. Do not coat unexposed tile surfaces.

2.4 MATERIALS

- A. Porcelain Tile:
 - 1. Acceptable Manufacturer: As specified in Drawing Finish Schedule.
 - 2. Porcelain Tile: Porcelain based, impervious unglazed ceramic, through body color.
 - 3. Water Absorption: Less than 0.1% maximum, ASTM C373.
 - 4. Finish: As specified in Drawings Finish Schedule.
 - 5. Size: As specified in Drawings Finish Schedule.
 - 6. Color: As specified in Drawings Finish Schedule.
 - 7. Finish: Textured.
 - a. Dynamic Coefficient Of Friction (DCOF): Greater than 0.42 per ANSI 137.1.

8. Trim Shapes: Caps, returns and other trim accessories as required; same characteristics as tile.
- B. Trim:
1. Provide necessary caps, stops, returns, trimmers and other shapes to complete installation.
 2. Color and finish to match adjacent tile unless shown otherwise.
 3. Ceramic Trim:
 - a. Cove Base: Square top edge. Align joints and set flush with floor tile.
- C. Mortar – Thin Set:
1. Portland Cement with Latex Additive:
 - a. Latex additive and site mixed Cement mortar.
 - b. Comply with ANSI-A118.4.
 - c. Acceptable Products:
 - 1) CustomCrete Latex Mortar Admix with site mixed mortar by Custom Building Products.
 - 2) Planicrete AC with 4:1 Mud Bed Mix by Mapei.
- D. Epoxy Adhesive:
1. Multi-component, factory prepared, 100% epoxy resin and hardener with sand or mineral filler material.
 2. Comply with ANSI A118.3 for thin-set applications for chemical resistant, water cleanable quarry tile installations.
 3. Acceptable Products:
 - a. Kerapoxy 410 by Mapei.
- E. Latex Modified Grout:
1. Description: Latex-modified, factory blended, mildew resistant, sanded, grout consisting of cement, graded quartz, and additives; comply with ANSI A118.7.
 2. Latex Additive: Type as recommended by latex mortar manufacturer.
 3. Acceptable Products:
 - a. Polyblend Sanded Tile Grout by Custom Building Products.
 - b. Satillo Grout Mix with Acrylic Mortar Admix 1:1 with water by Custom Building Products.
 - c. 500 Series Sanded Grout Mixed with 1776 Grout Admix Plus by Laticrete.
 - d. Ultracolor Plus FA polymer-modified sanded grout by Mapei.
- F. Unsanded Latex Modified Grout for Wall Tile:
1. Description: Latex-modified, factory blended, mildew resistant, non-sanded, grout consisting of cement and additives; comply with ANSI A118.6.
 2. Latex Additive: Type as recommended by latex mortar manufacturer.
 3. Color: To be selected.
 4. Acceptable Products:
 - a. Polyblend Non-Sanded Tile Grout by Custom Building Products.
 - b. White Dry Tile Grout by Custom Building Products.
 - c. 644 White Dry-Set Grout mixed with 17765 Grout Admix Plus by Laticrete.
 - d. 1600 Series Tri-Poly Fortified Non Sanded Grout by Laticrete.
 - e. Ultracolor Plus FA polymer-modified unsanded grout by Mapei.
- G. Unsanded Urethane Grout:
1. Description: Pre-mixed non-cementitious urethane , factory blended, antimicrobial, mildew resistant, non-sanded, grout; complying with ANSI A118.3-UG.

2. Color: To be selected.
 3. Acceptable Products:
 - a. QuartzLock2 by Bostik.
 - b. Flexcolor CQ (acrylic-based) by Mapei.
- H. Waterproofing Membrane:
1. Description: Trowel applied elastomeric compound.
 2. Acceptable Products:
 - a. Mapelastic Turbo by Mapei.
 3. Accessories:
 - a. Preformed fiberglass mesh coving, inside and outside corners, and drain fittings.
 - b. Preformed expansion joint flashing.
- I. Crack Isolation Membrane:
1. Description: Trowel applied elastomeric compound.
 2. Acceptable Products:
 - a. Mapelastic Turbo by Mapei.
- J. Tile Backer Board:
1. Moisture-resistant treated gypsum core, glass mats both sides, and vinyl, water barrier coating on finished side.
 - a. Conventional cement-board and green-board products are not acceptable.
 2. Thickness: 1/2 inches 13 mm.
 3. Mold-resistance score: 10 per ASTM D3273.
 4. Base Product: DensShield Tile Backer by Georgia Pacific.
 - a. Include Level 5 finish at non-tiled portions.
 5. Optional Products:
 - a. Fiberock Interior Panel, Aqua-Tough by USG.
 - b. GlasRoc Tile Backer by CertainTeed.
 6. TBB wallboard scheduled in Fire Rated Walls:
 - a. Approved fire resistive products with comparable moisture-resistance.
 - b. Base Product: DensShield Fireguard Tile Backer by Georgia Pacific.
- K. Accessories:
1. Fasteners: Corrosion resistant type required by board manufacturer for securing units.
 2. Joint Reinforcement Tape: As recommended by board manufacturer.
 3. Vapor Retarder:
 - a. Comply with ASTM D4397.
 - b. Thickness and maximum permeance rating:
 - 1) 4.0 mils, 0.19 perms 10.87 ng/s/m²/Pa.
 - c. Vapor retarder tape:
 - 1) For sealing joints and penetrations in vapor retarder.
 - 2) Pressure-sensitive type recommended by manufacturer.
- L. Joint Sealant:
1. Two component polyurethane sealant, ASTM C920, Type M, self-leveling, for horizontal joints, Type II, non-sag, for vertical joints as specified in Section 07 92 16.
 2. Color: Match grout.
 3. Sealant:

- a. Chemically compatible with tile, mortar, and grout.
 - b. Physically and chemically capable to withstand local environmental conditions.
- M. Joint Backing:
 - 1. Closed cell foam polyethylene.
- N. Prefabricated Sealant Joint:
 - 1. Prefabricated aluminum joint with two part, chemically curing non-sag polyurethane sealant.
 - 2. Height as required by tile by 8 feet 2.44 M lengths.
 - 3. Aluminum: Clear anodized.
 - 4. Sealant: Match grout.
 - 5. PolyBlend Ceramic Tile Caulk by Custom Building Products or Mapesil T by Mapei.
- O. Expansion and Control Joints for Thin-set and/or Thickset Applications:
 - 1. Main Material:
 - a. Extruded aluminum.
 - 2. Profiles joined by soft CPE movement joint material, with integral perforated anchoring legs for setting joint into setting bed.
 - 3. Height: As required to suit application.
 - 4. Color: As selected by Architect.
 - 5. Schluter - DILEX-KS
- P. Corner Joints:
 - 1. Extruded rigid coved wall corner, with integral perforated anchoring legs.
 - 2. Floor leg height: As required to suit application.
 - 3. Wall leg height: As required to suit application.
 - 4. Material: As specified in Interiors Notes & Finish Legend.
- Q. Corner Movement Joints:
 - 1. Roll formed stainless steel inside corner, cove-shaped 2-piece joint profile joined by soft thermoplastic rubber movement zone and with perforated anchoring.
 - 2. Floor leg height: As required to suit application.
 - 3. Wall leg height: As required to suit application.
 - 4. Material: Aluminum.
 - 5. Acceptable Products:
 - a. Schluter - DILEX-HKW
- R. Transition Joint Strips:
 - 1. Extruded aluminum transition strips; profile and height as indicated; with integral perforated anchoring leg for setting strip into setting material.
 - 2. Transition strip profile:
 - a. Sloped, variable height: where adjacent flooring level is different than tile.
 - 1) Schluter-RENO-V.
 - b. Sloped, narrow profile: Where adjacent flooring level is lower than tile.
 - 1) Schluter - RENO-U.
 - 3. Height:
 - a. As required to suit application.
 - b. Maximum change in level: 0 inches to 1/2 inches 0 mm to 13 mm.
 - c. Maximum slope: 1:2.
 - 4. Material: Aluminum.

S. Edge and Transition Strips:

1. Extruded aluminum, or roll-formed stainless steel edge strips, 1/8 inches 3 mm wide at top edge; height as indicated.
2. Height: As required to suit application.
3. Finish: As specified in Interiors Notes & Finish Legend

T. Setting Buttons:

1. Plastic buttons of thickness required for joint size indicated to maintain uniform joint width.

U. Penetrating Sealers:

1. Water-based sealer capable of repelling dirt, oil and stains from tile and grout surfaces.
2. Low odor, pH-neutral and non-abrasive.
3. Vapor open, non-film forming.
4. Stain Resistance per Ceramic Tile Institute CTI-072: Excellent.
5. Compatible with tile types scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Comply with requirements of referenced standards and recommendations of material manufacturers for environmental conditions before, during, and after installation.
- B. Verify concrete floor surfaces are suitable for tile installation.
 1. Firm, dry, clean, and free of oily or waxy films, mortar, and soil.
 2. Grounds, anchors, plugs, hangers, bucks, electrical and mechanical work in or behind tile installed.
 3. Coordinate installation with requirements of Section 07 16 04 Concrete Floor Moisture Testing, and Section 07 16 05 Water Vapor Emission Control System.
 4. Verify limits of moisture and alkalinity are within levels tolerated by Tile manufacturer and setting materials manufacturer.
 5. Verify areas to receive tile installed by thin bed method have wood float finish, are true within 1/4 inches in 10 feet 6 mm in 3 m and are pitched to drains where required.
- C. Correct unsatisfactory conditions and proceed with installation only after substrate deficiencies have been corrected and surfaces are acceptable.
- D. Start of work constitutes acceptance of surfaces, and waiver of claim that surfaces are unsuitable.

3.2 PREPARATION

- A. Prepare surfaces in accordance with manufacturers' instructions for setting materials or additives used.
- B. Acid based cleaners are not permitted.
- C. Completely remove curing compounds or other substances that would interfere with proper bond of setting materials.
- D. Do not seal substrate unless required by manufacturer.
- E. Prime substrate when required by manufacturer.
- F. Factory Blending:
 1. Blend tile in factory and package accordingly so tile are uniform in color range as those throughout packaging and match approved samples.
 2. If not factory blended, return to manufacturer or blend tiles at project site before installing.

G. Field Applied Grout Release product, Temporary Protective Coating:

1. Petroleum paraffin wax or proprietary grout release formulation.
2. Provide where specified or required to prevent adhesion or staining of exposed tile surfaces by grout.
3. Precoat exposed surfaces of tile with continuous film of temporary protective coating.
4. Do not coat unexposed tile surfaces.

3.3 INSTALLATION

A. Tile Backer Board:

1. Place and fasten with galvanized or resin coated gypsum board screws at 8 inches 200 mm OC in field of panel and 6 inches 150 mm OC at edges.
2. Provide 1/4 inches 6 mm gap above floor or fixture lip for installation of flexible caulking.
3. Maintain manufacturer's required space between board edges.
4. Fill joints by applying tile setting material and joint reinforcement.
5. Vapor Retarder:
 - a. Extend vapor retarder to extremities of areas indicated to be protected from vapor transmission.
 - b. Secure in place with mechanical fasteners or adhesives.
 - c. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose mineral-fiber insulation.
 - d. Seal vertical joints in vapor retarders over framing by lapping not less than two wall studs.
 - e. Fasten vapor retarders to framing at top, end, and bottom edges, perimeter of wall openings, and lap joints; space fasteners no greater than 16 inches 400 mm apart.
 - f. Seal joints in vapor retarders caused by pipes, conduits, electrical boxes and similar items penetrating vapor retarders with vapor retarder tape.
 - g. Repair tears and punctures in vapor retarder immediately before installation of cementitious backer units.

B. Membrane:

1. Install membrane with products or methods approved in writing by membrane manufacturer.
2. Flash membrane to cure prior to setting tile.
3. Do not allow construction traffic on membrane.

C. Waterproofing:

1. Install waterproofing in accordance with manufacturer's instructions.
2. Return waterproofing vertically at adjacent walls in accordance with manufacturer details, to minimum height of 4 inches 100 mm.
3. Flood test waterproof membranes after fully cured. See ASTM D5957 or reference the Manufacturer's published procedure.
4. Field Quality Control water test when required.

D. Tile Installation, General:

1. Install tile materials in accordance with ANSI A137.1-2012, ANSI A137.2, ANSI and TCNA specifications, and TCNA Handbook for Ceramic Tile Installation, with exception of more stringent requirements of manufacturer or these Specifications.
2. Cut and fit tile tight to penetrations, protrusions and vertical interruptions and seal.
 - a. See Section 07 92 16.
3. Form corners and bases neatly.
4. Install ceramic cove base in accordance with TCNA "Flush" style.

- a. TCNA "Thin-Lip" style installation is not allowed.
 - 5. Work tile joints uniform in width, subject to variance in tolerance allowed in tile size.
 - 6. Ensure nominal grout centerlines are straight.
 - 7. Make joint watertight, without voids, cracks, excess mortar, or grout.
 - 8. Prepare surface, fit, set, bond, grout and clean in accordance with applicable requirements of ANSI standards and Tile Council of North America.
 - a. Floors
 - 1) Dry-set on interior slabs on grade: TCNA F113.
 - 2) Dry-set on interior elevated slabs: TCNA F122.
 - 3) Dry-set on interior slabs on grade where epoxy grout is indicated: TCNA F115.
 - 4) Dry-set on interior elevated slabs where epoxy grout are indicated: TCNA F131.
 - b. Walls:
 - 1) Dry-set on Gypsum Board: TCNA W243.
 - 9. Where accent tiles are of a lesser thickness than surrounding field tiles, increase bedding thickness as required to achieve flush alignment between finished faces of accent tiles and adjacent field tiles.
- E. Layout:
- 1. Lay out work to pattern indicated so full tile or joint is centered on each wall.
 - a. Lay out tile to minimize cutting and to avoid tile less than half size.
 - 2. Continue pattern through openings.
 - 3. For heights stated in feet and inches, use courses of full tile to produce nearest attainable heights without cutting tile.
 - 4. Align joints in tile in both directions.
 - 5. Align joints between wall, floor, and base tile.
 - 6. Make joints between sheets of tile same width as joints within sheet.
 - 7. File edges of cut tile smooth and even.
 - 8. Cut and fit tile at penetrations through tile.
 - 9. Grind edges of tile abutting built-in items.
 - 10. Fit tile at outlets, piping, and other penetrations so plates, collars, or covers overlap tile.
 - 11. Extend tile work into recesses and under or behind equipment and fixtures, to form complete covering without interruption, except as otherwise indicated.
 - 12. Accurately form intersections and returns.
 - 13. Form internal corners and external corners square.
- F. Thin Set Method, Floors and Walls:
- 1. Apply mortar or adhesive with notched trowel using scraping motion to work material into contact with surface to be covered.
 - a. Maintain 90% coverage on back of tile and fully bed corners.
 - 2. Apply only as much mortar or adhesive as can be covered within time recommended by mortar or adhesive manufacturer.
 - 3. When installing large tiles, ceramics or mosaics, trowel small quantity of mortar or adhesive onto back of each tile or sheet of tiles.
 - 4. Set tiles in place and level surface of tile.
 - 5. Align tile to show uniform joints and set until firm.
 - 6. Clean excess mortar or adhesive from surface of tile while mortar is fresh.
 - 7. Sound tile after setting. Replace hollow sounding tiles.
- G. Grouting:

1. Allow tiles to set before grouting.
2. Install in accordance with grout manufacturer's recommendations and ANSI A108.10.
3. Clean excess grout from surface as work progresses.
4. Cure after grouting by covering with kraft or construction paper for 72 hours.
5. Install sealant in vertical wall joints at interior corners.

H. Movement Joints:

1. Comply with TCNA EJ171.
2. Coordinate with Drawings.
3. Locate movement joints where indicated.
4. Where not indicated, locate movement joints directly over following substrate conditions:
 - a. Changes in substrate material.
 - b. Over control joints, expansion joints and seismic joints in substrate.
 - c. Over construction joints in substrate.
 - d. At junctures where floors meet walls and other restraining elements such as curbs, columns, bases, and wall corners.
 - e. At other locations recommended by TCNA EJ171 Movement Joint requirements.
5. Locate additional movement joints per following:
 - a. Exterior: 12 feet 3.66 M.
 - b. Interior: 25 feet 7.6 M.
 - c. Interior, where exposed to direct sunlight or moisture: 12 feet 3.66 M.
6. Joint Width: In accordance with TCNA EJ171.
7. Rake or cut control joints through setting bed to supporting slab or structure.
8. Maintain joints free of mortar.
9. Fill joints with self-leveling polyurethane sealant and backing material.
 - a. See Section 07 92 16.
10. Provide sealant material at items penetrating tile work, unless otherwise indicated.
11. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.
 - a. Seal tile to outlets, piping, and other penetrations.
12. Fill joints around water closets with white silicone sealant.
 - a. See Section 07 92 16.
13. Use manufacturer's expansion joint flashing when covering expansion joints with waterproof or crack isolation membranes.

I. Penetrating Sealer:

1. Surface Preparation:
 - a. Verify tile and grout are fully cured.
 - b. Verify surfaces are dry, clean, and free of waxes, sealers, and finishes.
 - c. Test product in obscure area to produce desirable results.
2. Apply Penetrating Sealer to tiled surfaces, unless otherwise noted.
 - a. Application of penetrating sealer is not necessary where epoxy grouts are used.
 - b. Apply in accordance with Manufacturer's instructions.
3. Test after two hours by applying drops of water on surface.
 - a. If water penetrates, apply an additional coat of sealer.
4. Remove visible residue within 60 minutes after application.

3.4 CLEANING

- A. Perform cleaning while mortar is fresh before hardening on surfaces.

- B. Wash tile diagonally across joints.
- C. Polish with clean dry cloth.
- D. Remove grout haze following recommendation of mortar additive manufacturer.
- E. Remove residual waxes or grout release agent, temporary protective coatings, by method recommended by coating manufacturer.
 - 1. Confirm acceptability with brick and grout manufacturer.
 - 2. Trap and remove coating to prevent it from clogging floor drains.

3.5 PROTECTION AND REPAIR

- A. Prohibit traffic on floor finish for 72 hours after installation.
- B. Where temporary use of new floors is unavoidable, supply large, flat boards or plywood panels for walkways over kraft paper.
- C. Replace broken, cracked, chipped, stained, or damaged tile.

END OF SECTION

SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Acoustical Ceiling Systems in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM A641/A641M Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 2. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 3. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 - 4. ASTM C423 Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - 5. ASTM C635/C635M Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panels Ceilings.
 - 6. ASTM C636/C636M Standard Specification for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
 - 7. ASTM D2240 Test Method for Rubber Property - Durometer Hardness
 - 8. ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - 9. ASTM E413 Classification for Rating Sound Insulation.
 - 10. ASTM E488/E488M Standard Test Methods for Strength of Anchors in Concrete Elements.
 - 11. ASTM E580/E580M Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
 - 12. ASTM E1264 Standard Classification for Acoustical Ceiling Products.
 - 13. ASTM E1414/E1414M Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
 - 14. ASTM E1190 Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members
- B. Site Classification and Seismic Design Categories as defined in the International Building Code.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's literature indicating products comply with specifications.
- B. Samples:
 - 1. One samples of each type of tile listed in Drawing, Interior Notes and Finish Legend.
- C. Contract Closeout Information:
 - 1. Maintenance Data: See Section 01 78 23.
 - 2. Interior finish fire performance data: See Section 01 78 26.
 - a. Provide for each finish material and type specified:
 - 1) Manufacturer's printed information including:
 - a) Fire class.

- b) NFPA test number.
- c) Photograph.
- 2) Proof of purchase.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Steel Suspension Systems:
 - 1. Base:
 - a. Armstrong World Industries.
 - 2. Optional:
 - a. USG Corporation
 - b. Chicago Metallic
- B. Aluminum Suspension Systems, non-gasketed:
 - 1. Base:
 - a. Armstrong World Industries
 - 2. Optional:
 - a. USG Corporation
 - b. Chicago Metallic
- C. Formed Edge Systems:
 - 1. Base:
 - a. Armstrong World Industries
 - 2. Optional:
 - a. Chicago Metallic
 - b. Gordon Interior Specialties Division
 - c. Hunter Douglas
- D. Acoustical Ceiling Tile:
 - 1. Base:
 - a. As noted for individual types in Interior Finish Legend.
 - b. Armstrong World Industries.
 - 2. Optional:
 - a. USG.
 - b. CertainTeed.
 - c. Rockfon.
- E. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 ACOUSTIC SUSPENSION SYSTEMS

- A. General Requirements:
 - 1. Heavy duty systems, ASTM C635/C635M.
 - 2. Main runner jointing by spliced, interlocking ends, tab locks, pin locks, or other suitable connections.
 - 3. Cross runners interlocking with main runners.
 - 4. Include components and accessories necessary resist seismic loads and dead loads of items such as light fixtures and air diffusers.
 - 5. Hanger Wire:

- a. Pre-stretched, with a yield stress load of at least 5 times design load, but not less than 0.106 inches (12 GA) 2.7 mm.
 - b. Utilize continuous lengths, without kinks and splices.
 - c. Galvanized Steel:
 - 1) Galvanized, soft annealed steel wire conforming to ASTM A641/A641M.
- 6. Attachment Devices:
 - a. Anchors in Concrete:
 - 1) Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing per ASTM E488/E488M or ASTM E1512.
 - 2) Acceptable types: Cast-in-place, post-installed expansion anchors and post-installed bonded anchors.
 - 3) Material: Carbon-steel components zinc plated to comply with ASTM B633, Class Fe/Zn 5 for Class SC 1 service condition.
 - 4) Material: Stainless-steel components complying with ASTM-F593 and ASTM-F594, Group 1 Alloy 304 or 316.
 - b. Power-Actuated Fasteners in Concrete:
 - 1) Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E1190.
- B. Suspension System Types:
 - 1. Exposed steel grid, non-rated:
 - a. Description: Galvanized, double web steel, main and cross runners.
 - b. Face width: 15/16 inches 24 mm.
 - c. Base Product:
 - 1) Refer to Interior Finish Legend.
 - 2) Prelude XL, by Armstrong.
 - 3) Donn DX/DXL by USG.
 - 4) 200 Series by Chicago Metallic.
 - 5) 1200 Series by Chicago Metallic.
 - d. Finish on exposed surfaces: Smooth, flat white.
 - 2. Exposed steel grid, fire rated:
 - a. Description: Galvanized double web steel, main and cross runners.
 - b. Face width: 15/16 inches 24 mm.
 - c. Base Product:
 - 1) Prelude XL Fire Guard by Armstrong.
 - d. Finish on exposed surfaces: Smooth, flat white.
 - e. Components: UL labeled.
 - 3. Narrow grid, non-rated:
 - a. Description: Narrow, articulated face.
 - b. Face width: 9/16 inches 14 mm.
 - c. Base Product:
 - 1) Refer to Interior Finish Legend.
 - 2) Superfine XL by Armstrong.
 - 3) 3500 Series by Chicago Metallic.

- 4) 3570 Series by Chicago Metallic.
 - d. Finish on exposed surfaces: Smooth, flat white.
- 4. Formed Edge System:
 - a. Base Product:
 - 1) Axiom by Armstrong.
 - b. Profile: As shown in Drawings.
 - c. Dimensions: As shown in Drawings.
- 5. Framing and suspension systems for Gypsum Board Ceilings:
 - a. Specified in Section 09 22 16.

2.3 ACOUSTICAL CEILING TILE

- A. General Requirements:
 - 1. Scheduled finishes to be factory applied.
 - 2. Class A incombustible units.
 - 3. Fire rated units (when used): UL labeled.
 - 4. Edges uniformly fabricated, true, square.
 - 5. Sizes as required to fit scheduled suspension system.
 - 6. Standard tile/panel size: See Reflected Ceiling Plan.
- B. Ceiling Tile Types:
 - 1. Basic Mineral Fiber Ceiling Tile:
 - a. Description: Wet-formed mineral fiber with acoustically transparent membrane and factory-applied latex paint.
 - b. Base Product: Ultima by Armstrong.
 - c. Classification: ASTM E1264, Type IV, Form 2, Pattern E.
 - d. Surface Texture: Smooth.
 - e. Light reflectance: Not less than 0.88.
 - f. NRC: Not less than 0.75.
 - g. Edge: Square.
 - h. Thickness: Minimum 3/4 inches 19 mm.
 - 2. Diffusers and Grilles: See Section 23 31 13.
- C. Light Fixtures: See Section 26 51 13.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrate to accept installation.
- B. Examine installation site for irregularities having effect on quality and execution of work.
- C. Consult other trades involved before start of ceiling work, to determine areas of potential interference.
- D. Do not start installation until interferences have been resolved.
- E. Installation constitutes acceptance of responsibility for performance.

3.2 PREPARATION

- A. Coordinate ceiling layout with sprinkler head spacing and work penetrating acoustical ceiling systems.
- B. Tolerances:

1. Comply with ASTM C635/C635M Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
2. Deviation from level plane: 1/8 inches in 10 feet 3 mm in 3 m with no load applied maximum.
3. Bow: 1/32 inches in 2 feet 0.8 mm in 610 mm maximum.
4. Camber: 1/32 inches in 2 feet 0.8 mm in 610 mm maximum.
5. Twist: 1 degree in 2 feet 1 degree in 610 mm maximum.

3.3 INSTALLATION

A. Suspension System:

1. Install suspension system in accordance with manufacturers' instructions.
2. Install suspension system in accordance with manufacturer's instructions, and California Title 24.
3. Grid layout:
 - a. See Reflected Ceiling Plans.
 - b. Install grid based on electrical lighting fixture layout indicated in Electrical Drawings, unless otherwise indicated,
 - c. Acoustical panel dimension at perimeter walls: Not less than 6 inches 150 mm.
 - d. In case of conflict notify Architect.
4. Install grid square with room and with grid or acoustical panel center lines coinciding with center lines of room, each direction.
5. Intersections between main tees and cross tees:
 - a. Butt cut and notch as required.
6. Wall angles:
 - a. Install wall angles or moldings where ceilings meet walls, partitions, vertical elements, and other types of ceilings or ceiling fixtures.
 - 1) Secure angles to wall construction at stud locations.
 - a) Maximum spacing from terminal ends: 3 inches 76 mm.
 - b) Draw fasteners tight against vertical surfaces.
 - 2) Level tolerance: not more than 1 in 1000.
 - 3) Miter cut inside and outside corners.
 - 4) Install with leg supporting bottom flange of runners.
7. Hanger wires:
 - a. Provide hangers and inserts necessary to support ceiling suspension systems and ceiling dead loads.
 - b. Coordinate location and alignment with work of other trades.
 - c. Install hanger wires plumb to main tees and cross tees.
 - 1) Do not suspend any part of suspension system from ducts, pipes, conduit, cable tray or equipment.
 - 2) Provide supplementary rough suspension system where necessary to support ceilings beneath pipes, ducts, equipment, cable trays.
 - 3) Splay hangers no greater than 30 degrees from vertical to avoid obstructions or other conditions that prevent plumb, vertical installation.
 - 4) Offset horizontal forces by bracing or counter-splaying.
 - d. Space hangers to prevent eccentric deflection and rotation due to loads from items in or on ceiling.
 - 1) Provide supplemental hangers to support lighting fixtures and within 6 inches 150 mm from end of main runners and fixtures which exceed manufacturer's published load data.

- 2) Do not bear runners on walls or partitions.
 8. Main runners:
 - a. Utilize wall angles to align and receive terminal ends of main tees without transferring load to wall angle.
 - b. Space main tees as indicated to receive lay-in panels and fixtures.
 - c. Support terminal ends of main tees by wires located within 6 inches 150 mm from boundary walls.
 9. Cross runners:
 - a. Space cross tees as indicated to receive lay-in panels and fixtures.
 - 1) Install cross runners with positive interlock.
 - b. Utilize wall angles to align and receive terminal ends of cross tees without transferring load to wall angle.
 - c. Support terminal ends of cross tees by wires located within 6 inches 150 mm from boundary walls.
 10. Leave suspension system ready to accept installation of acoustic materials.
- B. Lay-In Items:
1. Install acoustic materials in accordance with manufacturer's instructions.
 2. Place lay-in panels, fixtures, diffusers, grilles, and similar items in manner not compromising suspension system performance.
 3. Field cut materials to fit grid.
 4. Tegular and similar tiles with articulated edges:
 - a. Cut edges to match profile of factory edges and paint to match.
 5. Ceiling paint:
 - a. Touch-up minor surface scratches and blemishes.
 - b. Cover field cut edges exposed to view.
 - c. Armstrong SuperCoat Ceiling Panel Touch-up Paint.
- C. Identify access tile with a white headed thumb tack.
- 3.4 CLEANING:**
- A. Clean all surfaces following installation per manufacturer's cleaning instructions.
 - B. Maintenance per Manufacturer's finish maintenance instructions.
- 3.5 PROTECTION:**
- A. Protect ceilings from damage during the remainder of construction.
 - B. Finished ceilings shall be without damage. Replace units having scratches, abrasions, or other defects with new units.

END OF SECTION

SECTION 09 54 27
WOOD CEILING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Wood Ceiling System, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Architectural Woodwork Institute (AWI):
 - 1. Architectural Woodwork Standards.
 - 2. Premium grade.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Dimensioned plans of wood ceilings.
 - 2. Section details showing components, construction and supports.
- B. Product Data:
 - 1. Submit manufacturer's data.
- C. Samples:
 - 1. One samples of each veneer specified in Drawing Finish Schedule.
- D. Contract Closeout Information
 - 1. Maintenance data
 - a. See section 01 78 23.

1.4 QUALITY ASSURANCE

- A. Single Source Responsibility:
 - 1. Provide components of wood ceiling system manufactured by the same company to ensure compatibility of color, texture and physical properties.

1.5 WARRANTY

- A. Manufacturer's standard warranty for all materials, wood ceiling and grid for material and workmanship.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate and review delivery and unloading with manufacturers recommendations
- B. Acclimatization: before installing wood panels, permit them to reach room temperature and stabilize moisture content (at least 72 hours) per AWI standards.
- C. Handling: Handle linear wood panels carefully to avoid chipping edges or damaging units in any way.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Wood Ceiling System:

1. Base:
 - a. 9Wood.
2. Optional:
 - a. ACGI by Armstrong World Industries.
 - b. Rulon International.
3. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Wood Ceiling System:
 1. 2100 Panelized Linear by 9Wood
 - a. SKU: 2114-3
 - b. Width: $\frac{3}{4}$ "
 - c. Depth: 3 $\frac{1}{4}$ "
 - d. Members per Linear Foot: 3 Members per Linear Foot
- B. Species and Grade:
 1. Veneer Species: White Oak: Rift Sliced, Driftwood Stain.
- C. Product Configuration:
 1. As detailed.
- D. by [] Panel Edge:
 1. Veneer to match face.
- E. Attachment System:
 1. Suspended according to manufacturer's suggested method of suspension.
- F. Fire Rating:
 1. Class 1(A) Fire Rating.
- G. Finish:
 1. As specified in Interiors Notes & Finish Legend.
- H. Metal Suspension System, General
 1. Metal T-Grid Suspension System: Provide standard interior metal heavy duty 15/16" suspension T Grid system using main runners, cross-tees, wall angles or shadow moldings of types, structural classification, and black finishes indicated and that comply with applicable ASTM C 635 requirements. Comply with all applicable seismic code and ordinances.
 2. Refer to manufacturers' recommendations for attachment devices.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
 1. Handle and install panels with care to prevent surface and structure damage.
 2. Panels may be field cut for penetrations. Keep field cutting to a minimum.
- B. Measure ceiling areas and establish layout for hangers and carriers, in accordance with installation instructions.
- C. Suspend panels from Contractor supplied Unistrut using manufacturer supplied hangers.
- D. Protection

1. Protect completed work above suspension system from damage during installation of suspension system components.

END OF SECTION

SECTION 09 65 13

RESILIENT BASE

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Resilient Base, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - 2. ASTM E648 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
 - 3. ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
 - 4. ASTM F1861 Standard Specification for Resilient Wall Base
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 253 Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source
 - 2. NFPA 258 Recommended Practice for Determining Smoke Generation of Solid Materials

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
 - 2. VOC content.
- B. Samples:
 - 1. Resilient Base:
 - a. One sample of material and color as specified in Drawing Finish Schedule.
- C. Contract Closeout Information:
 - 1. Maintenance data:
 - a. See Section 01 78 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Resilient Base:
 - 1. Base:
 - a. Tarkett.
 - 2. Optional:
 - a. Armstrong World Industries.
 - b. Mannington.
 - c. Roppe.
 - d. VPI Floor Products.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Performance Requirements:

1. Thermoplastic Rubber: Type TP.
2. Critical Radiant Flux:
 - a. Class I, not less than 0.45 W/cm².
3. Flame Spread: Maximum, 75.
4. Smoke Developed: Maximum, 250.

B. Resilient Base:

1. Rubber top set, coved type.
2. 1/8 by 4 inches 3 by 100 mm, 1/4 inches 6 mm wide at bottom.
3. Field formed external and internal corners.
4. Provide continuous rolls, minimum 95 feet 29 m long.

C. Resilient Base at carpet:

1. Rubber top set, straight type.
2. 1/8 by 4 inches 3 by 100 mm.
3. Field formed external and internal corners.
4. Provide continuous rolls, minimum 95 feet 29 m long.

D. Contoured Resilient Base:

1. Tarkett, Millwork Series:
 - a. Profile: as specified in Interiors Notes & Finish Legend
 - b. Size: as specified in Interiors Notes & Finish Legend
 - c. Color: as specified in Interiors Notes & Finish Legend
 - d. Adhesive as recommended by manufacturer.

E. Leveling compound: As recommended by manufacturer, compatible with adhesives.

F. Adhesives and primers:

1. As recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces for defects and irregularities.
- B. Verify substrates are free of materials that may affect adhesion.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected.
- D. Installation indicates acceptance of substrates and responsibility for performance.

3.2 PREPARATION

- A. Fill cracks, joints, etc., with water resistant non-crumbling patching compound.
- B. Trowel to smooth and proper level.

3.3 INSTALLATION

- A. Install after wall finishes.
- B. Install prior to carpet and acoustical material.
- C. Prepare substrate in accordance with manufacturer's instructions.

- D. Protect adjacent work from damage.
- E. Schedule installation to minimize accumulation of air contaminants that cannot be removed prior to occupancy.
- F. Install base after wall material has dried out thoroughly.
 - 1. Provide base at intersections of floor and vertical surfaces in areas scheduled to receive base, where intersection is exposed to view.
 - 2. Vertical surfaces include walls, partial height walls, columns, casework toes kicks, kneespaces, and cabinet sides.
 - 3. Apply primer and adhesive as recommended by manufacturer.
 - 4. Set base straight and true.
 - 5. Fit base neatly into breaks and recesses.
 - 6. Install corners as recommended by manufacturer.
 - 7. Scribe to trim at door frames.
 - 8. Make joints tight.
 - 9. Install with top and bottom edges in firm contact with wall and floor.

3.4 CLEANING

- A. Remove surplus adhesive immediately after application and rolling.
- B. Clean in accordance with manufacturer's recommendations after materials have sufficiently seated.

END OF SECTION

SECTION 09 65 19
RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Resilient Tile Flooring (RT) in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM F1700 Standard Specification for Solid Vinyl Tile
 - 2. ASTM D2047 Measuring Static Coefficient of Friction of Flooring Finishes

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings
 - 1. Indicated tile layout, orientation, patterns, installation methods, perimeter conditions, junction with dissimilar materials, adhesives and details.
- C. Samples:
 - 1. One sample of each material specified in Drawing Finish Schedule.
- D. Project Information:
 - 1. Manufacturer's data stating that adhesives comply with applicable VOC regulations.
- E. Contract Closeout Information:
 - 1. Maintenance data.
 - a. See Section 01 78 23.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Experienced in installation of resilient tile flooring.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Resilient Tile: (RT)
 - 1. Base:
 - a. Refer to Drawings Interior Finish Legend.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIAL: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Resilient Tile: (RT)
 - 1. Base Products: Refer to Drawings Interior Finish Legend.
 - 2. Reference Standard: ASTM F1066:

- a. Class 2, Through pattern tile.
- 3. Minimum Static Load Limit: 75 psi 5.3 kg/cm² per ASTM F970.
- 4. Critical Radiant Flux, per ASTM E648 / NFPA 253:
 - a. Class I, not less than 0.45 W/cm².
- 5. Smoke Developed: 450 or less per ASTM E662 / NFPA 258.
- 6. Nominal Total Thickness: Refer to Drawings Interior Finish Legend.
- 7. Nominal Tile Size: Refer to Drawings Interior Finish Legend.
- 8. Dynamic coefficient of friction: > 0.42 per ANSI 137.1.
- B. Leveling Compound:
 - 1. As recommended by manufacturer:
 - a. Compatible with adhesives.
 - b. Moisture resistant.
 - c. Non-crumbling.
 - d. VOC content shall not be greater than 100 g/L.
- C. Primers and Adhesive:
 - 1. For general use.
 - 2. As recommended by flooring manufacturer.
 - 3. Primers and adhesives shall have a VOC content no greater than 50 g/L.
- D. Transition Strip:
 - 1. Nominal Size: Slimline transitions where required.
 - 2. Use tapered profiles where abutting material is of different thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces for defects, irregularities, and conditions under which flooring and base are to be installed.
- B. Verify substrates are free of materials that may affect adhesion.
- C. Identify cracks and other surface defects which need repair prior to application of floor system.
- D. Inspect substrate for markers, paint and similar materials used for layout by others and take remedial action as necessary to remove layout line work to prevent bleed-through.
- E. Verify floors are level or meet indicated slope.
- F. Do not proceed with installation until unsatisfactory conditions have been corrected.
- G. Installation indicates acceptance of substrates and responsibility for performance.

3.2 PREPARATION

- A. Prepare substrate in accordance with manufacturer's instructions.
- B. Coordinate installation with requirements of Section 07 16 04 Concrete Floor Moisture Testing and Section 07 16 05 Water Vapor Emission Control System.
- C. Fill construction joints and other non-moving joints with product approved by manufacturer of flooring system.
- D. Coordinate leveling with vapor emission control system provider.

3.3 INSTALLATION

- A. Install flooring in accordance with manufacturer's recommendations.
- B. Install flooring wall to wall before the installation of equipment, movable partitions, etc.

1. Extend flooring into toe spaces, door recesses, closets, and similar openings.
- C. If required, install flooring on pan-type floor access covers.
 1. Maintain continuity of color and pattern within pieces of flooring installed on covers.
 2. Adhere flooring to the subfloor around covers and to covers.
- D. Scribe, cut, and fit to permanent fixtures, columns, walls, partitions, pipes, outlets, and built-in furniture and cabinets.
- E. Lay tile in patterns indicated in Drawings.
 1. Layout resilient flooring to provide equal size at perimeter.
 2. Adjust layout as necessary to reduce the amount of resilient flooring which is cut to less than half full width.
- F. Bond tile to floor, flush, tight accurate seams, and in true alignment with adjacent tiles and with finished surface.
- G. Provide tiles in one room or area from one production run.
- H. Minimize accumulation of air contaminants that cannot be removed prior to occupancy.
- I. Transitions:
 1. Where Resilient Tile Flooring abuts thicker finish flooring materials, feather leveling compound for approximately 12 inches 300 mm for each 1/8 inches 3 mm of rise so finished surfaces align.
 2. Install reducer strips at exposed edges.
 3. Install accent transition strip where tile color changes or floor finish material changes to sheet vinyl or sheet rubber:
 4. Locate transition strip directly under closed door position where seam occurs in door openings.
- J. Roll each row when finished and roll total floor when completed.
 1. Roll floor in both directions.
 2. Roll with device and weight recommended by maker of tiles to ensure that the underside mat surface is fully bonded to the glue and sub-floor.
 3. Avoid over-rolling.

3.4 ADJUST AND CLEAN

- A. Immediately after application and rolling, remove surplus adhesive.
- B. Clean floors in accordance with manufacturer's recommendations.
- C. Protect with non-staining building paper to prevent dirt and damage.
- D. Protect traffic areas with fiberboard or plywood.

END OF SECTION

SECTION 09 65 36
STATIC DISSIPATIVE RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Static Dissipative Resilient Tile Flooring, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - 2. ASTM F150 Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring
 - 3. ASTM E648 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
 - 4. ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
 - 5. ASTM F970 Standard Test Method for Static Load Limit
- B. American National Standards Institute (ANSI):
 - 1. ANSI/ESD S7.1 Resistive Characterization of Materials - Floor Materials
 - 2. ANSI/ESD STM 97.2 Floor Materials and Footware - Voltage Measurement in Combination with a Person
- C. National Fire Protection Association (NFPA):
 - 1. NFPA 101 Life Safety Code
 - 2. NFPA 253 Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source
 - 3. NFPA 258 Recommended Practice for Determining Smoke Generation of Solid Materials
 - 4. NFPA 270 Standard Test Method for Measurement of Smoke Obscuration Using a Conical Radiant Source in a Single Closed Chamber

1.3 SUBMITTALS

- A. Product Data:
 - 1. Certification of installer qualifications.
- B. Shop Drawings:
 - 1. Plans showing location of product.
 - 2. Coving details.
- C. Samples:
 - 1. One sample of each material specified in Drawing Finish Schedule.
 - 2. Full range of colors for Architect selection.
- D. Project Information:
 - 1. Field test report.
 - 2. Installation instructions.
 - 3. Manufacturer's certification of flooring tests by independent laboratory and compliant with required fire tests.

4. Statements of compliance with quality assurance requirements.
- E. Contract Closeout Information:
 1. Maintenance data:
 - a. See Section 01 78 23.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Manufacturer authorized or approved.
- B. Source Quality Control: Provide static dissipative adhesive, grounding strips, flooring, and polish by one manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Static Dissipative Resilient Tile:
 1. Base:
 - a. Armstrong World Industries, Inc.
 2. Optional:
 - a. Forbo Industries
 - b. Polyflor, Ltd.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Static Dissipative Resilient Tile:
 1. SDT Excelon Tile Flooring by Armstrong World Industries, Inc.
 2. Static load limit: 75 psi.
 3. Dynamic coefficient of friction: 0.42 minimum.
 4. Comply with requirements of ASTM F1066, including but not limited to:
 - a. Class 2 - Through-Pattern.
 - b. Dimensional tolerance.
 - c. Square-ness of manufacture.
 - d. Resistance to indentation.
 - e. Impact resistance.
 - f. Dimensional stability.
 - g. Resistance to chemicals.
 - h. Resistance to heat.
 5. Size: 12 x 12 x 1/8 inches nominal.
 6. Critical radiant flux: Class I, 0.45 W/cm² minimum.
 7. Smoke developed: 450 or less.
 8. Flame spread: 75 maximum.
 9. Electrical resistance: 1,000,000 to 1,000,000,000 ohms.
 10. Static generation:
 - a. Less than 10 volts at 40 percent relative humidity with ESD shoes
 - b. Less than 100 volts at 12 percent relative humidity with ESD shoes.
 11. Static decay: Less than 0.5 seconds from 5,000 volts to 0.0 volts.

- 12. Color and pattern:
 - a. As selected from manufacturer's current standard range.
- B. Static Dissipative Adhesive:
 - 1. S-202 Static Dissipative Tile Adhesive by Armstrong World Industries, Inc.
- C. Static Dissipative Grounding Strips:
 - 1. Manufacturer's standard copper ground connection strips.
- D. Leveling Compound:
 - 1. Type recommended by tile manufacturer.
- E. Wall Base:
 - 1. Specified in Section 09 65 13.
- F. Joint Sealant:
 - 1. Provide at top of wall base or integral cove cap.
 - 2. Plastic filler as recommended by flooring manufacturer.
- G. Accessories:
 - 1. Transition strips and reducing strips tapered to meet abutting materials.
 - 2. Threshold of thickness and width as shown on drawings.
 - 3. Resilient edge strips, width as shown on drawings with gauge equal to flooring.
 - a. Tapered edge.
 - b. Color to match flooring.
 - 4. Metal edge strip:
 - a. Concealed anchorage: Butt-type metal edge strips.
 - b. Material: Extruded aluminum, mill finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces for defects, irregularities and conditions under which flooring is to be installed.
- B. Verify substrates are dry, clean, smooth and free of paint, varnish, solvents, wax, oils, or foreign matter.
- C. Repair cracks and other surface defects.
- D. Verify floors are level or meet indicated slope.
- E. Do not proceed with installation until unsatisfactory conditions have been corrected.
- F. Installation constitutes acceptance of substrate and responsibility for performance.

3.2 PREPARATION

- A. Coordinate installation with requirements of Section 07 16 04 Concrete Floor Moisture Testing and Section 07 16 05 Water Vapor Emission Control System.
- B. Prepare substrate in accordance with manufacturer's instructions.
- C. Fill construction joints and other non-moving joints with product approved by manufacturer of flooring system.
- D. Where Static Dissipative Resilient Tile Flooring abuts thicker finish flooring materials, feather leveling compound for approximately 12 inches for each 1/8 inches of rise to align finished surfaces.

- E. Coordinate leveling with vapor emission control system provider.

3.3 INSTALLATION

- A. Provide installation under direct supervision of manufacturer's representative.
- B. Coordinate installation with other floor, wall, and ceiling work.
 - 1. Do not start work until related work of other trades in same area has been completed.
- C. Mix and apply adhesive as recommended by manufacturer.
- D. Install continuous copper grounding strips set in adhesive where recommended by manufacturer for maximum static dissipative performance.
 - 1. Coordinate location of leads with equipment grounding conductor interface provided in Division 26.
- E. Install each tile fully bonded to floor and flush, tight and in true alignment with adjacent tiles, for finished surface free from imperfections.
 - 1. Fit flooring neatly into breaks and recesses, under casework, against walls, around pipes, and other installations and obstructions.
 - 2. Lay out tile in a manner to avoid tiles of less than 1/2 size.
 - 3. Install edging strips where edge of floor covering is exposed.
 - a. Install accent strips in door openings, located directly under door when door is in closed position.
- F. Install tile flooring and base as scheduled for rooms under and behind equipment.
- G. Roll flooring using smooth roller.

3.4 FIELD TESTING

- A. Perform resistance testing of completed floor per following:
 - 1. Conduct field tests in accordance with ASTM F150.
 - 2. Perform one test for each 2500 square feet of floor, but not less than one test for each room.
- B. Correct areas failing to comply with electrical resistance requirements, including replacement of flooring if necessary.
 - 1. Retest flooring until electrical resistance requirements comply.
 - 2. Submit final test report.

3.5 CLEANING

- A. Clean floors as recommended by manufacturer just prior to occupancy.

3.6 PROTECTION

- A. Provide non-staining protection for finished flooring until building is ready for occupancy.

END OF SECTION

SECTION 09 66 23
THIN-SET EPOXY TERRAZZO

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Thin-Set Epoxy Terrazzo, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Written certification of compliance with NTMA requirements.
 - 2. Manufacturer's installation instructions and certificate indicating that materials comply with specifications.
 - 3. Manufacturer's written approval of installer.
- B. Shop Drawings:
 - 1. Joint treatments, edge conditions and layout.
 - a. Details of anchorage and special features.
- C. Samples:
 - 1. Three samples 6 inches 150 mm square of each material specified in Drawing Finish Schedule.
 - 2. Samples of pattern and color of terrazzo for review of color, pattern, and texture.
- D. Contract Closeout Information:
 - 1. Maintenance data:
 - a. See Section 01 78 23.

1.3 QUALITY ASSURANCE

- A. Contractor's Qualifications:
 - 1. Installation must be by a manufacturer-certified applicator with skilled mechanics having not less than 3 years of satisfactory experience in the installation of the type of system as specified in this section.
 - 2. Installer certified in writing by the manufacturer of the Thin-set Epoxy Terrazzo Flooring System.
 - 3. Current contractor member in good standing with the National Terrazzo Mosaic Association (NTMA).
- B. Source Quality Control: Obtain materials from same source manufacturer.
- C. Comply with recommendations of National Terrazzo and Mosaic Association, (NTMA).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Synthetic Matrix Terrazzo:
 - 1. Base:
 - a. Terrazzo & Marble Supply Companies
 - 2. Optional:
 - a. Dex-O-TeX

- b. Sherwin-Williams High Performance Flooring.
- B. Divider Strips:
 - 1. Base:
 - a. Domus
 - b. Manhattan American.
 - c. National Metal Shapes, Inc.
 - d. Creative Edge.
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

- A. Physical Properties:
 - 1. Hardness, at 24 hours, Shore D, ASTM D2240: 85/65.
 - 2. Compressive Strength, ASTM D695: 10,000 psi.
 - 3. Tensile Strength, ASTM D638: 3000 psi.
 - 4. Water Absorption, ASTM D570: 0.10 percent.
 - 5. Adhesion, ACI-503R: 300 psi, 100 percent concrete failure.
 - 6. Abrasion Resistance, ASTM D4060: CS-17 Wheel, 70-90 milligrams lost.
 - 7. Flammability, ASTM D635: Self-extinguishing over concrete.
 - 8. Flexural Strength, ASTM D790: 4500 psi.
 - 9. Impact Resistance, MIL-D-3134, Sec. 4.7.3: 16 ft-lbs without cracking, delamination, or chipping.
 - 10. Resistance to Elevated Temperatures, MIL-D-3134J: No slip or flow at required temperature of 158 deg F.
 - 11. Slip Resistance, ANSI 137.1: Compliant.

2.3 MATERIALS

- A. Synthetic Matrix Terrazzo Flooring System:
 - 1. Factory-mixed, thermosetting, epoxy resin and hardener, mineral filler, and pigment. 100 percent non-volatile, complying with or exceeding NTMA requirements.
 - 2. Integral Cove Base:
 - a. Form integral coved base with top bead and divider strip.
 - b. Cove: 1 inch 25 mm radius.
 - c. Height: 6 inches 150 mm.
 - d. Horizontal: maximum of 2 inches 50 mm from wall to divider strip.
 - e. Place divider strips in base at same interval as floor.
 - 3. Finished Terrazzo Thickness:
 - a. 3/8 inches 10 mm.
 - b. Base Product: Thin-Set Epoxy Terrazzo by Terroxy Resin System
 - 4. Optional:
 - a. Resufloor Terrazzo TG by Sherwin-Williams High Performance
 - b. Cheminert Terrazzo by Dex-O-Tex.
- B. Binder Resin:
 - 1. Base Product: Terroxy binder Resin by Terroxy Resin System
- C. Aggregate:
 - 1. Natural, sound, crushed marble chips, color, and grading to match Architect's approved sample.

2. Colors and chip size as selected by Architect. provided in Interior Notes & Finish Legend
 - a. Up to three different colors of chips may be selected for each color of terrazzo.
 3. Use maximum size aggregate, within limits of workability for flooring thickness indicated.
- D. Crack and Joint Filler:
1. Epoxy base.
 - a. Base Manufacturer: As recommended by matrix manufacturer.
- E. Crack Isolation Membrane:
1. High solids flexible epoxy membrane and fiberglass scrim.
 - a. Base Product: As recommended by matrix manufacturer
- F. Finishing Grout / Filler:
1. Compound with filler and pigments, as recommended by matrix manufacturer.
 2. Base Product: Terroxy Industrial Coating and Terroxy UB Clear by Terroxy Resin System.
- G. Finish Sealer:
1. Compound furnished or approved by matrix manufacturer.
- H. Divider Strips:
1. Style: As required for type and thickness of terrazzo.
 2. Material and shape manufactured as terrazzo divider strip.
 3. Material:
 - a. White alloy zinc or aluminum.
 4. Size:
 - a. 1/8 inch 2.6 mm by depth matching the thickness of terrazzo.
- I. Accessory Strips:
1. Provide Cove Base Beads, Cove Divider Strips, and other items necessary to install work.
 2. Material: Match floor divider strips.
- J. Adhesives and Sealants:
1. As recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces for defects, irregularities, and conditions under which flooring is to be installed.
- B. Verify substrates are free of materials that may affect adhesion.
- C. Identify cracks and other surface defects which need repair prior to application of floor system.
- D. Inspect substrate for markers, paint and similar materials used for layout by others and take remedial action as necessary to remove layout line work to prevent bleed-through.
- E. Verify floors are level or meet indicated slope.
- F. Do not proceed with installation until unsatisfactory conditions have been corrected.
- G. Installation indicates acceptance of substrates and responsibility for performance.

3.2 PREPARATION

- A. Evaluate substrate condition, including substrate moisture transmission, quantity and severity of cracking, and the extent of repairs needed.

- B. Coordinate installation with requirements of Section 07 16 04 Concrete Floor Moisture Testing and Section 07 16 05 Water Vapor Emission Control System.
- C. Prepare cracks, construction joints, control joints and other non-moving joints with specified products in accordance with manufacturer's recommendations.
- D. Expansion joints and similar moving joints:
 - 1. Terrazzo System to terminate at the edge of isolation and expansion joints.

3.3 INSTALLATION

- A. Apply each component of Thin-set Epoxy Terrazzo Flooring System in compliance with manufacturer's written installation instructions and strictly adhere to mixing and installation methods, recoat windows, cure times and environmental restrictions.
- B. Prime in accordance with manufacturer's instructions.
- C. Install divider and accessory strips in adhesive without voids below strips.
- D. Align cove divider strips with floor divider strips.
- E. Place matrix and aggregates.
- F. Ensure that fluids from grinding operation do not react with metal strips to stain adjacent surfaces.
- G. Finish Sealer:
 - 1. Seal surface with finish sealer after thoroughly curing and cleaning.
 - a. Wash surfaces with a neutral cleaner.
 - b. Rinse with clean water and allow surface to dry.
 - c. Apply sealer in accordance with sealer manufacturer's directions.

3.4 PROTECTION

- A. Protect flooring from damage and wear during other phases of the construction operation, using temporary covers as recommended by the manufacturer, if required. Remove temporary covering just prior to final inspection.

3.5 CLEANING

- A. Clean flooring prior to final inspection, using materials and procedures as recommended by flooring manufacturer.

END OF SECTION

SECTION 09 67 81
CONCRETE FLOOR SEALER

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Concrete Floor Sealer, as indicated, in accordance with provisions of the Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - 2. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Contract Closeout Information:
 - 1. Maintenance data:
 - a. See Section 01 78 23.

1.4 QUALITY ASSURANCE

- A. Applicator Qualifications:
 - 1. Licensee of or approved in writing by manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Concrete Floor Sealer:
 - 1. Base:
 - a. L&M Construction Chemicals, Laticrete International, Inc.
 - 2. Optional:
 - a. Dayton Superior
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Concrete Floor Sealer:
 - 1. Water-based, low VOC, acrylic copolymer solutions that cure, seal and dustproof concrete with minimal yellowing.
 - 2. Conform to ASTM C1315, Type I, Class A.
 - 3. VOC compliant.
 - 4. Meet local air quality regulations.
 - 5. Minimum Solids Content: 30 percent by volume.

6. Primer: As recommended by manufacturer.
7. Base Product:
 - a. L&M Dress & Seal WB 30 by Laticrete International, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Cure concrete as directed by sealer manufacturer.
- B. Verify concrete is free of fins, ridges, voids and suitable to accept installation.
- C. Examine surfaces to receive sealer. Notify Architect if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.
- D. Installation constitutes acceptance of responsibility for performance.

3.2 PREPARATION

- A. Verify curing agents used are compatible with coating system or completely remove.
- B. Remove dirt, dust, oil, grease, asphalt, and foreign matter.
- C. Patch holes or voids.
- D. Rout out cracks exceeding 1/16 inches 1.5 mm wide and caulk.
- E. Caulk non-moving joints up to 1 inch 25 mm wide with suitable backer and sealant.
- F. Do not caulk or overcoat joints where movement exceeds 25 percent or joints over 1 inch 25 mm wide.
- G. Protect adjacent surfaces not designated to receive curing compound.

3.3 INSTALLATION

- A. Do not apply to surfaces scheduled to receive cementitious coatings or toppings, such as concrete, terrazzo, polyester, or epoxy coatings.
- B. Apply in accordance with manufacturer's recommendations; minimum 2 coats.
 1. Apply first coat at not over 400 square feet/gal 9.8 m²/L.
 2. Apply subsequent coat not over 400 square feet/gal 9.8 m²/L.
- C. Allow no traffic on sealed surface for 72 hours after application.

3.4 PATCHING AND CLEANING

- A. Patch areas which fail to match adjacent work.
- B. Broom clean surface after completion of work.

END OF SECTION

SECTION 09 68 13
TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Carpet Tile in accordance with provisions of the Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. American Society of Testing and Materials (ASTM):
 - 1. ASTM D1335 Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings.
 - 2. ASTM D3936 Standard Test Method for Resistance to Delamination of the Secondary Backing of Pile Yarn Floor Covering.
 - 3. ASTM D5116 Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.
 - 4. ASTM D5417 Standard Practice for Operation of the Vettermann Drum Tester.
 - 5. ASTM E648 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
 - 6. ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 253 Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source
 - 2. NFPA 258 Recommended Practice for Determining Smoke Generation of Solid Materials.
- C. American National Standards Institute (ANSI):
 - 1. ISO 14040 Environmental Management - Life Cycle Assessment - Principles And Framework.
 - 2. ISO 14044 Environmental Management - Life Cycle Assessment - Requirements And Guidelines.
- D. Carpet and Rug Institute (CRI):
 - 1. CRI TM101 Assessment of Carpet Surface Appearance Change.
 - 2. CRI TM102 Fluorochemical Finishes.
 - 3. CRI-104 Standard for Installation of Commercial Carpet.
 - 4. CRI Green Label program.
 - 5. CRI Green Label Plus program.
- E. Consumer Product Safety Commission (CPSC):
 - 1. 16 CFR Part 1630 - Standard for the Surface Flammability of Carpets and Rugs (FF-1-70).
- F. American Association of Textile Chemists and Colorists (AATCC):
 - 1. AATCC TM16.3 Colorfastness to Light: Xenon-Arc.
 - 2. AATCC TM20 Fiber Analysis – Qualitative.
 - 3. AATCC TM129 Colorfastness to Light: Xenon-Arc.
 - 4. AATCC TM134 Electrostatic Propensity of Carpets.
 - 5. AATCC TM164 Colorfastness to Oxides of Nitrogen in the Atmosphere Under High Humidities.

6. AATCC TM171 Carpets: Cleaning of, Hot Water Extraction.
7. AATCC TM189 Fluorine Content of Carpet Fibers.

1.3 SUBMITTALS

- A. Product Data:
 1. For each type of material and accessory.
- B. Shop Drawings:
 1. Indicate tile layout, orientation, patterns, installation methods, color arrangement, perimeter conditions, junctions with dissimilar materials, adhesive, and details.
- C. Samples:
 1. Standard size sample of each material and color specified in Drawing Finish Schedule.
- D. Contract Closeout Information:
 1. Maintenance data:
 - a. See Section 01 78 23.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 1. Carpet manufacturer shall have no less than ten years of production experience with carpet similar to type specified in this document; and whose published product literature clearly indicates compliance of products with requirements of this section.
- B. Contractor Qualifications:
 1. Firm with not less than five years of successful carpeting experience similar to work of this section and recommended and approved by the carpet manufacturer. Upon request, submit letter from carpet manufacturer stating certification qualifications and acceptance.
- C. Installer Qualifications:
 1. Mill-trained skilled mechanics supervised by experienced superintendent with 50,000 yards experience.
- D. Single Source Responsibility:
 1. Provide product material by a single manufacturer for each carpet type specified.
- E. Fire and Smoke Compliance:
 1. Comply with 16 CFR Part 1630 - Standard for the Surface Flammability of Carpets and Rugs (FF-1-70)
 2. Critical Radiant Flux, per ASTM E648 and NFPA 253:
 - a. Class I, not less than 0.45 W/cm².
 3. Smoke Developed:
 - a. 450 or less per ASTM E662 / NFPA 258.

1.5 EXTRA MATERIAL

- A. Provide minimum of 1 box additional material of each type, pattern and color for maintenance purposes.
- B. Refer to Section 01 78 43 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Carpet Tile (CPT, WCPT1):
 1. Base:

- a. As specified in Drawing Finish Schedule.
 - B. Other manufacturers desiring approval comply with Section 01 61 00.
- 2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS**
- A. Carpet Tile:
 - 1. First quality, no seconds or imperfections.
 - 2. Deliver with mill register numbers attached.
 - 3. Comply with applicable state and local codes.
 - B. Carpet Edging Strips:
 - 1. Base Product: Carpet to Resilient Transition 170 by BurkeMercer.
 - 2. Color as selected by Architect.
 - C. Leveling Compound:
 - 1. Non-crumbling, non-staining, cementitious type.
 - 2. Install in thickness from 1/8 inch to 1-1/2 inches.
 - 3. Compressive strength 5,000 pounds at 28 days.
 - 4. Prepare surface with manufacturer recommended primer.
 - 5. K 15 by Ardex or Ultraplan 1 Plus by Mapei.
 - D. Patching Compound:
 - 1. Fill cracks, joints, holes, or uneven areas with polymer modified cement-based compound.
 - 2. Install from featheredge to 1 inch thick.
 - 3. Feather Finish by Ardex or Planiprep SC by Mapei.
 - E. Adhesive:
 - 1. Non-staining, non-bleeding, strippable type.
 - 2. As recommended by carpet manufacturer with VOC content no greater than 50 g/L.
 - 3. Allow removal of carpet without damage or adherence to carpet.
 - F. Carpet Types:
 - 1. See material and color specified in Interior Finish Schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify concrete floor surfaces are suitable for Carpet Tile installation.
- B. Coordinate installation with requirements of Section 07 16 04 Concrete Floor Moisture Testing and Section 07 16 05 Water Vapor Emission Control System.

3.2 PREPARATION

- A. Clean areas to receive carpet tile.
 - 1. Strip waxes and finishes.
 - 2. Vacuum and wet mop.
- B. Layout:
 - 1. Arrange joints symmetrically at centerline of rooms.
 - 2. Lay and match adjacent tiles for pile and pattern directions.

3.3 INSTALLATION

- A. Install carpet patterns in accordance with layouts indicated in Drawings.
 - 1. Develop templates as required.
- B. Comply with manufacturer's instructions and recommendations for seam locations and lay of carpet pile.
 - 1. Do not mix dye lots in same area.
 - 2. Install carpet under open bottom items, removable flanges, furnishings, alcoves, and closets.
 - 3. Install tight against walls, columns, cabinets, and over recessed door closers.
 - 4. Butt edges tight without distortion.
 - 5. Where carpet tiles abut deeper finish flooring materials, feather leveling compound for approximately 12 inches 25 mm for each 1/8 inches 3 mm of rise so finished surfaces align.
 - 6. Fill or level floors at uneven areas with leveling compound and feather minimum 4 feet 1.2 m.
 - 7. Expansion joints:
 - a. Do not bridge building expansion joints with continuous carpeting.
 - b. Provide for movement.
- C. Install carpet edging strips, transition strips and reducer strips at non-carpeted floor surface.
 - 1. Conceal cut edges with protective edge guards or overlapping flanges.
 - 2. Score and trim narrow end of reducer strip to conform to adjacent floor finish.

3.4 CLEAN

- A. Remove spots and adhesive from face or seams in accordance with manufacturer recommendations.
- B. Vacuum using pile lifter.
- C. Advise Owner regarding care and maintenance.

END OF SECTION

SECTION 09 91 13

EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Exterior Painting, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Definitions:
 - 1. "Paint" and "painting" refer to applied coatings.
 - 2. Mechanical work and equipment: Work included in Mechanical Specification Divisions.
 - 3. Electrical work and equipment: Work included in Electrical Specification Divisions.
- B. Work Included:
 - 1. Exterior surfaces scheduled to be painted, unless indicated to be painted under other sections.
 - 2. Exposed exterior and on-site concrete masonry unit surfaces, including areaway walls, backside faces of parapets, screen walls, and retaining walls.
 - 3. Mechanical and electrical work:
 - a. Exterior equipment and items not completely factory finished.
- C. Surfaces not to be painted:
 - 1. Anodized aluminum, stainless steel, chromium plate, glass, copper, bronze or similar materials.
 - 2. Moving parts of valves, operating units, mechanical and electrical parts, such as valve and damper operators, sending devices, motor and fan shafts.
 - 3. Code labels, such as UL, FM that are Mylar or flat, non-embossed, plates.
 - a. Embossed plates and labels stamped into frames will be painted, label and information on label to be readily visible and convenient for identification by authority having jurisdiction.
 - 4. Equipment identification or rating plates.
 - 5. Items having complete factory finish with exception of:
 - a. Exterior mechanical equipment.
 - b. Exterior electrical equipment.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's data for each paint type to be applied indicating conformance to specifications.
- B. Samples:
 - 1. Manufacturer's full palette of colors for selection by Architect.
 - 2. Provide three 8-1/2 inches x 11 inches samples of each color and finish selected.
 - 3. MPI Gloss samples.
- C. Contract Closeout Information:
 - 1. Maintenance data:
 - a. See Section 01 78 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide paint as product of one manufacturer as far as possible.
- B. Paint, stain, and coating systems listed are Sherwin Williams unless noted otherwise.
 - 1. Use comparable performance and aesthetic requirements for Paints by Optional manufacturers.
- C. Paints:
 - 1. Base:
 - a. Sherwin-Williams.
 - 2. Optional:
 - a. Benjamin Moore.
 - b. PPG Paints.
- D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Paints and Stain Systems:
 - 1. Paint, stain, and coating systems listed are Sherwin-Williams unless noted otherwise.
 - 2. Colors:
 - a. As selected by Architect from manufacturer's full palette and as indicated in Section 23 05 53.
- B. Gloss range: MPI Standards as measured in accordance with ASTM D523:
 - 1. Gloss Level 1, Flat: Maximum 5 at 60 degrees, maximum 10 at 85 degrees.
 - 2. Gloss Level 2, Velvet: Maximum 10 at 60 degrees, 10-35 at 85 degrees.
 - 3. Gloss Level 3, Eggshell: 10-25 at 60 degrees, 10-35 at 85 degrees.
 - 4. Gloss Level 4, Satin: 20-35 at 60 degrees, minimum 35 at 85 degrees.
 - 5. Gloss Level 5, Semi-gloss: 35-70 at 60 degrees.
 - 6. Gloss Level 6, Gloss: 70-85 at 60 degrees.
 - 7. Gloss Level 7, High gloss: More than 85 at 60 degrees.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces for defects and correct to prevent unsatisfactory results.
- B. Verify compatibility of intermediate and topcoat finishes applied over surfaces primed by others.
- C. Commencement of work constitutes acceptance of surfaces and responsibility for performance.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Clean substrates of substances that could affect appearance or impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
 - 2. Remove mildew and neutralize surface.

- C. Prior to painting, test surfaces with moisture meter.
 - 1. Paint when moisture is within paint manufacturer's acceptable limits.
- D. Wood:
 - 1. Immediately before applying finish:
 - a. Sand surfaces with 180 grit or finer sandpaper, as necessary to accomplish the following:
 - 1) Smooth surface texture.
 - 2) Prepare grain to receive finish.
 - b. Remove dust.
 - 2. Opaque Finishes:
 - a. After priming coat has dried, seal knots, pitch and resinous sapwood.
- E. Ferrous Metal and Hollow Metal:
 - 1. Follow requirements of SSPC SP1 and SP3.
 - a. Except where higher prep levels are indicated.
 - 2. Wire brush, or grind as necessary to remove shoulders at edge of sound paint to prevent telegraphing.
 - 3. Touch up damaged shop coats.
 - 4. For surfaces with touched up shop coat, omit first coat.
 - 5. Hollow metal frame joints at intersections of Rabbets, Stops, and Soffit Joints:
 - a. Neatly fill corner seam with painter's caulk (in field) prior to painting.
- F. Galvanized Metal and Non-anodized Aluminum:
 - 1. Follow requirements of SSPC SP1.
 - 2. Treat surfaces with galvanized surface cleaner as recommended by primer and topcoat manufacturer.

3.3 APPLICATION

- A. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items, or provide ample in place protection.
- B. Touch up abraded areas of shop prime coats, suction or hot spots in plaster, gypsum wallboard, concrete block, and concrete before painting.
- C. Provide coverage to hide.
 - 1. Evenly spread and smoothly flow on for full, smooth cover.
 - 2. Apply additional coats where undercoats show until paint film is of uniform finish and color.
- D. Back prime wood trim with penetrating sealer.
- E. Apply additional coats in accordance with manufacturer's instructions.
- F. Finish closets and semi-exposed surfaces to match nearest adjoining surfaces.
 - 1. Include surfaces behind grills.
- G. Upon completion of painting, replace removed items and remove protection.
- H. Finish colors not indicated shall be selected by Architect from paint manufacturer's standard colors.

3.4 PROTECTION AND CLEANUP

- A. Provide WET PAINT signs.
- B. Protect adjacent work from damage by painting and finishing work.
- C. Remove temporary protective wrappings, after completion of operations.

D. Clean, repair or replace, and repaint damaged work.

3.5 EXTERIOR PAINT SYSTEMS

A. Metal Doors, Frames and Miscellaneous Metals - Ferrous, Primed, Zinc-coated, and Aluminum:

1. Water based urethane, Gloss Level 4, Semi-Gloss:

a. Sherwin-Williams:

- 1) Prime coat: Pro Industrial Pro-Cryl Universal Acrylic Primer.
- 2) Intermediate coat: Water based Acrolon 100 Urethane, Semi-Gloss.
- 3) Topcoat: Acrolon 100 Urethane, Semi-Gloss.

B. Metal Stairs, Handrails, and Guardrails - Ferrous, Primed, Zinc-coated, and Aluminum:

1. Water based urethane, Gloss Level 6, Gloss:

a. Sherwin-Williams:

- 1) Prime coat: Pro Industrial Pro-Cryl Universal Acrylic Primer.
- 2) Intermediate coat: Water based Acrolon 100 Urethane, Gloss.
- 3) Topcoat: Water based Acrolon 100 Urethane, Gloss.

C. Architectural Structural Steel: Bus Canopy Steel, Bus-sign posts, Fences, Other exterior atmospheric exposed steel.

1. Epoxy (PNTE), Gloss Level 6 (Gloss):

a. MPI:

- 1) Prime coat: Recommended by topcoat manufacturer for substrate.
- 2) Intermediate coat: Epoxy, High Build, Macropoxy 646, Gloss Level 6.
- 3) Topcoat: Acrylic Polymer, Acrylon Ultra, Gloss Level 6.

END OF SECTION

SECTION 09 91 23

INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Interior Painting, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Definitions:
 - 1. "Paint" and "painting" refer to applied coatings, except Section 09 96 59, Section 09 91 13, and Section 07 19 16.
 - 2. Finished room or space: Room or space indicated to receive a finish on Drawing Finish Schedule.
 - 3. Mechanical work: Work included in Mechanical Specification Divisions.
 - 4. Electrical work: Work included in Electrical Specification Divisions.
- B. Work Included:
 - 1. Interior surfaces in finished rooms or spaces, unless indicated not to be painted or indicated to be painted under other sections.
 - 2. Mechanical and electrical work:
 - a. Interior mechanical and electrical equipment not completely factory finished.
 - b. In finished rooms and spaces: Exposed ductwork, piping, insulated piping, conduit, busways, raceways, fire protection piping, fittings and supports and associated accessories.
 - c. Where duct surfaces are visible through grilles or diffusers, paint visible surfaces of ducts flat black.
- C. Surfaces Not to be Painted:
 - 1. Anodized aluminum, stainless steel, chromium plate, glass, copper, bronze or similar materials.
 - 2. Moving parts of valves, operating units, motor and fan shafts, sending devices or mechanical and electrical parts such as valve and damper operators.
 - 3. Code labels, such as UL, FM that are mylar or flat, non-embossed plates.
 - a. Embossed plates and labels stamped into frames are to be painted.
 - b. Information shall be readily visible and convenient for identification by authority having jurisdiction.
 - 4. Equipment identification or rating plates.
- D. Factory Finishing of Wood Items Specified Elsewhere:
 - 1. Flush Wood Doors: See Section 08 14 16.
- E. ASTM International (ASTM):
 - 1. ASTM D2486 Standard Test Method for Scrub Resistance of Interior Latex Flat Wall Paints.
 - 2. ASTM D2805 Standard Test Method for Hiding Power of Paints by Reflectometry.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's data for each paint system specified.

- B. Samples:
 - 1. Two 8 1/2 inches x 11 inches samples of each color and finish as noted in Drawing Finish Schedule.
- C. Contract Closeout Information:
 - 1. Maintenance data:
 - a. See Section 01 78 23.

1.4 EXTRA MATERIAL

- A. Provide 1 GAL L of each type, color or size specified.
- B. See Section 01 78 43.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Paints:
 - 1. Base:
 - a. Sherwin-Williams
 - 2. Optional:
 - a. Benjamin Moore
 - b. PPG Paints
- B. Stains and Varnishes:
 - 1. Base:
 - a. Sherwin-Williams
 - 2. Optional:
 - a. Benjamin Moore
 - b. PPG Paints.
 - c. Pratt & Lambert
- C. Structural Steel Paint - See Section 05 12 10 for primer:
 - 1. Base:
 - a. Sherwin-Williams
 - 2. Optional:
 - a. Benjamin Moore
 - b. PPG Paints
- D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Manufacturers listed as noted in Drawing Finish Schedule are for color reference only.
- B. Provide paint products from one manufacturer as far as possible.
- C. Paints and Stain Systems:
 - 1. Paint, stain, and coating systems are by Sherwin-Williams unless noted otherwise.
 - 2. Interior Paints shall not contain cadmium or lead.
- D. Gloss range: As indicated for paint systems when measured in accordance with ASTM D523:
 - 1. Flat: Below 15, at 85-degrees.
 - 2. Eggshell: Between 5 and 20, at 60-degrees.

3. Satin: Between 15 and 35, at 60-degrees.
 4. Semi-gloss: Between 30 and 65, at 60-degrees.
 5. Gloss: More than 65, at 60-degrees.
- E. Colors:
1. As noted in Drawing Finish Schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces for defects and correct to prevent unsatisfactory results.
- B. Verify compatibility of intermediate and topcoat finishes applied over surfaces primed by others.
- C. Commencement of work constitutes acceptance of surfaces and responsibility for performance.
- D. Do not paint items having complete factory finish with exception of items noted in Drawing Finish Schedule and as indicated in Section 23 05 53.

3.2 PREPARATION

- A. Verify surfaces are clean, dry and free of foreign materials which will affect adhesion or appearance.
- B. Remove mildew and neutralize surface.
- C. Eliminate efflorescence before painting.
- D. Prior to painting, test surfaces with moisture meter.
 1. Paint when moisture is within paint manufacturer's acceptable limits.
- E. Wood:
 1. Sand surfaces receiving finish with 180-grit, or finer sandpaper.
 - a. Remove fingerprints and marks.
 - b. Produce smooth texture.
 - c. Prepare grain to receive finish.
 2. Remove dust.
 3. Opaque Finishes:
 - a. Back prime wood trim with penetrating sealer.
 - b. Seal knots, pitch and resinous sapwood.
 4. Stain and Clear Finishes:
 - a. Treat wood with compatible washcoat prior to stain application.
 - b. Putty nail holes and minor defects, to match finish wood color.
- F. Ferrous Metal and Hollow Metal:
 1. Follow requirements of SSPC SP1 and SP3 except where higher preparation levels are indicated.
 2. Wire brush, or grind as necessary to remove shoulders at edge of sound paint to prevent telegraphing.
 3. Touch up damaged shop coats.
 4. Caulk hollow metal frame joints, corner seams, intersections of rabbets, stops, and soffit joints prior to painting.
- G. Galvanized Metal and Non-anodized Aluminum:
 1. Follow requirements of SSPC SP1 except where higher preparation levels are indicated.
 2. Treat surfaces with galvanized surface cleaner as recommended by primer and topcoat manufacturer.

H. Gypsum Wallboard:

1. Repair minor irregularities.
2. Avoid raising nap of paper.
3. Apply prime coat.
4. Correct areas showing defects after application of primer.
5. Re-prime refinished areas.

I. Concrete and Masonry:

1. Repair minor defects.
2. Remove oil from concrete.

3.3 APPLICATION

- A. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items, or provide ample in place protection.
- B. Touch up abraded areas of shop prime coats, suction or hot spots in plaster, gypsum wallboard, concrete block, and concrete before painting.
- C. Provide coverage to hide.
 1. Evenly spread and smoothly flow on for full, smooth cover.
 2. Apply additional coats where undercoats show until paint film is of uniform finish and color.
- D. Back prime wood trim with penetrating sealer.
- E. Apply additional coats in accordance with manufacturer's instructions.
- F. Finish closets and semi-exposed surfaces to match nearest adjoining surfaces.
 1. Include surfaces behind grills.
- G. Upon completion of painting, replace removed items and remove protection.

3.4 PROTECTION AND CLEANUP

- A. Provide WET PAINT signs.
- B. Protect adjacent work from damage by painting and finishing work.
- C. Remove temporary protective wrappings, after completion of operations.
- D. Clean, repair or replace, and repaint damaged work.

3.5 INTERIOR PAINT SYSTEMS

A. Gypsum Wallboard and Plaster Surfaces, Walls:

1. Latex (PT), Gloss Level 3, Eggshell:
 - a. Sherwin-Williams:
 - 1) Prime coat: ProMar 200 Zero VOC Interior Latex Primer.
 - 2) Intermediate coat: ProMar 200 Zero VOC Interior Latex Eg-Shel.
 - 3) Topcoat: ProMar 200 Zero VOC Interior Latex Eg-Shel.
2. Epoxy (PTE), Gloss Level 6, Gloss:
 - a. Sherwin-Williams:
 - 1) Prime coat: ProMar 200 Zero VOC Interior Latex Primer.
 - 2) Intermediate coat: Pro Industrial Water Based Catalyzed Epoxy, Gloss.
 - 3) Topcoat: Pro Industrial Water Based Catalyzed Epoxy, Gloss.

B. Gypsum Wallboard - Ceilings and Soffits:

1. Latex (PT), Gloss Level 1, Flat:
 - a. Sherwin-Williams:

- 1) Prime coat: ProMar 200 Zero VOC Interior Latex Primer.
- 2) Intermediate coat: ProMar 200 Zero VOC Interior Latex, Flat
- 3) Topcoat: ProMar 200 Zero VOC Interior Latex, Flat.
2. Epoxy (PTE), Gloss Level 3, Eggshell:
 - a. Sherwin-Williams:
 - 1) Prime coat: ProMar 200 Zero VOC Interior Latex Primer.
 - 2) Intermediate coat: Pro Industrial Water Based Catalyzed Epoxy, Eg-Shel.
 - 3) Topcoat: Pro Industrial Water Based Catalyzed Epoxy, Eg-Shel.
3. Dryfall (PNTDF), Gloss Level 3, Eggshell:
 - a. Sherwin-Williams:
 - 1) Prime coat: Pro Industrial Waterborne Acrylic Dryfall, Eg-Shel.
 - 2) Topcoat: Pro Industrial Waterborne Acrylic Dryfall, Eg-Shel.
- C. Metal Stairs, Handrails, Guardrails and Miscellaneous Metals - Ferrous, Primed, Zinc-coated, and Aluminum:
 1. Waterborne epoxy, Gloss Level 6, Gloss:
 - a. Sherwin-Williams:
 - 1) Prime coat: Pro Industrial Pro-Cryl Universal Primer.
 - 2) Intermediate coat: Pro Industrial Water Based Catalyzed Epoxy, Gloss.
 - 3) Topcoat: Pro Industrial Water Based Catalyzed Epoxy, Gloss.
- D. Duct Surfaces Visible Through Grilles or Diffusers:
 1. Interior Latex Gloss Level 1 Flat:
 - a. Sherwin-Williams:
 - 1) Prime coat: ProMar 200 Zero VOC Interior Latex Primer.
 - 2) Topcoat: ProMar 200 Interior Latex, Flat.
 - a) Color: Black.
- E. Metal Doors and Frames:
 1. Waterborne epoxy, Gloss Level 5 Semi-gloss:
 - a. Sherwin-Williams:
 - 1) Prime coat: Pro Industrial Pro-Cryl Universal Primer.
 - 2) Intermediate coat: Pro Industrial Pre-Catalyzed Water Based Epoxy, Semi-Gloss.
 - 3) Topcoat: Pro Industrial Pre-Catalyzed Water Based Epoxy, Semi-Gloss.
- F. Architectural Structural Steel:
 1. Water based urethane, Gloss Level 6, Gloss:
 - a. Sherwin-Williams:
 - 1) Prime coat: Shop-applied. See Section 05 12 13.
 - a) Touch-up in field as required.
 - 2) Prime coat: Pro Industrial Pro-Cryl Universal Primer.
 - 3) Intermediate coat: Pro Industrial Acrylic, Semi- Gloss.
 - 4) Topcoat: Pro Industrial Acrylic, Semi- Gloss.
 - a) Clear coat: Diamond-Clad Clear Coat Urethane, B65 Series.
- G. Stained Wood:
 1. Stain:
 - a. Sherwin-Williams:
 - 1) MinWax Wood Finish 250 Interior Oil Stain.

2. Filler Coat:
 - a. Horizontal surfaces where open-grained wood is indicated. Exception: Omit filler coat at closed grained wood species.
 - b. Sherwin-Williams:
 - 1) Sher-Wood Natural Filler.
3. Clear intermediate and topcoats:
 - a. Premium quality.
 - 1) Comply with current edition of AWI Architectural Woodwork Quality Standards.
 - b. Sheen:
 - 1) Measured with 60-degree gloss meter.
 - 2) Flat; 15 to 30 points.
 - c. Apply product in 2 coats.
 - 1) Lightly sand between coats.
 - d. Polyurethane based Varnish:
 - 1) Sherwin-Williams:
 - a) MinWax Fast-Drying Polyurethane Varnish.

END OF SECTION



DIVISION 10

SPECIALTIES



SECTION 10 11 00
MARKERBOARDS AND TACKBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Markerboards and Tackboards, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. Include dimensional plans, elevations, and details of typical members and components.
 - 2. Show anchors, grounds, reinforcement, and layout, and indicate finishes.
- B. Product Data:
 - 1. Provide copies of manufacturer's specifications and installation instructions for each type of material and accessory required.
 - 2. Where fire resistance classification is indicated, submit copies of nationally recognized testing laboratory listings of products proposed for use.
 - 3. Include data required to show specification compliance.
- C. Samples:
 - 1. One standard sized sample of each color specified in Interiors Notes & Finish Legend.
- D. Project Information:
 - 1. Installer qualifications.
- E. Contract Closeout Information:
 - 1. Maintenance data.
 - a. See Section 01 78 23.

1.3 QUALITY ASSURANCE

- A. Single Source Responsibility: Furnish Markerboards, Tackboards, and Chalkboards by single manufacturer for project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Markerboards and Tackboards:
 - 1. Base:
 - a. Markerboards: Deko Premier Markerboards.
 - 2. Optional:
 - a. Claridge Products & Equipment.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIAL: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Markerboard (MB):
 - 1. Glass-free magnetic resinous panel with factory finished edges.

- a. MB1: as specified in Interior Notes & Finish Legend.
- 2. Concealed mounting.
- 3. Non-staining, flexible, shatterproof & optically clear.
- 4. Eased and polished edges.
- 5. Color: White.
- B. Frames and Trim:
 - 1. J- Trim as provided by manufacturer.
 - 2. Size and shape as indicated.
 - 3. Single length units to minimize joints.
 - 4. Clear, satin anodized finish.
 - 5. Provide structural support accessories required to provide necessary support.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrate to accept installation.
- B. Verify that adequate Wall Backing has been installed.
 - 1. Metal Wall Backing: Specified in Section 09 22 16.
 - 2. Coordinate and direct installation of backing where required.
- C. Correct unsatisfactory conditions.
- D. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. Comply with manufacturer's instructions and recommendations.
- B. Locate with top 6 feet 1800 mm AFF if board is 36 inches 900 mm high or less.
- C. Locate with top 7 feet 2100 mm AFF if board is greater than 36 inches 900 mm high.
- D. Provide additional backing as indicated or necessary to properly stiffen and support boards.
- E. Install with concealed hangers, plumb and level.
- F. Provide trim at joints between Markerboards and Tackboards.
- G. Trim vertical joints with aluminum H type divider bars.
- H. Coordinate job assembled units with grounds, trim, and accessories.

END OF SECTION

SECTION 10 14 03
IDENTIFICATION DEVICES - EXTERIOR

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services required for fabrication and installation of Identification Devices as indicated in the Drawings and described in this Section.
- B. Identification devices indicated in AG-Series Drawings are specified in this Section.
- C. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Fabrication and installation drawings for identification device types.
 - a. Scaled drawings of major components.
 - b. Demonstrate load capacity of components by labeling or calculations.
 - c. Include dimensioned plans, elevations, and scaled details of identification device wording and lettering layout.
 - 2. Field verify dimensions and locations for identification device types prior to developing shop drawings.
 - 3. Furnish location template drawings for items supported or anchored to permanent building construction.
- C. Samples:
 - 1. Scaled print of each identification device (sign type).
 - 2. Minimum 6 by 6 inches 150 by 150 mm sample of materials for identification device types.
 - 3. Minimum 6 by 6 inches 150 by 150 mm sample of colors requiring color matches on samples of actual identification device material.
 - a. Submit clarification drawings detailing scale, materials, finishes, fasteners, etc. for section prototypes for review and approval prior to fabrication.
- D. Project Information:
 - 1. Engineering design details and calculations for identification device material components, gauges, footings, anchors with applicable design loads noted, sealed by registered Engineer (licensed to practice Structural Engineering in the state where project is located) for identification devices requiring footings, foundations, and structural support, including identification device types mounted on exterior of building.
 - a. Include plans, and elevations.
 - b. Indicate accessory items and anchorages.
 - c. Design in accordance with Local Building Codes.
- E. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - a. See Section 01 78 23.
 - 2. Spare parts.
 - a. See Section 01 78 43.

1.3 QUALITY ASSURANCE

- A. UL listed light fixtures and electrical components.
- B. Provide fabrication drawings engineered to support dead, live, lateral (wind or seismic), and snow or ice loads indicated for mechanically mounted or anchored identification devices.
 - 1. Comply with Section 01 71 21, Specialty Engineering Requirements.
 - 2. Include seal and signature of engineer licensed in the state where project is located.
- C. Foundations:
 - 1. Design, engineering, and installation of freestanding footings are the responsibility of the sign manufacturer.
 - 2. Install signage on footings level, plumb, square, and true.
 - 3. Comply with Section 01 71 21, Specialty Engineering Requirements.
 - 4. Include seal and signature of engineer licensed in the state where project is located.
- D. Permits:
 - 1. Secure exterior signage permits based on the local codes and regulations.
 - 2. Notify Architect to resolve design limitations based on code restrictions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Identification Devices - Exterior:
 - 1. Base:
 - a. Trademark Visual.
 - 2. Optional:
 - a. ASI Sign Systems.
 - b. Jones Sign.
 - c. DCL (Design Communication Ltd.)
 - d. L&H Sign Company
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Identification Devices:
 - 1. References to Drawings are to sheets labeled AG.
 - a. Information may also be listed on other sheets such as A and E.
 - 2. Following information is shown on Drawings for each sign type:
 - a. Individual component and accent materials.
 - b. Letter style, case, and height.
 - c. Character proportions.
 - d. Letter colors.
 - e. Background color and other graphics.
 - f. Mounting method and shims or spacers used.
 - g. Location of sign relative to other building elements.
 - h. Finish level.
 - 3. Direction and identification devices for communications systems: International Symbols.
- B. Identification Device Finish Level:

1. High Finish:
 - a. May include following materials, or combination of materials:
 - 1) Back-painted, sandblasted glass panel with silkscreened letters.
 - 2) Etched, paint-filled letters.
 - 3) Etched stainless steel panel.
 - 4) LED digital matrix display.
 - 5) Painted aluminum letters.
 - 6) Painted aluminum panel.
 - 7) Painted die-cut graphic film letters.
 - 8) Water-jet cut stainless steel letters.
 2. Finish and Contrast:
 - a. Characters and background:
 - 1) Non-glare.
 - 2) 70% contrast between characters with background.
- C. Materials:
1. Inert.
 2. Materials listed establish the minimum acceptable quality, size, and performance. Equivalent or superior materials will be allowed. Acceptance of alternate materials will be determined in the submittal process.
- D. Dissimilar Metals Protection:
1. Prevent galvanic reactions between products used.
- E. Acrylic:
1. Cast acrylic sheet:
 - a. Cast, not extruded or continuous cast, methyl methacrylate monomer plastic sheet.
 - b. Provide in sizes and thicknesses indicated.
 - c. Minimum flexural strength: Mean 116,000 psi 800 MPa when tested in accordance with ASTM D790.
 - d. Minimum allowable continuous service temperature of 176 deg F 80 deg C.
 2. General types:
 - a. Transparent sheet:
 - 1) Clear, colorless sheet, matte finish.
 - 2) Light transmittance: 92% when tested in accordance with ASTM D1003.
 - b. White translucent sheet:
 - 1) Density required to produce uniform brightness and minimum halation effects.
 - c. Opaque sheet:
 - 1) Colored opaque acrylic sheet in colors and finishes indicated; If not indicated, provide in colors selected from the manufacturer's full range of standard colors.
 - 2) 30-30 Acrylic: Tinted.
 3. Abrasive resistance coating (ARC):
 - a. Product: Abrasive resistant coating as recommended by manufacturer.
 - b. Apply ARC to exposed faces of acrylic sheet after graphics have been applied.
- F. Aluminum:
1. Sheet:
 - a. Alloy and temper recommended by aluminum manufacturer for type of use, and finish indicated.

- b. Provide with minimum strength and durability in accordance with ASTM B209, Table for 5052 for thickness specified.
 - 2. Extrusions:
 - a. Alloy and temper recommended by aluminum manufacturer for the type of use, and finish indicated.
 - b. Provide with minimum strength and durability in accordance with ASTM B221, Table for 6061 for thickness indicated.
 - 3. Castings:
 - a. Alloy and temper for use and finish indicated as recommended by aluminum manufacturer for casting process used.
 - 4. Finish
 - a. PVDF coating: Minimum 1 mil fluorocarbon coating, 70% PVDF.
 - 1) Color(s):
 - a) To be selected by Architect from manufacturer's premium lines.
 - b) Basis of Design: ACIERO CORTEN
- G. Graphics:
- 1. Electrostatic or electronic graphics process.
 - 2. Applicator: Applied Image, Farmingdale, New Jersey.
- H. Paints:
- 1. Apply paint under-coating for identification devices for deterioration of metals prevention.
 - 2. Evenly spray apply finish in accordance with manufacturer's recommendation.
 - a. Finish to be free of grit, dirt, smears, spots, and orange peel effect.
 - b. Ensure paint compatible with metal used.
 - 3. Each coat shall have UV Inhibitors
 - 4. Manufacturer: Matthews Paint Company, Pleasant Prairie, WI.
- I. Polymer:
- 1. Sheet photopolymer:
 - a. Manufacturer: Nova Polymers Inc., Yeadon, PA.
 - b. Product: NovAcryl, PT Series nylon based photopolymer on extruded, clear, UV stable copolyester PETG thermoplastic base.
 - 1) Model: PT-236.
 - c. High resolution, ADA compliant, raised graphic sign.
 - 1) Minimum face relief: 0.032 inches 1 mm in compliance with ADA.
 - 2) Maximum face relief: 0.040 inches 1 mm in compliance with ADA.
 - d. Base thickness: 6.0 mm.
 - e. Face relief: 1.0 mm nylon resin based photopolymer layer.
 - f. Substrate: Clear PETG plastic base with UV inhibitor.
 - g. Photopolymer Durometer: 80 Shore D Durometer hardness.
 - h. Process in accordance with manufacture's General Processing Guidelines.
 - i. Laminated photopolymers are not acceptable.
 - j. Finishes:
 - 1) Automotive grade acrylic polyurethane finishes.
 - k. Manufacturer:
 - 1) Base: Matthews Paint Company, Pleasant Prairie, WI.
 - 2) Optional: Carbit Paint, Co, Inc., Chicago, IL
 - l. Lacquer based finishes are not acceptable.

2. Solid polymer:
 - a. Material: Solid sheet nonporous polymer, homogeneous filled acrylic.
 - 1) Coated, laminated, or composite construction are not acceptable.
 - b. Manufacturer:
 - 1) Base: DuPont Corian.
 - 2) Optional:
 - a) Avonite.
 - b) Surrell.

J. Reflective Film:

1. Non-removable reflective film:
 - a. Adhesive coated opaque sheeting with durable permanent adhesion.
 - b. Properties:
 - 1) Adhesion on etched aluminum: 2.5 pounds/inch 0.44 N/mm.
 - 2) Applied temperature: Minus 30 deg F 34 deg C to plus 200 deg F 93 deg C.
 - 3) Dimensional stability: 0.010 inches 0.25 mm.
 - 4) Flexibility: No cracking.
 - 5) Observation angle: .2 degrees to .5 degrees/40 degrees 7 to 4.5.
 - 6) Removability: Up to 18 months.
 - 7) Thickness: 0.010 inches 0.25 mm.
2. Removable reflective film:
 - a. Adhesive coated opaque sheeting.
 - 1) Liner: Easy release for removable messages.
 - 2) Sheeting: Reflective even when wet by rain.
 - b. Properties:
 - 1) Adhesion on etched aluminum: 2.5 pounds/inch 0.44 N/mm.
 - 2) Applied temperature: Minus 30 deg F 34 deg C to plus 200 deg F 93 deg C.
 - 3) Dimensional stability: 0.010 inches 0.25 mm.
 - 4) Entrance angle: Minus 4 degrees 35 to 18/40 degrees 7 to 4.5.
 - 5) Flexibility: No cracking.
 - 6) Observation angle: 0.2 degrees to 0.5 degrees.
 - 7) Removability: Up to 18 months.
 - 8) Thickness: 0.010 inches 0.25 mm.

K. Graphic Film:

1. Clear protective overlayment:
 - a. Manufacturer:
 - 1) Base: 3M.
 - a) Scotchcal Matte Overlamine 8911 ES.
 - 2) Optional: Avery.
 - a) Avery Protective Overlay.
 - b. Description:
 - 1) High durability, UV resistant film with pressure sensitive adhesive.
 - 2) Overlamine electrostatic imaged graphics and piezo inkjet printed graphics in accordance with manufacturer recommendations.
 - 3) Adhesive and color: Pressure-sensitive, clear.
 - 4) Liner: Kraft paper.

- 5) Overlamine: 2 mils 0.05 mm transparent film.
 - 6) Finish gloss: Matte.
 - 7) Thickness overlamine and adhesive: 3.0 to 4.0 mils 0.075 to 0.1 mm.
2. Digital image graphic film:
 - a. Manufacturer:
 - 1) Base: 3M.
 - a) Controltac Plus Conformable Graphic Film 8620 ES.
 - 2) Optional: Avery.
 - a) Ink Jet film: Apply to flat, vertical surfaces with and without rivets, and corrugated and riveted surfaces.
 - b. Description:
 - 1) Durable, conformable, positionable, and removable graphic film designed for electrostatic imaging.
 - 2) Produce 4 color graphics with electrostatic and electronic graphics systems.
 - 3) Film: Cast graphic film.
 - 4) Color: White, opaque.
 - 5) Thickness: 2.0 mil 0.05 mm without adhesive; 3 to 4 mils 0.08 to 0.10 mm with adhesive.
 3. Graphic film:
 - a. Non-reflective film:
 - 1) Opaque sheeting, with repositionable pressure activated adhesive backing.
 - 2) Minimum application temperature: 40 deg F 5 deg C.
 - 3) Maximum application temperature to be 100 deg F 38 deg C.
 - 4) Exterior exposure life: 7 years when installed in accordance with manufacturer's recommendations.
 - 5) Properties:
 - a) Adhesion to etched aluminum: 7.0 pounds/inch 1.23 N/mm.
 - b) Dimensional stability: 1/64 inches 0.4 mm.
 - c) Resistance: No effect at minus 73 deg F 58 deg C and 40 deg F 4 deg C.
 - d) Temperature Range: Minus 40 deg F 40 deg C to plus 200 deg F 93 deg C.
 - e) Tensile strength: 5 pounds/inch 0.88 N/mm at 73 deg F 23 deg C.
 - f) Thickness: 0.003 inches to 0.004 inches 0.075 to 0.1 mm.
 - b. Graphic film:
 - 1) Opaque, non-reflective graphic film with pressure sensitive adhesive backing, suitable for exterior and interior applications.
 - 2) Thickness: 0.0035 inches 0.09 mm minimum.
- L. Fasteners and Anchors:
1. Anchors and inserts:
 - a. Exterior installations, and areas requiring corrosion resistance:
 - 1) Non-ferrous metal, or hot-dipped galvanized anchors and inserts.
 - b. Concrete and masonry work: Toothed steel, or lead expansion bolt devices with inserts for drilled-in-place anchors.
 2. Bracket mounting:
 - a. Identification devices which project at right angles from walls or ceilings.
 - 1) Manufacture's recommended standard concealed brackets, fittings, and hardware.
 - 2) Attach brackets and fittings securely to walls or ceilings with concealed fasteners and anchoring devices in accordance with manufacturer's recommendations.

3. Mount cast plaques using standard method recommended by manufacturer for each type of wall surface.
4. Concealed mounting:
 - a. Insert threaded studs into tapped lugs on back of plaque.
 - b. Set in predrilled holes filled with quick setting cement.
5. Mount plaques with exposed fasteners anchored through face of plaque into wall surface.
6. Flush mounting: Letters mounted with backs in contact with wall surface.
7. Glass mounting: When mounting identification device panels to front surface of glass, provide 0.080 inches 2 mm aluminum backup plate, on inside surface of glass.
8. Magnetic tape:
 - a. Manufacturer: 3M.
9. Mechanical fastening: Manufacturer's recommended fasteners based on identification device type and substrate.
10. Metal letters and numbers:
 - a. Manufacturer's standard fastening method for letter form, type of mounting, wall construction, and condition of exposure.
 - b. Heavy paper template: Provided by Manufacturer for establishing letter spacing and for locating holes for fasteners.
11. Projected mounting: Mount letters at a projected distance from the wall surface as indicated.
12. Reclosable fasteners:
 - a. Manufacturer: 3M.
 - b. Fastener types.
 - 1) Dual Lock SJ3562, Type 170.
 - 2) Dual Lock SJ3560. Type 250.
 - 3) Dual Lock SJ3561, Type 400.
 - c. Provide fastener types as recommended by manufacturer.
13. Shim plate mounting:
 - a. Concealed aluminum shim plates 1/16 inches 2 mm thick, with predrilled and countersunk holes.
 - b. Provide at locations indicated, and where other mounting methods are not practicable.
 - c. Attach shim plate with fasteners and anchors providing secure attachment to substrate.
 - d. Attach panel identification devices to shim plate and substrate.
14. Wall mounting: Attach panel identification devices to wall surfaces using following methods:
 - a. Tape mounting: Double-sided foam tape, thickness indicated, or as required to mount identification devices to smooth, non-porous surfaces.
 - b. Silicone adhesive mounting:
 - 1) Liquid silicone adhesive recommended by Manufacturer for attaching identification devices to irregular, porous, or graphic film-covered surfaces.
15. Installer requirements:
 - a. Based on manufacturer recommendations, installer shall be responsible for fastener compatibility with substrates.
 - b. Insure that oxidation does not occur, or that other reactive processes do not occur between related signage materials and fasteners.

M. Adhesives:

1. Permanent adhesive:
 - a. Manufacturer: 3M.
 - b. Scotch 468MP, hi-performance adhesive, or as recommended by manufacturer.

2. Silicone adhesive:
 - a. Manufacturer: Momentive.
 - b. Type: Silicone paneling adhesive as recommended by manufacturer.
 3. Double faced laminating film:
 - a. Manufacture: Fasson, Division of Avery International Company.
 - b. Type: FASTAPE A Laminating Film, or as recommended by manufacturer.
 4. Permanent double faced tape:
 - a. Manufacturer: 3M.
 - b. Type: 1/32 inches 1 mm, Scotch Mount Neoprene Tape No. 4962, or as recommended by manufacturer.
 5. Removable double faced tape:
 - a. Manufacturer: 3M.
 - b. Type: 1/32 inches 1 mm, double faced removable tape No. 4432, or as recommended by manufacturer.
 - c. Color: Black.
 6. Installer ensure adhesive compatibility with substrates.
- N. Finishes:
1. Glass: Non-glare.
 2. Metal finishes: Finish in compliance with NAAMM Metal Finishes Manual for finish designations and application recommendations.
 3. Paint: Satin finish.
 4. Stainless steel: ANSI No. 4 finish, horizontal grain, unless otherwise noted or specified.
 5. Comply with American with Disabilities Act:
 - a. Measure finishes with a Glossmeter to ensure compliance.
- O. Graphics:
1. Image Process:
 - a. Graphic content and style:
 - 1) Provide identification device copy in compliance with requirements indicated for content, finishes, materials, positions, sizes, spacing, styles, and colors of letters, numbers, symbols, and other graphic images.
 2. Typography:
 - a. Typography and graphics:
 - 1) Photographically or mechanically reproduced.
 - b. International Symbols:
 - 1) In accordance with U.S. Department of Transportation current standards publication.
 - c. Identification device typeface fonts:
 - 1) Provide as indicated on Drawings.
 - d. Letter forms:
 - 1) Use approved type font masters from original type foundry.
 - 2) Cut letter forms using graphic film cutter plotter equipment.
 - 3) Letter forms edges and corners are to be clean and true.
- P. Artwork:
1. Manufacturer provides typesetting, and mechanical artwork required for identification device types.

2.3 FABRICATION

A. General Requirements:

1. Fabricate and assemble identification devices in shop to the greatest extent possible.
2. Fabricate parts and assemblies ready for installation at the building site.
3. Surface defects considered unacceptable: Oil canning, cupping, and warping.
4. Grind welds smooth.
5. Be responsible for structural stability and mounting for graphics and identification devices.

B. Identification Device Panels:

1. Comply with requirements indicated for colors, designs, details of construction, finishes, materials, shapes, sizes, and thicknesses.
2. Surfaces: Smooth, even, and level.
3. Identification device panel flatness:
 - a. Fabricate panels to remain flat within 1/32 inches 1 mm over the concave surface.
 - b. Fabricate panels to remain flat under installed conditions within a tolerance of plus or minus 1/16 inches 2 mm measured diagonally.
4. Edge Condition: 90 degree square cut, unless otherwise noted.
5. Corner condition: Provide square corners, unless otherwise noted.
6. Panel materials:
 - a. See drawings for types and locations.

C. Applied Copy:

1. Die-cut copy characters from graphic film.
2. Provide pressure sensitive adhesive backing.
3. Apply copy to exposed face of identification device panel.
4. Apply copy to other surfaces where indicated.

D. Photoetched Copy:

1. Fabricate raised lettering on metal background using acid etching process.
2. Metal background for acid etching: Stainless steel or magnesium plate.
 - a. Finish metal background as indicated.
 - b. Paint raised surface.

E. Engraved Copy:

1. Graphic elements, letters, numbers, and symbols machine engraved into identification device panel face.
 - a. Engrave to a precisely formed copy, incised to uniform depth.
 - b. Engrave using high speed cutters, mechanically linked to master template in a pantographic system.
2. Engraved acrylic: Epoxy enamel fill engraved acrylic copy.
3. Face engraved clear acrylic:
 - a. Fill engraved copy with Epoxy enamel.
 - b. Opaque background color coating shall be applied to back face of acrylic sheet.
 - c. Copy shall be engraved to a minimum depth of 1/32 inches, and 1/4 inches minimum stroke thickness.
4. Engraved metal: Epoxy enamel fill engraved copy.
5. Engraved plastic laminate: Engrave through exposed plastic laminate face ply to expose contrasting core ply.
6. Subsurface engraved acrylic sheet:

- a. Back face: Reverse engrave.
 - b. Engraved copy: Fill with epoxy enamel.
 - c. Opaque background color coating: Apply over epoxy-enamel filled copy.
- F. Silkscreened Copy:
 - 1. Subsurface copy:
 - a. Form panel face: Apply copy to back face of clear acrylic sheet to form panel face.
 - b. Produce precisely-formed opaque images with smooth edges.
 - c. Print copy: Reverse silkscreen process.
 - 1) Copy shall be over sprayed with opaque background color coating.
- G. Raised Copy:
 - 1. Exterior grade:
 - a. Fabrication of raised lettering on metal background to magnesium alloy plate shall be by acid etching process.
 - 2. Machine-cut letter forms, and chemically weld to indicated materials.
 - a. Form characters with square cut edges free from burrs and cut marks.
 - b. Panel material and raised copy thickness: Not less than 1/32 inches.
- H. Metal Letters and Numbers:
 - 1. Comply with requirements indicated for manufacturing process, finish, materials, message content, style, and size.
 - 2. Metal: Stainless steel, unless otherwise indicated.
- I. Fabricated Metal Letters and Numbers:
 - 1. Fabricate metal letters and numbers in sizes and styles indicated.
 - a. Thicknesses: As indicated.
 - b. Form exposed faces and sides of characters.
 - c. Produce surfaces free from warp and distortion.
 - d. Provide internal bracing for stability.
 - e. Provide internal bracing for attachment of required mounting accessories.
- J. Illuminated Units:
 - 1. Illuminate units using manufacturer's standard UL approved lighting components.
 - a. Lighting components include insulators, neon tubing, transformers, and other components.
 - b. Provide access for servicing and for concealed connections to building system.
 - c. Coordinate electrical connections with Electrical Specification Divisions.
 - 2. Illuminate and inspect after fabrication to ensure no material elements such as cables, structural supports, or adhesive stickers block lighting producing unintended shadows or dark spots.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which materials are to be installed.
- B. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. General Requirements:

1. Locate identification devices and accessories where shown or scheduled in AG-Series drawings.
2. Use mounting method types indicated and as described, and in accordance with manufacturer's recommendations.
3. Field determine exact locations and dimensions for identification devices prior to fabrication.
4. Immediately notify Owner and Architect if building and site conditions are at variance with drawings.
 - a. Do not proceed until the unsatisfactory conditions have been corrected.
5. Install identification devices in positions shown on drawings.
 - a. Install identification devices at heights indicated, plumb, and in alignment.
 - b. Brace devices securely until permanent anchorage is made.
 - c. Identification device surfaces are to be installed free from distortion or other defects in appearance.
 - d. Perform cutting, drilling, and fitting carefully.
 - e. When required, fit at site before finishing.
- B. Mount identification devices according to methods specified or as indicated on drawings for each type.
- C. Manufacturer to provide printed instructions or drawings on wall blocking locations and type required to Signage Contractor in a timely manner to allow installation.

3.3 CLEAN-UP

- A. At completion of the installation, clean identification devices with appropriate cleaning agents prior to final inspection and acceptance. Grease, fingerprints, smudges, adhesive, etc. remaining on identification devices or components will not be acceptable. Protect identification device units from damage until acceptance by Owner.
- B. Remove packing and debris from the project site upon completion and leave the site in a condition which is clean and free of damage and abuse.

END OF SECTION

SECTION 10 14 06
IDENTIFICATION DEVICES - INTERIOR

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Identification Devices - Interior, as indicated, and described in this Section.
- B. Include exterior signs and exterior grade signs as listed in Signage Message Schedule.
- C. Completely coordinate with work of other trades.
 - 1. Prevent conflicts between signage and other devices or accessories by installing actual size temporary signs in critical locations where other items will be installed first.
 - 2. Where conflicts occur between signage and other devices or accessories, comply with ADA requirements for sign locations.

1.2 QUALITY ASSURANCE

- A. Provide fabrication drawings engineered to support dead, live, and lateral (wind or seismic) loads indicated for mechanically mounted or anchored identification devices.
 - 1. Comply with Section 01 71 21, Specialty Engineering Requirements.
 - 2. Include seal and signature of engineer licensed in the state where project is located.
- B. Americans with Disabilities Act (ADA):
 - 1. ADA Standards for Accessible Design
- C. American National Standards Institute, (ANSI):
 - 1. ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities.
- D. Underwriters Laboratories (UL)

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Fabrication and Installation Drawings:
 - a. Provide for each identification device type.
 - b. Scaled drawings of major components.
 - c. Demonstrate load capacity of components by labeling or calculations.
 - 2. Signage Message Schedule:
 - a. Coordinating schedule between Location Plans and Signage Layouts.
 - b. Use same organizing principles as Contract Documents whether alphabetical, by level, by color, or another category.
 - c. Provide as a standalone submittal, submitted with Location Plans.
 - 3. Location Plans:
 - a. Dimensioned plans and elevations to show exact sign locations.
 - b. Provide as a standalone submittal, submitted with Message Schedule.
 - 4. Signage Layouts:
 - a. Scaled proof of each identification device wording and lettering layout to confirm that the appropriate design intent for the signage has been met.
 - b. Show layouts in the same order provided in the original Signage Message Schedule.

- c. Provide as a standalone submittal.
- 5. Field verify dimensions and locations for identification device types prior to developing shop drawings.
- 6. Furnish location template drawings for items supported or anchored to permanent building construction.
- C. Samples:
 - 1. Minimum 6 inches x 6 inches 150 mm x 150 mm sample of materials for identification device types.
 - 2. Minimum 6 inches x 6 inches 150 mm x 150 mm sample of colors requiring color matches on samples of actual identification device material.
- D. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - a. See Section 01 78 23.
 - 2. Spare parts.
 - a. See Section 01 78 43.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Identification Devices - Interior:
 - 1. Base:
 - a. Trademark Visual.
 - 2. Optional:
 - a. ASI Sign Systems.
 - b. Jones Sign.
 - c. DCL (Design Communication Ltd.)
 - d. L&H Sign Company
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Identification Devices:
 - 1. References to Drawings are to sheets labeled AG.
 - a. Information may also be listed on other sheets such as A and E.
 - 2. Following information is shown on Drawings for each sign type:
 - a. Individual component and accent materials.
 - b. Letter style, case and height.
 - c. Character proportions.
 - d. Letter colors.
 - e. Background color and other graphics.
 - f. Mounting method and shims or spacers used.
 - g. Location of sign relative to other building elements.
 - h. Finish level.
 - 3. Direction and identification devices for communications systems: International Symbols.
- B. Identification Device Finish Level:
 - 1. High Finish:

- a. May include following materials, or combination of materials:
 - 1) Back-painted, sandblasted glass panel with silkscreened letters.
 - 2) Etched, paint-filled letters.
 - 3) Etched stainless steel panel.
 - 4) LED digital matrix display.
 - 5) Painted aluminum letters.
 - 6) Painted aluminum panel.
 - 7) Painted die-cut graphic film letters.
 - 8) Water-jet cut stainless steel letters.
 - 2. Finish and Contrast:
 - a. Characters and background:
 - 1) Non-glare.
 - 2) 70% contrast between characters with background.
- C. Materials:
 - 1. Inert.
 - 2. Materials listed establish the minimum acceptable quality, size, and performance. Equivalent or superior materials will be allowed. Acceptance of alternate materials will be determined in the submittal process.
- D. Acrylic:
 - 1. Cast acrylic sheet:
 - a. Cast, not extruded or continuous cast, methyl methacrylate monomer plastic sheet.
 - b. Provide in sizes and thicknesses indicated.
 - c. Minimum flexural strength: Mean 116,000 psi 800 MPa when tested in accordance with ASTM D790.
 - d. Minimum allowable continuous service temperature of 176 degrees F 80 degrees C.
 - 2. General types:
 - a. Transparent sheet:
 - 1) Clear, colorless sheet, matte finish.
 - 2) Light transmittance: 92% when tested in accordance with ASTM D1003.
 - b. White translucent sheet:
 - 1) Density required to produce uniform brightness and minimum halation effects.
 - c. Opaque sheet:
 - 1) Colored opaque acrylic sheet in colors and finishes indicated; If not indicated, provide in colors selected from the manufacturer's full range of standard colors.
 - 2) 30-30 Acrylic: Tinted.
 - 3) Manufacturer: Rohm and Haas.
 - 3. Edges: Polish edges.
 - 4. Abrasive resistance coating (ARC):
 - a. Product: Abrasive resistant coating as recommended by manufacturer.
 - b. Apply ARC to exposed faces of acrylic sheet after graphics have been applied.
- E. ADA Tactile Sign Face Elements:
 - 1. Sheet Photopolymer:
 - a. Manufacturer: Nova Polymers Inc.
 - b. Product: NovAcryl, PT Series nylon based photopolymer on extruded, clear, UV stable copolyester PETG thermoplastic base.
 - 1) Model: PT-236.

- 2) High resolution, ADA compliant, raised graphic sign.
 - a) Minimum face relief: 0.032 inches 1 mm in compliance with ADA.
 - b) Maximum face relief: 0.040 inches 1 mm in compliance with ADA.
 - 3) Base thickness: 6.0 mm.
 - 4) Face relief: 1.0 mm nylon resin based photopolymer layer.
 - 5) Substrate: Clear PETG plastic base with UV inhibitor.
 - 6) Photopolymer Durometer: 80 Shore D Durometer hardness.
 - c. Process in accordance with manufacturer's General Processing Guidelines.
 - d. Laminated photopolymers are not acceptable.
 - e. Finishes:
 - 1) Automotive grade acrylic polyurethane finishes.
 - 2) Manufacturer:
 - a) Base: Matthews Paint Company.
 - b) Optional: Carbit Paint, Co, Inc.
 - 3) Lacquer based finishes are not acceptable.
 - 2. Solid polymer:
 - a. Material: Solid sheet nonporous polymer, homogeneous filled acrylic.
 - 1) Coated, laminated, or composite construction are not acceptable.
 - b. Manufacturer:
 - 1) Base: DuPont Corian.
 - 2) Optional:
 - a) Avonite.
 - b) Surrell.
 - 3. Applique:
 - a. Sign Face: Painted Acrylic. If first surface then with a matte finish
 - b. Applied numbers and/or letters.
 - 1) Acrylic.
 - 2) Individually cut dimensional characters.
 - 3) 1/32" thick with matte finish.
 - 4) Grade 2 Braille: Clear raster balls.
 - 5) Fastened: VHB Tape - .0303 inch double-face tape.
 - c. Process in accordance with manufacturer's General Processing Guidelines.
 - 1) Lacquer based finishes are not acceptable.
 - 4. 3D Digital Print:
 - a. V/LED-cured, direct-print raised characters and background graphics on a variety of substrates and insert materials including painted acrylic, translucent acrylic, PETG, satin anodized or painted aluminum, direct-print background graphics and more.
 - b. Printed Graphics:
 - 1) 1/32" thick
 - 2) Fully domed, Grade 2 Braille dots.
 - c. Photopolymer process or applied letters and Braille are not acceptable.
- F. Graphic film:
- 1. Clear protective overlayment:
 - a. Manufacturer:
 - 1) Base: 3M.
 - a) Scotchcal Matte Overlamine 8911 ES.

- 2) Optional: Avery.
 - a) Avery Protective Overlay.
- b. Description:
 - 1) High durability, UV resistant film with pressure sensitive adhesive.
 - 2) Overlamine electrostatic imaged graphics, and piezo inkjet printed graphics in accordance with manufacturer recommendations.
 - 3) Adhesive and color: Pressure-sensitive, clear.
 - 4) Liner: Kraft paper.
 - 5) Overlamine: 2 mils 0.05 mm transparent film.
 - 6) Finish gloss: Matte.
 - 7) Thickness overlamine and adhesive: 3.0 to 4.0 mils 0.08 to 0.10 mm.
2. Digital image graphic film:
 - a. Manufacturer:
 - 1) Base: 3M.
 - a) Controltac Plus Conformable Graphic Film 8620 ES.
 - 2) Optional: Avery.
 - a) Ink Jet film: Apply to flat, vertical surfaces with and without rivets, and corrugated and riveted surfaces.
 - b. Description:
 - 1) Durable, conformable, repositionable and removable graphic film designed for electrostatic imaging.
 - 2) Produce 4 color graphics with electrostatic and electronic graphics systems.
 - 3) Film: Cast graphic film.
 - 4) Color: White, opaque.
 - 5) Thickness: 2.0 mil 0.05 mm without adhesive; 3 to 4 mils 0.08 to 0.10 mm with adhesive.
 - 6) Adhesive type and color: Repositionable, pressure activated, gray.
 - 7) Liner: LayFlat polyethylene liner.
3. Graphic film:
 - a. Non-reflective film:
 - 1) Opaque sheeting, with repositionable pressure activated adhesive backing.
 - 2) Minimum application temperature: 40 degrees F 4 degrees C.
 - 3) Maximum application temperature: 100 degrees F 38 degrees C.
 - 4) Exterior exposure life: 7 years when installed in accordance with manufacturer's recommendations.
 - 5) Properties:
 - a) Adhesion to etched aluminum: 7.0 pounds/IN 1225 N/m.
 - b) Dimensional stability: 1/64 inches 0.4 mm.
 - c) Resistance: No effect at minus 73 degrees F and 40 degrees F minus 58 degrees C and 4 degrees C.
 - d) Temperature Range: Minus 40 degrees F to plus 200 degrees F Minus 40 degrees C and 93 degrees C.
 - e) Tensile strength: 5 pounds/IN 875 N/m at 73 degrees F 22 degrees C.
 - f) Thickness: 0.003 inches to 0.004 inches 0.075 to 0.1 mm.
 - b. Graphic film:
 - 1) Opaque, non-reflective film with pressure sensitive adhesive backing, suitable for exterior and interior applications.
 - 2) Thickness: 0.0035 inches 0.09 mm minimum.

G. Fasteners and Anchors:

1. Anchors and inserts:
 - a. Exterior installations, and areas requiring corrosion resistance:
 - 1) Non-ferrous metal, or hot-dipped galvanized anchors and inserts.
 - b. Concrete and masonry work: Toothed steel, or lead expansion bolt devices with inserts for drilled-in-place anchors.
2. Bracket mounting:
 - a. Identification devices which project at right angles from walls or ceilings.
 - 1) Manufacturer's recommended standard concealed brackets, fittings, and hardware.
 - 2) Attach brackets and fittings securely to walls or ceilings with concealed fasteners and anchoring devices in accordance with manufacturer's recommendations.
3. Mount cast plaques using standard method recommended by manufacturer for each type of wall surface.
4. Concealed mounting:
 - a. Insert threaded studs into tapped lugs on back of plaque.
 - b. Set in predrilled holes filled with quick setting cement.
5. Mount plaques with exposed fasteners anchored through face of plaque into wall surface.
6. Flush mounting: Letters mounted with backs in contact with wall surface.
7. Glass mounting: When mounting identification device panels to front surface of glass, provide 0.080 inches 2 mm aluminum backup plate, on inside surface of glass.
8. Magnetic tape:
 - a. Manufacturer: 3M.
9. Mechanical fastening: Manufacturer's recommended fasteners based on identification device type and substrate.
10. Metal letters and numbers:
 - a. Manufacturer's standard fastening method for letter form, type of mounting, wall construction, and condition of exposure.
 - b. Heavy paper template: Provided by Manufacturer for establishing letter spacing and for locating holes for fasteners.
11. Projected mounting: Mount letters at a projected distance from the wall surface as indicated.
12. Reclosable fasteners:
 - a. Manufacturer: 3M.
 - b. Fastener types.
 - 1) Dual Lock SJ3562, Type 170.
 - 2) Dual Lock SJ3560. Type 250.
 - 3) Dual Lock SJ3561, Type 400.
 - c. Provide fastener types as recommended by manufacturer.
13. Shim plate mounting:
 - a. Concealed aluminum shim plates 1/16 inches 2 mm thick, with predrilled and countersunk holes.
 - b. Provide at locations indicated, and where other mounting methods are not practicable.
 - c. Attach shim plate with fasteners and anchors providing secure attachment to substrate.
 - d. Attach panel identification devices to shim plate and substrate.
14. Wall mounting: Attach panel identification devices to wall surfaces using following methods:
 - a. Tape mounting: Double-sided foam tape, thickness indicated, or as required to mount identification devices to smooth, non-porous surfaces.
 - b. Silicone adhesive mounting:

- 1) Liquid silicone adhesive recommended by Manufacturer for attaching identification devices to irregular, porous, or graphic film covered surfaces.

15. Installer requirements:

- a. Based on manufacturer recommendations, installer shall be responsible for fastener compatibility with substrates.
- b. Ensure that oxidation and other reactive processes do not occur between related signage materials and fasteners.

H. Adhesives:

1. Permanent adhesive:
 - a. Manufacturer: 3M.
 - b. Scotch 468MP, hi-performance adhesive, or as recommended by manufacturer.
2. Silicone adhesive:
 - a. Manufacturer: Mumentive.
 - b. Type: Silicone paneling adhesive as recommended by manufacturer.
3. Double faced laminating film:
 - a. Manufacture: Fasson, Division of Avery International Company.
 - b. Type: FASTAPE A Laminating Film, or as recommended by manufacturer.
4. Permanent double faced tape:
 - a. Manufacturer: 3M.
 - b. Type: 1/32 inches 1 mm, Scotch Mount Neoprene Tape No. 4962, or as recommended by manufacturer.
5. Removable double faced tape:
 - a. Manufacturer: 3M.
 - b. Type: 1/32 inches 1 mm, double faced removable tape No. 4432, or as recommended by manufacturer.
 - c. Color: Black.
6. Installer ensure adhesive compatibility with substrates.

I. Finishes:

1. Glass: Non-glare.
2. Metal finishes: Finish in compliance with NAAMM Metal Finishes Manual for finish designations and application recommendations.
3. Paint: Satin finish.
4. Stainless steel: ANSI No. 4 finish, horizontal grain, unless otherwise noted or specified.
5. Comply with American with Disabilities Act:
 - a. Measure finishes with a Glossimeter to ensure compliance.

J. Graphics:

1. Image Process:
 - a. Graphic content and style:
 - 1) Provide identification device copy in compliance with requirements indicated for content, finishes, materials, positions, sizes, spacing, styles, and colors of letters, numbers, symbols, and other graphic images.
2. Typography:
 - a. Typography and graphics:
 - 1) Photographically or mechanically reproduced.
 - b. International Symbols:
 - 1) In accordance with U.S. Department of Transportation current standards publication.

- c. Identification device typeface fonts:
 - 1) Provide as indicated on Drawings.
 - d. Letter forms:
 - 1) Use approved type font masters from original type foundry.
 - 2) Cut letter forms using graphic film cutter plotter equipment.
 - 3) Letter forms edges and corners are to be clean and true.
- K. Artwork:
- 1. Manufacturer provide typesetting, and mechanical artwork required for identification device types.
 - 2. Evacuation Plans:
 - a. HDR will provide floor plans, life safety plans and locations for evacuation plan signs.
 - b. The sign company will use those locations, as well as the floor plans, to produce the evacuation plan artwork based on design direction from HDR.
 - c. Orient map art and 'you are here' info in the direction from which it will be viewed.
 - d. Include representation of exits, primary and secondary paths, fire pull alarms and fire extinguisher locations based on the project Life Safety Plans and local fire code evacuation plan requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which materials are to be installed.
- B. Installation constitutes acceptance of responsibility for performance.

3.2 FABRICATION

- A. General Requirements:
 - 1. Fabricate and assemble identification devices in shop to the greatest extent possible.
 - 2. Fabricate parts and assemblies ready for installation at the building site.
 - 3. Surface defects considered unacceptable: Oil canning, cupping, and warping.
 - 4. Grind welds shall smooth.
 - 5. Be responsible for structural stability and mounting for graphics and identification devices.
- B. Identification Device Panels:
 - 1. Comply with requirements indicated for colors, designs, details of construction, finishes, materials, shapes, sizes, and thicknesses.
 - 2. Surfaces: Smooth, even, and level.
 - 3. Identification device panel flatness:
 - a. Fabricate panels to remain flat within 1/32 inches 1 mm over the concave surface.
 - b. Fabricate panels to remain flat under installed conditions within a tolerance of plus or minus 1/16 inches 2 mm measured diagonally.
 - 4. Edge Condition: 90 degree square cut, unless otherwise noted.
 - 5. Corner condition: Provide square corners, unless otherwise noted.
 - 6. Panel materials:
 - a. See Drawings for types and locations.
- C. Raised Copy:
 - 1. Exterior grade:
 - a. Fabrication of raised lettering on metal background to magnesium alloy plate shall be by acid etching process.

2. Interior Grade, solid core materials:
 - a. Manufacturer: Nova Polymers Inc.
 - b. Provide solid core materials in thicknesses indicated.
3. Machine-cut letter forms, and chemically welded to indicated materials.
 - a. Form characters with square cut edges free from burrs and cut marks.
 - b. Panel material, and raised copy thickness: Not less than 1/32 inches 1 mm.

3.3 INSTALLATION

A. General Requirements:

1. Locate identification devices and accessories where shown or scheduled in AG-Series drawings.
2. Use mounting method types indicated and as described, and in accordance with manufacturer's recommendations.
3. Field determine exact locations and dimensions for identification devices prior to fabrication.
4. Prevent conflicts between the placement of ADA room signs with items such as hand sanitizers and electronic devices.
 - a. Install room signs before other devices and accessories.
 - b. Provide temporary signs of the same dimension and location where other items will be installed first.
5. Contractor immediately notify Owner and Architect if building and site conditions are at variance with drawings.
 - a. Do not to proceed until the unsatisfactory conditions have been corrected.
6. Install identification devices in positions shown on drawings.
 - a. Install identification devices at heights indicated, plumb, and in alignment.
 - b. Brace devices securely until permanent anchorage is made.
 - c. Identification device surfaces are to be installed free from distortion or other defects in appearance.
 - d. Perform cutting, drilling, and fitting carefully.
 - e. When required, fit at site before finishing.
7. For digital print wall graphics, the manufacturer is responsible for priming the wall surface for graphics to be installed. Communicate to HDR and contractor how the wall surface should be prepared to preserve the printed material warranty.

B. General Location Requirements:

1. Single doors: Install identification device on wall adjacent to latch side of door.
2. Double doors: Install identification device on nearest adjacent wall.
3. Mount 60 inches 1525 mm above finish floor to centerline of identification device, unless otherwise indicated.
 - a. Mount signs so that tactile characters and Braille are located between 48 inches and 60 inches 1220 mm and 1525 mm above finish floor.
4. At a minimum, provide identification devices as follows:

- C. Provide signs at elevator call stations directing use of stairs: See ASME-A17.1, Appendix H.
- D. Provide stair identification devices in exit stairs connecting more than 3 stories: Reference International Building Code and NFPA 101.
- E. Mount identification devices according to methods specified or as indicated on drawings for each type.
- F. Manufacturer to provide printed instructions or drawings on wall blocking locations and type required to Contractor in a timely manner to allow installation.

3.4 CLEAN-UP

- A. At completion of the installation, clean identification devices with appropriate cleaning agents prior to final inspection and acceptance. Grease, fingerprints, smudges, adhesive, etc. remaining on identification devices or components will not be acceptable. Protect identification device units from damage until acceptance by Owner.
- B. Remove packing and debris from the project site upon completion and leave the site in a condition which is clean and free of damage and abuse.

END OF SECTION

SECTION 10 21 12
METAL TOILET PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Metal Toilet Partitions, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ANSI/BHMA:
 - a. A156.18, Materials and Finishes.
 - 2. ASTM:
 - a. A480, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - b. B456, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
 - 3. U.S. Department of Justice:
 - a. ADA Standards for Accessible Design, current addition.
 - 4. ICC/ANSI:
 - a. ICC/ANSI 117.1 Accessible and Usable Buildings and Facilities.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Prepare detail drawings for all applications including:
 - a. Room layout.
 - b. Component sizes and dimensions.
 - c. Attachment details and coordination with adjacent work.
- B. Product Data:
 - 1. Product data sheets and details for Metal Toilet Partitions, components and accessories.
 - 2. Product literature for hardware.
- C. Samples:
 - 1. One standard size samples of each color and finish as noted in Drawing Finish Schedule.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Metal Toilet Partitions:
 - 1. Base:
 - a. Accurate or Global Partitions by American Specialties Inc.
 - 2. Optional:
 - a.
 - b. General Partitions Manufacturing Corporation.
 - c. Hadrian.
 - d. Metpar Corporation.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Metal Toilet Partitions:

1. Steel sheet formed over panel core material.
2. Panel core material:
 - a. Double-faced, impregnated, kraft paper honeycomb.
 - b. Vermin and moisture resistant.
 - c. Sound deadened.
3. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections are not acceptable.
4. Component Thicknesses:
 - a. Pilasters: 1-1/4 inches.
 - b. Doors, Panels and Urinal Screens: 1 inch.
5. Panel Height: 58 inches high.
 - a. Mounting Height: 12 inches AFF to bottom of panel; 70 inches AFF to top.
6. Stall Dimensions: As indicated on Drawings.
7. Minimum sheet steel thicknesses:
 - a. Pilasters: 20 GA.
 - b. Panels and screens: 22 GA.
 - c. Doors: 22 GA.

B. Stainless Steel Partitions:

1. Type 304 18-8 Stainless Steel.
2. Finish: #4 brushed or satin

C. Doors:

1. For 32 inches or wider standard stalls: Minimum 26 inches wide.
2. For standard stalls less than 32 inches wide: Minimum 24 inches wide.
3. For accessible stalls:
 - a. Minimum 32 inches clear opening.
 - b. Self-closing.

D. Pilasters:

1. Adjustable hanger, leveling bolts, or both.
2. Ceiling-Hung:
 - a. Complete with threaded rods, lock washers, and leveling adjustment nuts, designed to support pilasters from structure without transmitting any load to finish ceiling.
 - b. Stainless steel top trim piece, finished to match hardware, 3 inches wide.

E. Urinal Screens:

1. Wall Hung:
 - a. Size:
 - 1) 18 inches x 48 inches.
 - b. Same construction and finish as toilet compartments.
 - c. Continuous, double-flanged wall bracket.

F. Pilaster Shoes:

1. AISI Type 302/304 18-8 stainless steel.
 2. 20 GA, 3 inches high.
- G. Stirrup Brackets:
1. Manufacturer's heavy duty design for attaching panels to walls and pilasters.
 2. Chromium plated brass or Type 302 stainless steel.
- H. Operational Hardware:
1. Material: Chrome plated brass or stainless steel.
 2. Universal Knob/Lever:
 - a. Concealed in door.
 - b. ADA compliant.
 - c. Emergency Access.
 3. Strike:
 - a. Wrap around type strike/keeper designed to properly receive and hold latch.
 - b. Integral bumper.
 4. Door pull:
 - a. ADA compliant.
- I. Bumper Coat Hook:
1. Rubber tipped combination bumper and coat hook.
 2. Provide one for each compartment.
- J. Pivot Hinges:
1. Cam action, self-closing, inset into cut-out in door.
 2. Top Pivot: 1/2 inches nylon pin.
 3. Bottom Pivot: 3/16 inches Stainless Steel pin.
 4. Body Material: Chromium plated brass or stainless steel
 5. Adjustable to permit doors to rest position at any angle within a 270 degrees arc.
- K. Toilet Tissue Holders and related Accessories:
1. See Section 10 28 13.
- L. Anchorages and fasteners:
1. Exposed fasteners:
 - a. Tamper-resistant, stainless steel or brass.
 - b. Finish: match hardware
 2. Concealed anchors:
 - a. Hot dip galvanized steel.
 - b. ASTM A385

2.3 FABRICATION

- A. Verify dimensions in field prior to fabrication.
- B. Pre-assemble units in shop to greatest extent possible. No field cutting of panels allowed.
- C. Pressure laminate face sheets to core material.
 1. Seal edges with continuous locking strip.
 2. Miter, weld, and grind corners smooth or cap with manufacturer's standard stainless steel edge and corner fittings.
- D. Provide concealed reinforcement for installation of hardware, fittings, brackets, and accessories.

- E. Reinforce panels for attachment of grab bars.
- F. Finishing:
 - 1. Clean surfaces of processing compounds and contaminants.
 - 2. Pretreat with a phosphate coating.
 - 3. Apply rust inhibiting primer.
 - 4. Apply thermosetting powder coat in accordance with paint manufacturer's instructions to provide minimum 1.5 mil dry film thickness.
- G. Exposed Metal and Hardware Finishes:
 - 1. Stainless steel:
 - a. ASTM A480, bright polished finish No. 4; or
 - b. ANSI/BHMA A156.18, Code 629; to match US32.
 - 2. On brass, bronze, and steel:
 - a. ASTM B456, SC-2 bright chromium plated over nickel plating; or
 - b. ANSI/BHMA A156.18, Code 625 on brass and bronze, Code 651 on steel; to match US26.
 - 3. Aluminum:
 - a. AA-M12C22A31 clear satin anodized; or
 - b. ANSI/BHMA A156.18, Code 628; to match US28.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrate to accept installation.
- B. Verify that adequate Wall Backing has been installed.
 - 1. Metal Wall Backing: Specified in Section 09 22 16.
 - 2. Coordinate and direct installation at locations required for Toilet Partitions and accessories.
- C. Correct unsatisfactory conditions.
- D. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. Install in a rigid, straight, plumb and level manner, to indicated layout.
- B. Clearances:
 - 1. Between pilasters and panels: Maximum 1/2 inches.
 - 2. Between panels and walls: Maximum 1 inch.
 - 3. Between doors and pilasters: Maximum 3/16 inches.
 - 4. Between floor and bottom of panels: 12 inches.
- C. Secure to walls with minimum of 2 stirrup brackets near top and bottom of panel.
 - 1. Locate brackets so holes occur in masonry or tile joints.
 - 2. Use manufacturer's recommended anchoring devices, as indicated on shop drawings.
- D. Floor Mounted / Overhead Braced Partitions:
 - 1. Secure pilasters to floor.
 - 2. Level, plumb, and tighten.
 - 3. Secure overhead brace with minimum of two fasteners per pilaster.
 - 4. Set tops of closed doors parallel with overhead brace.
- E. Urinal Screens:

1. Provide wall channels, wall plates and studs as recommended by manufacturer to suit wall construction.
2. Set units in accordance with manufacturer's instructions to support units and resist impact.

3.3 ADJUST AND CLEAN

- A. Adjust and lubricate hardware for proper operation after installation.
 1. Set hinges on in-swing doors to hold unlatched doors open approximately 30 degrees.
 2. Set hinges on out-swing doors to return to fully closed position.
- B. Protect until time of acceptance by Owner.
- C. Replace damaged work as directed.
- D. Perform final adjustments just prior to final inspection.
- E. Clean exposed surfaces, hardware, fittings, and accessories and touch up minor scratches and other imperfections using materials and methods recommended by manufacturer.

END OF SECTION

SECTION 10 26 00
WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Wall Protection Specialties, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
 - 2. ASTM D1308 Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
 - 3. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
- B. American Architectural Manufacturers Association (AAMA):
 - 1. AAMA 611 Voluntary Specification for Anodized Architectural Aluminum

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Show locations, extent and installation details of wall guard.
 - 2. Show methods of attachment to adjoining construction.
- B. Product Data:
 - 1. Manufacturer's standard literature indicating systems and products specified.
- C. Samples:
 - 1. Material samples of each color and texture listed for wall protection as noted in Drawing Finish Schedule.
- D. Contract Closeout Information:
 - 1. Maintenance data.

1.4 QUALITY ASSURANCE

- A. Single Source Responsibility:
 - 1. Provide components of the wall protection system manufactured by same company to ensure compatibility of color, texture, and physical properties.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Wall Protection Specialties:
 - 1. Base:
 - a. Inpro
 - 2. Optional:
 - a. Construction Specialties

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Stainless Steel Corner Guards (SSCG)

1. Flush Mount Stainless Steel Corner Guard.
2. 16 GA 1.5 mm type 304 or 430 stainless steel with No. 4 satin finish.
3. Size: 3-1/2 by 3-1/2 inches 89 by 89 mm.
4. Nose radius: 1/8 inches 3.2 mm.
5. SSCG Partial height, top of wall base to top of corner guard: 48 inches 1.2 m.

B. Wall Guard (WG)

1. Palladium Rigid Sheet Wall Protection by Inpro
2. Sheet thickness: 0.040 inches 1.0 mm
3. Color, pattern, and texture:
 - a. See Drawing Finish Schedule.
4. Include appropriate primers, adhesives, and sealants.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify walls are in proper condition to receive installation of protection items.
- B. Correct unsatisfactory conditions.
- C. Coordinate installation of backing required for wall protection specialties scheduled.
- D. Commencement of installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Install with fasteners suitable for wall substrates encountered and provide adequate anchoring for anticipated impact loads.
- C. Install items where indicated.

3.3 INSTALLATION - WALL GUARD (WG)

- A. Prepare substrates as required to receive wall guard.
- B. Prepare substrates to receive adhesive with acrylic primer which does not contain poly vinyl acetate (PVA).
- C. Install in accordance with manufacturer's recommendations.
- D. Where items mounted in wall are surrounded by wall guard, trim wall guard to fit behind flanges and cover plates.
- E. Where items mounted in wall are partially surrounded by wall guard, trim wall guard to abut edges of flanges and cover plates.
- F. Preparation – WG over New Gypsum Wallboard:
 1. Ensure new drywall has been taped and sanded smooth.
 2. Wipe clean to remove dust.
- G. Partial Height Installations – Wainscot:
 1. Provide where indicated.
 2. Start bottom edge at floor line and install prior to installation of wall base.

- a. Install wall base over wall guard.
- 3. Install sheets horizontally to top of wainscot height and terminate with color coordinated trim cap.
- 4. Install wall guard with matching color sealant along top edge of panels.
- 5. Vertical Joints:
 - a. Install wall guard with butted joints and matching colored sealant at vertical wall joints and inside corners.
 - b. Joint width: 1/16 inches 1.6 mm.
 - c. Install 2-piece corner guard, CG-1, at outside corners. Match wainscot height.

H. Sealant:

- 1. See Section 07 92 16.
- 2. Seal to adjacent finish materials including top edge, lateral edges, and bottom edge.

3.4 ADJUSTING AND CLEANING

- A. Adjust installed end caps as necessary to ensure tight seams.
- B. Remove and replace defective, misaligned, or damaged units.
- C. Verify wall protection items are plumb and rigidly secured to substrate. Make adjustments required.
- D. Remove protective films.
- E. Clean items adjacent areas using materials and methods recommended by manufacturer.

3.5 PROTECTION

- A. Protect installed materials to prevent damage by other trades.

END OF SECTION

SECTION 10 28 13

TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Toilet and Bath Accessories in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM A240/A240M Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip
- B. U.S. Department of Justice:
 - 1. ADA Standards for Accessible Design.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's standard literature indicating systems and products specified.
- B. Contract Closeout Information:
 - 1. Maintenance data.
 - a. See Section 01 78 23.
 - 2. Letter stating that extra material has been delivered.

1.4 QUALITY ASSURANCE

- A. Provide accessories from one manufacturer as far as practicable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Toilet and Bath Accessories:
 - 1. Base:
 - a. American Specialties, Inc. (ASI)
 - b. As noted for specific items.
 - 2. Optional:
 - a. Bobrick Washroom Equipment
 - b. Bradley
 - c. GAMCO, a Division of Bobrick
 - d. Seachrome
 - e. Tubular Specialties Manufacturing (TSM)
 - f. A & J Washroom Accessories
 - g. Brey-Krause Manufacturing
- B. Other manufacturers of a complete line of stainless steel accessories desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Type 304, 18-8 stainless steel per ASTM A240/A240M, unless noted otherwise.

1. Finish: Satin #4 on exposed surfaces.
- B. Corrosion resistant fasteners and attachment devices, and other fittings necessary to assure function and operation of accessories.
- C. See drawings for items, quantities, locations, and required mounting heights.
- D. Locks:
 1. Tumbler locks keyed alike.

2.3 TOILET ACCESSORIES

- A. Hooks:
 1. TA1A and TA1B:
 - a. Single Robe Hook.
 - b. Model 7340-S by ASI.
- B. Toilet Tissue Dispensers:
 1. TA2:
 - a. Double Roll Tissue Dispenser.
 - b. Cast aluminum with ABS thermoplastic spindle.
 - c. Model 0264-1A by ASI.
 - d. Non-controlled delivery.
- C. Sanitary Disposal:
 1. TA5:
 - a. Model 0852 by ASI.
 - b. Surface mounted.
- D. Paper Towel Dispensers/ Disposals:
 1. TA6:
 - a. Model 0469 by ASI.
 - b. Capacity: 600 C-fold or 800 multi-fold towels.
 - c. Removable 12 gallon waste receptacle.
- E. Paper Towel Dispensers:
 1. TA7:
 - a. Model 0210 by ASI
 - b. Surface mounted.
 - c. Capacity: 400 C-fold or 525 multi-fold towels
- F. Soap Dispensers:
 1. TA9V:
 - a. Model 0347 by ASI.
 - b. All-purpose valve.
 - c. Surface mounted.
 - d. Locate right side of mirror.
 - e. Center over sink on side wall.
 - f. Mount with spout at 42 inches AFF.
- G. Mop Broom Rack:
 1. TA10:
 - a. Model 8215-3 by ASI.

- b. Three rubber cam mop holders
 - c. 26 inches wide.
 - d. Surface mounted.
- H. Mirrors:
 - 1. TA13:
 - a. Model 0600 by ASI.
 - b. Polished stainless steel framed mirror.
 - c. 18 inches wide by 36 inches high.
- I. Shelves:
 - 1. TA15:
 - a. Model 0692 by ASI.
 - b. Brushed stainless steel shelf and brackets.
 - c. 16 inches wide by 6 inches deep.
- J. Toilet Seat Cover Dispensers:
 - 1. TA20:
 - a. Model 0477-SM by ASI.
 - b. Surface mounted.
 - c. 250 sheets.
- K. Baby Changing Stations:
 - 1. TA21:
 - a. Model 9012 by ASI.
 - b. Horizontal.
 - c. Include a supply of 500 liners per station.
 - d. Material:
 - 1) High Density Polyethylene (HDPE).
 - 2) Color: Grey.
- L. Grab Bars:
 - 1. General:
 - a. Base Products: 3800 Series by American Specialties.
 - b. Bar Diameter: 1-1/2-inch OD.
 - c. Concealed mounting.
 - d. Include anchoring devices to withstand minimum concentrated load of 250 pounds typical and 800 pounds at bariatric locations.
 - e. Include 3800M spacer to keep grab bar parallel to wall faces at offset conditions.
 - 2. TA33V:
 - a. 18-inch vertical grab bar.
 - 3. TA36:
 - a. 36-inch horizontal grab bar.
 - 4. TA37:
 - a. 42-inch horizontal grab bar.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrate to accept installation.

- B. Coordinate and direct installation of backing where required for toilet accessories.
- C. Verify that adequate wall backing has been installed.
 - 1. Coordinate and direct installation backing where required for toilet accessories.
 - 2. Utilize proprietary backing devices where available.
 - 3. At remaining locations, provide metal backing per Section 09 22 16.
- D. Correct deficiencies before proceeding to install accessories.
- E. Where item is mounted on or in a toilet partition, coordinate interior reinforcing location with partition manufacturer.
- F. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions.
 - 1. Install plumb, level, and rigidly anchored to substrates.
- B. Where drawings or schedule require barrier-free accessibility, install accessories in accordance with applicable regulations.
- C. Coordinate accessory locations to fit spaces.
- D. Coordinate items to avoid mounting conflicts.
- E. Mount items with theft-resistant fasteners.
- F. Seal grab bar mounting plate to shower walls with silicone sealant or gasket prior to installation of bar.

3.3 ADJUSTING AND CLEANING

- A. Protect accessories from damage due to construction.
 - 1. Remove protective coverings when no longer required.
- B. Test accessories and adjust for proper operation.
- C. Clean exposed surfaces.

END OF SECTION

SECTION 10 41 00
EMERGENCY ACCESS AND INFORMATION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Emergency Access System, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. UL 1037 Standard for Antitheft Alarms and Devices.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer standard literature for Emergency Access System.
 - 2. For each type of material and accessory.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Emergency Access System:
 - 1. Base:
 - a. Knox Company.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. High Security Key Box:
 - 1. Knox-Box 3200 Series by Knox Company.
 - a. Welded steel box with stainless steel hinged door and master key.
 - b. 1/4 inches thick plate steel box housing.
 - c. 1/2 inches thick steel plate door with weather gasket.
 - d. Dimensions: 4 inches high x 5 inches wide x 3-3/4 inches deep.
 - e. Recessed mount
 - 1) Include manufacturer's recessed mounting kit.
 - f. Surface mount
 - g. Include 4, 3/8 inches Grade 5 or Grade 8 carriage bolts with nuts and washers.
 - h. Lock mechanism:
 - 1) Double-action rotating tumbler lock.
 - 2) 1/8 inches steel dust cover.
 - 3) Biased cut key.
 - i. Color: Black.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate installation of recessed mounting kit with wall construction.

1. Cast back box and conduit, if specified, into concrete.
 2. Set back box at the time of masonry installation.
 3. Install face of back box flush to surface of finished wall.
- B. Install box with manufacturer approved connectors.
- C. Deliver keys to building Owner.

END OF SECTION

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Fire Protection Specialties in accord with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM E814 Standard Test Method for Fire Tests of Penetration Firestop Systems
 - 2. ASTM F2503 Standard Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 10 Standard for Portable Fire Extinguishers.
- C. Americans with Disabilities Act (ADA):
 - 1. Standards for Accessible Design.

1.3 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Contract Closeout Information:
 - 1. Maintenance data:
 - a. See Section 01 78 23.

1.4 QUALITY ASSURANCE

- A. Provide fire extinguishers, cabinets, and accessories by single manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fire Protection Specialties:
 - 1. Base:
 - a. Activar JL Industries.
 - 2. Optional:
 - a. Badger.
 - b. Larsen's Manufacturing.
 - c. Nystrom.
- B. Fire Extinguishers:
 - 1. Base:
 - a. Activar JL Industries.
 - 2. Optional:
 - a. Amerex.
 - b. Badger.
 - c. Larsen's Manufacturing.

- d. Nystrom.
- C. Storage Case for Self-Contained Breathing Apparatus (SCBA):
 - 1. Base:
 - a. Allegro Industries.
 - 2. Optional:
 - a. MSA.
 - b. Encon Safety Products, Inc.

D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Fire Extinguishers:

- 1. Multi-Purpose Chemical Fire Extinguishers:
 - a. Typical FE, except where more specialized types are required.
 - b. Fluidized and siliconized chemical powder extinguishing agent suitable for class A, B and C fires.
 - c. Construction:
 - 1) Heavy-duty steel cylinder with metal valve and siphon tube with replaceable molded valve stem seal, visual pressure gauge, pull pin and upright squeeze grip.
 - 2) Corrosion and impact-resistant, powder coat finish.
 - 3) Color: Red, in accord with OSHA requirements.
 - d. Capacity: 10 pounds.
 - 1) UL-rating: 4A-80BC.
 - 2) Base Product Model: Cosmic 10E by JL Industries.
 - e. Provide one FE for each:
 - 1) Fire Extinguisher Cabinet (FEC).
 - 2) Fire Extinguisher (FE) location.

B. Fire Extinguisher Cabinets (FEC):

- 1. Provide FIRE EXTINGUISHER decal for each cabinet.
 - a. Orient letters vertically.
 - b. Color: Red.
- 2. Provide instructional decal for operating emergency break-away release mechanism.
- 3. Provide standard fixed door pull at each cabinet unless noted otherwise.
- 4. Keys to Door Locks: Three per lock.
- 5. Key all FEC locks the same.
- 6. Finishes:
 - a. Comply with NAAMM's Metal Finishes Manual for Architectural and Metal Products.
 - b. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
 - c. Finish fire protection cabinets after assembly.
- 7. FEC-1: Semi-recessed, Steel, Fire Extinguisher Cabinet:
 - a. Cold rolled steel tub with 1-1/2 inches square edge steel trim style and door.
 - 1) Fire-rated Cabinets: Provide fire-rated cabinets where FEC-1 is indicated to be installed in fire-rated walls.
 - 2) Maximum projection from wall surface: 1-1/2 inches.

- b. Cabinet Construction:
 - 1) Non-fire rated Cabinets: Single-wall, 0.026 inches (26 GA) steel.
 - 2) Fire Rated Cabinets: Double-wall construction fabricated from 0.043 inches (18 GA) steel lined with minimum 5/8 inches thick, fire-barrier material.
- c. Finish: Powder coated.
 - 1) Color: White.
- d. Tub Size, inside clear: 10-1/2 inches wide by 24 inches high by 6 inches deep.
- e. Door Style: Full Glazing; Clear acrylic.
- f. Lock: Cam lock with emergency break-away release mechanism.
 - 1) Base Product: Saf-T-Lok by JL Industries.
- g. Base Product: Ambassador Series 1016 and Ambassador FX series by JL Industries.
- 8. FEC-4: Surface-mounted, Stainless Steel, Fire Extinguisher Cabinet:
 - a. Description: Stainless steel cabinet box fully exposed and mounted directly on wall with no trim.
 - b. Material: 0.026 inches (26 GA) stainless steel.
 - 1) Finish: #4 brushed.
 - c. Tub Size, inside clear: 13-11/16 inches wide by 27-3/16 inches high by 6-1/2 inches deep.
 - d. Door Style: Full Glazing; Clear acrylic.
 - e. Lock: Cam lock with emergency break-away release mechanism.
 - 1) Base Product: Saf-T-Lok by JL Industries.
 - f. Base Product: Cosmopolitan series by JL Industries.
- C. Wall Brackets:
 - 1. Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated.
 - 2. Finish: Baked-enamel or powder coat.
 - 3. Include mounting accessories suitable for substrate wall type.
 - 4. Locations: Install wall brackets for each fire extinguisher (FE) not indicated to be installed in a cabinet.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrates to accept installation.
- B. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. Install extinguishers and cabinets within limitations of NFPA-10 and ADA.
- B. Fasten mounting brackets and cabinets to structure, square and plumb, to comply with manufacturer's instructions.
- C. Provide Unistrut or welded steel support where needed to mount cabinets or brackets in mechanical rooms and similar locations.
- D. Provide required closures.
- E. Mounting Height:
 - 1. Fire Extinguisher Cabinets (FEC):
 - a. Locate with centerline of cabinet door handle not more than 48 inches AFF.
 - 2. Fire Extinguishers (FE) not contained in a cabinet:

- a. Locate wall brackets such that extinguisher release mechanism will not be higher 48 inches AFF.

3.3 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films.
- B. Adjust fire protection cabinet doors to operate easily without binding.
 - 1. Verify that integral locking devices operate properly.
- C. Clean interior and exterior surfaces.

END OF SECTION

SECTION 10 82 00
ALUMINUM SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum Screens

1.2 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.
- B. Section 05 41 00 – Structural Metal Stud Framing: Metal framing for support of aluminum screens.
- C. Section 05 50 50 - Metal Fastenings and Accessories: Knotwood Mounts.
- D. Section 06 10 00 – Rough Carpentry: Wood stud framing for support of aluminum screens.

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - 2. ASTM E 136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
 - 3. ASTM E 2768-11 – Standard Test Method for Extended Duration Surface Burning Characteristics for Building Materials (30 min Tunnel Test). Results: Zero Flame Spread, Smoke Developed Index of 5. Meets criteria for Class A fire rating.
- B. American Architectural Manufacturers Association (AAMA)
 - 1. AAMA 2604 - Voluntary Specification, Performance requirements and Test Procedures for High Performing Organic Coatings on Aluminum Extrusions and Panels.
- C. Aluminum Association Standards (AA ASM)
 - 1. AA ASM 35 - Aluminum Sheet Metal Work in building construction.
 - 2. AA ADM 1 - Aluminum Design.
- D. American Society of Civil Engineers
 - 1. 7-10 - Minimum Design Loads for Buildings and Other Structures. American Society of Civil Engineers.
- E. 2017 Florida Building Code, Building

1.4 PERFORMANCE REQUIREMENTS

- A. Components: Design and size components to withstand dead and live loads in accordance with applicable code.
- B. Movement: Accommodate movement within system without damage to components or movement within system:
 - 1. Movement between system and perimeter components when subject to seasonal temperature cycling.
 - 2. Dynamic loading and release of loads.
 - 3. Deflection of structural support framing.
- C. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within screen system.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop drawings: indicate dimensions, layout, joints, expansion joints, construction details, methods of anchorage, and interface with adjacent materials.
- D. Verification Samples: For each finish product specified, two samples, representing actual product, color and gloss.
- E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- F. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic cleaning and maintenance of components.

1.6 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Experience producing aluminum finishes of the types specified in AAMA 2604 Certified.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.
- C. Mock-up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designed by Architect.
 - 2. Do not proceed with remaining work until workmanship, color, and gloss are approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package and store products under cover in manufacturer's unopened packaging until ready for transport and installation.
- B. Unload and store prefinished material off ground protected from weather, to prevent warping, twisting, bending, or abrasion.
- C. Prevent contact with materials capable of causing discoloration or staining.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results.
- B. Do not fabricate products under environmental conditions outside manufacturer's absolute limits.
- C. Weather limitations: Proceed with installation when existing and forecasted weather conditions permit assembly of metal fabrications to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

- A. Coordinate work with installation of adjacent components or materials to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. 15 year limited lifetime warranty against cracking, peeling and gloss/color retention within the guidelines stated by the American Aluminum Manufacturers Association (AAMA).

PART 2 - PRODUCTS

1.11 MANUFACTURERS

A. Basis of design: Knotwood Aluminum Screens

Represented by: **KNOTWOOD USA**

5555 W Roosevelt St Suite 400,
Phoenix, AZ 85043 United States
1-602-313-1641

Request information at: sales@knotwood.com

Web: www.knotwood.com

B. Or approved equal.

1.12 MATERIALS

A. Extruded Aluminum Fencing, Accessories and Trim: Knotwood Wood Grain Aluminum Grilles, Screens, and Accessories with Aluminate bonded film finish is extruded aluminum.

1. Batten Bracket - 2" x 2" (M) - V3
2. Batten - 2" x 2" (F) V3
3. Cast End Cap - 2" x 2"
4. Cast End Cap - 2" x 6"

B. Manufactured length is 18'6" – useable is 18'4".

1.13 FINISHES

A. Pretreatment: E-CLPS Chrome Free five stage aluminum pretreatment system. Complies with, AAMA 2604 Performance Standard and meets EPA, OSHA, State and Local environmental requirements, and contains no chromates, cyanides, or other heavy metals. Waste treatment is usually a simple pH neutralization and disposal to the sanitary sewer.

B. Dulux Group Mannex base coat and Duratec Series electrostatic applied Architectural Powder Coatings are approved to AAMA 2604 Performance Standard.

C. Gloss Level: Standard Gloss is 30 percent, plus or minus 5 percent.

D. Super Durable Powder Coatings: Aluminate Premium Wood Finishes use a polyurethane powder coat with ink-based wood grain patterns sublimated into the base powder effectively tattooing the powder coating. The combined effect creates all the aesthetic aspects of real wood while offering the same environmental advantages of powder coated finishes.

E. Check availability on www.knotwood.com

1. Standard Woodgrain Colors:
 - a. White Ash

1.14 FABRICATION

A. Prepare surfaces, pre-treat and coat components in accordance with AAMA 2604 Quality Standards.

B. Wrap and package coated components using methods suitable for transit and covered site storage without damage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until colors have been verified.

B. Verify if framing or structural components are ready to receive the Knotwood system.

C. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by the manufacturer.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions.
- B. Barrier Protection: Do not install over cementitious materials, dissimilar metals or pressure treated material without adequate barrier protection.
- C. Fasten siding to structural supports; aligned, level, and plumb.
- D. Locate joints over supports.
- E. Use concealed fasteners as per manufacturer's instructions unless otherwise approved by Architect.
- F. Install Screens and accessories in accordance with best practice, with all joint members plumb and true.
- G. Allow for expansion and contraction of materials according to manufacturer's instructions.

3.4 FIELD QUALITY CONTROL

- A. After installation of Screens, check entire surface for obvious flaws or defects.
- B. Replace and repair any problem areas, paying close attention to the substrate for causes of the problem.

3.5 CLEANING

- A. After application of Screens, clean as necessary to remove all fingerprints and soiled areas.
- B. Upon completion of Screen application, clean entire area, removing all scrap, packaging and unused materials related to this work.

3.6 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION



DIVISION 11

EQUIPMENT



SECTION 11 24 26

SAFETY TIE-BACKS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Safety Tie-Backs, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 DESCRIPTION

- A. Description of system:
 - 1. Design, fabrication, and installation of safety tie-backs anchored to roof structure for purpose of window washing and general building maintenance including:
 - a. Single eye safety tiebacks.
 - b. Signage indicating safe usage and restrictions.
 - c. Instructional materials.
 - 2. Design and locate anchors to provide accessibility to windows for purpose of cleaning, building maintenance, or both, with conventionally rigged window washing equipment.
 - 3. Provide soffit mounted anchors, wall mounted anchors, or both, to access windows which are difficult to reach from above due to adjacent soffits and other projecting overhangs.
 - 4. Coverage shall include following areas:
 - a. Individual windows, ribbon windows and curtain wall glass which is not easily reachable by ladder from grade.

1.3 REFERENCES

- A. Occupational Safety and Health Administration (OSHA):
 - 1. 1910, Subpart D Walking and Working Surfaces.
 - 2. Appendix C to 1910 Subpart I Personal Fall Arrest Systems.
 - 3. OSHA Ruling on Window Cleaning by Boatswain's Chair.
 - 4. 1910.66, Subpart F Powered Platforms.
- B. American Institute of Steel Construction (AISC):
 - 1. AISC 360 Specification for Structural Steel Buildings.
 - 2. AISC Steel Construction Manual.
- C. Aluminum Association (AA):
 - 1. AA ADM-1 Aluminum Design Manual; Aluminum Association.
- D. American Welding Society (AWS):
 - 1. AWS D1.1 Structural Welding Code - Steel.
 - 2. AWS D1.2 Structural Welding Code - Aluminum.
- E. American National Standards Institute (ANSI)/International Window Cleaning Association (IWCA):
 - 1. ANSI/IWCA I-14.1 Window Cleaning Safety Standard.
- F. American Society of Mechanical Engineers:
 - 1. ASME A120.1 Safety Requirements for Powered Platforms for Building Maintenance.

1.4 SUBMITTALS

- A. Product Data:
 - 1. For each type of material and accessory.
- B. Shop Drawings:
 - 1. Showing anchorage locations and details.
- C. Project Information:
 - 1. Manufacturer's installation instructions and recommendations.
 - 2. Manufacturer Certificate of liability insurance.
 - 3. Drawings showing proposed rigging arrangements which might be used to reach windows, including boatswain's chair, drop-stage and/or other methods.
- D. Contract Closeout Information:
 - 1. Structural calculations for Window Washing System indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
 - a. Submit concurrent with Shop Drawings.
 - 2. Operating Procedures Outline:
 - a. Include elements in both pictorial and written form to instruct employees in safe use of roof supported building maintenance equipment and window cleaning procedures.
 - 3. Warranty.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Manufacturer minimum 5 years of experience in design, fabrication and installation of similar size and scope systems.
 - 2. Manufacturer to carry specific liability insurance for products and completed systems in amount of \$10,000,000.00 to protect against product and system failure.
- B. Installer Qualifications:
 - 1. Installer minimum 5 years of experience in installation of similar systems or approved by manufacturer.
 - 2. Welding to be executed by certified welders in accordance with AWS requirements.

1.6 WARRANTY

- A. Manufacturer five year warranty against failure and replacement of components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Safety Tie-backs System:
 - 1. Base:
 - a. Guardian Fall Protection.
 - 2. Optional:
 - a. Boston Anchor.
 - b. High Rise Systems Inc.
 - c. Hysafe.
 - d. MIO Mechanical Corp.
 - e. Spider Staging.
 - f. Summit Anchor Company.
 - g. Swing Stage.

h. Tractel Incorporated.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

A. Provide Safety Tie-Back system engineered to support dead, live, and lateral (wind or seismic) loads indicated.

1. Comply with Section 01 71 21, Specialty Engineering Requirements.
2. Include headers and reinforcing members around openings.
3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

B. Design system to support 1000 pound working load and 5000 pound ultimate load applied to each anchor.

1. Compatible with current window washing practices and standards.
2. Locations shown on Drawings are conceptual.
3. Actual locations are to be determined by designer of system.

2.3 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Design roof anchorage system including locations and details required to meet listed codes and requirements.

B. Locations shown on Drawings are conceptual.

C. Actual locations as determined by equipment supplier in Shop Drawings, but shall comply with following:

1. Locate anchors with direct attachment to structural concrete or steel members.
 - a. Through-slab connections not allowed.
2. Proposed locations are subject to final approval by Architect.

D. Standards for components:

1. Exposed structural stainless steel: Type 304, with a yield strength of 42 ksi.
2. Non-Exposed structural components: ATSM A36, Type 350W with yield strength of 50 ksi for Hollow Structural Steel and 42 ksi for Plate Steel and other sections.
3. Galvanizing: ASTM A123.
4. Cold-Rolled Sections: ASTM A500 with yield strength of 55 ksi.
5. Fastening devices: ASTM A325 or Type 304 stainless steel.

E. Provide anchorage components fabricated of materials compatible with substrates to which welded or otherwise attached.

F. Flashing and Counterflashing:

1. Specified in roofing section at location of roof anchor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Correct unsatisfactory conditions.

B. Start of work constitutes acceptance of conditions and responsibility for performance.

3.2 INSTALLATION/ERECTION

A. Install components required to be attached to or connected with structure.

B. Coordinate as required.

- C. Install in accord with manufacturer's instructions and approved shop drawings.
- D. No through-wall style anchors may be used unless approved by Architect.
- E. Install top of safety tie-back at 6 inches minimum above adjacent roofing height, taking into account insulation thickness at each tie-back location.
- F. Flashing:
 - 1. Specified in Section 07 53 23.
- G. Where contact is made between dissimilar materials, protect to prevent corrosion.
- H. Coordinate components indicated to be installed on other affected building components with those suppliers, installers, or both.
- I. Retouch damaged galvanizing.
- J. Design components for attachment directly to structural steel members.

3.3 FIELD QUALITY CONTROL

- A. Check welds to structure.
- B. Verify water integrity of flashings, with roofer.

END OF SECTION



DIVISION 12

FURNISHINGS



SECTION 12 24 13

ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Roller Shades, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - 2. No growth for fungi ATCC9642, ATCC 9644, ATCC9645.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code.
 - 2. NFPA 701-2015, Standard methods for Fire Tests for Flame Propagation of Textiles and Films.
 - a. Passes flame propagation performance criteria for Test Method.
 - 3. NFPA Article 100 Electrical components listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system.
- C. Window Covering Manufacturer's Association (WCMA):
 - 1. ANSI/WCMA A100.1 American National Standard for Safety of Window Covering Products.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to adjacent work.
- B. Product Data:
 - 1. Manufacturer's data sheets on each product to be used, including:
 - a. Preparation instructions and recommendations.
 - b. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
 - c. Storage and handling requirements and recommendations.
 - d. Mounting details and installation methods.
 - e. Window treatment schedule:
 - 1) Use same room designations as indicated on Drawings and include opening sizes and key to typical mounting details.
- C. Samples:
 - 1. Provide for each finish product specified,
 - a. One set of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.
 - b. One set of shade components, unassembled, demonstrating compliance with specified requirements.
 - 1) Shadecloth sample and aluminum finish sample as selected.

2) Mark face of material to indicate interior faces.

D. Contract Closeout Information:

1. Warranty.
2. Maintenance Data:
 - a. See Section 01 78 23.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Obtain roller shades through one source from a single manufacturer.
2. Minimum 20 years of experience in manufacturing products comparable to those specified in this section.

B. Installer Qualifications:

1. Installer trained and certified by manufacturer with a minimum of 10 years of experience installing products comparable to those specified in this section.

1.5 WARRANTY

- A. Roller Shade Hardware: Manufacturer's standard non-depreciating 25 year limited warranty.
- B. Shadecloth: Manufacturer's standard non-depreciating 5 year limited warranty.
- C. Roller Shade Motors and Motor Control System: Manufacturer's standard non-depreciating five-year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Roller Shades:

1. Base:
 - a. MechoShade Systems.
2. Optional:
 - a. Draper.
 - b. Hunter Douglas Contract.
 - c. Lutron by Vimco.

B. Other manufacturers desiring approval comply with Section 01 61 00.

- C. At time of specification, it is known that this product and others do not comply with BABA requirements. If there are alternate options that complies at the time of construction that is found to comply with the following requirements.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Transparent Single-Fabric Shadecloth:

1. EuroTwill by MechoShade Systems, Inc.
2. Single thickness 0.030 inches vinyl fabric.
3. Dense Basket Weave: 6000 Series, 3 percent open.
4. Color: As selected from manufacturer's standard colors.

B. Transparent Single-Fabric Shadecloth:

1. EuroTwill by MechoShade Systems, Inc.
2. Fabric thickness 0.025 inches.

3. Dense Basket Weave: 6200 Series, 1 percent open.
4. Color: As selected from manufacturer's standard colors.

2.3 COMPONENTS

A. Motorized Shade Hardware and Shade Brackets:

1. Minimum 1/8 inches thick plated steel.
2. Field adjustable.

B. Manual Operated Chain Drive Hardware and Brackets:

1. Adjustable universal, regular and offset drive capacity.
2. Removable fascia with concealed fasteners.
3. Provide shade hardware system that allows for removable regular and/or reverse roll fascias to be mounted continuously across two or more shade bands without requiring exposed fasteners of any kind.
4. Provide multiple shade operation by a single chain operator.
5. Minimum 1/8 inches thick plated steel.
6. Drive Bracket and Brake Assembly:
 - a. Base: Mecho 5X by Mechoshade System, Inc.:
 - 1) SnapLoc fascia, room darkening side, center supports and connectors for multi-banded shades as specified in Interior Notes & Finish Legend.
 - b. M5 drive sprocket and brake assembly shall rotate and be supported on a welded 3/8 inches steel pin.
 - c. Brake pull force: 50 pounds in stopped position.
 - d. Permanently lubricated assembly.
 - e. Mount on the steel support bracket, independent of shade tube assembly.

C. Drive Chain:

1. No.10 stainless steel chain.
2. Rating: 90 pounds, minimum.
3. Wall mount chair tensioners as required per code.

D. Shade Motors:

1. Tubular, non-synchronous reversible motors, thermally protected.
2. Conceal motors inside shade roller tube.

E. Motor Control System:

1. IQ2-DC EDU Motor DC Voltage.motor logic control system by MechoShade Systems, Inc.
 - a. Wall Switches:
 - 1) Three-button architectural flush mounted switches with metal cover plate and concealed fasteners.

2.4 ACCESSORIES

A. Roller Shade Pocket for recessed mounting in acoustical tile or GWB ceilings for Shade Type:

1. Provide either extruded aluminum and or formed steel shade pocket, sized to accommodate roller shades, with exposed extruded aluminum closure mount, tile support and removable closure panel to provide access to shades.
 - a. Vent Shade Pocket with a minimum of four 1 inch diameter holes per foot allowing the solar gain to flow above the ceiling line.

B. Fascia for Shade Type:

1. Continuous extruded aluminum.

2. Conceal brackets, shade roller and fabric.
 3. Provide bracket / fascia end caps.
- C. Access Panel:
1. Provide for access to motor and control mechanism.
 2. See Section 08 31 16.
- D. Power Cord:
1. Extend length to connect to power circuit as indicated in the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Single-Source Responsibility
 1. Provide power panels and circuits of sufficient size of accommodate roller shade manufacturer's requirements, as indicated on the mechanical and electrical drawings.
 2. Coordinate with requirements of roller shade installer/dealer, before inaccessible areas are constructed
 3. Roller shade installer/dealer shall run line voltage as dedicated home runs (of sufficient quantity, in sufficient capacity as required) terminating in junction boxes in locations designated by roller shade dealer.
 4. Roller shade installer/dealer shall provide and run line voltage (from terminating points) to the motor controllers, wire roller shade motors to the motor controllers, and provide and run low voltage control wiring from motor controllers to switch/control locations designated by the Architect. Above-ceiling and concealed wiring shall be plenum-rated, or installed in conduit, as required by the electrical code having jurisdiction.
 5. Provide conduit with pull wire in areas, which might not be accessible to roller shade contractor due to building design, equipment location or schedule.
- B. Allow clearances for window operation hardware.
- C. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.
- D. Clean roller shade surfaces after installation, according to manufacturer's written instructions.
- E. Train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.

3.4 CLOSEOUT ACTIVITIES

- A. Refer to Section 01 81 33 - Cyber-Security Requirements for cyber security related closeout requirements.

3.5 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 12 36 63
SOLID SURFACE FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Solid Surface Fabrications, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Applicable standards:
 - 1. International Association of Plumbing and Mechanical Officials (IAPMO)
 - a. IAPMO Z124 Plastic Plumbing Fixtures.
 - 2. ASTM International:
 - 3. National Electrical Manufacturers Association (NEMA).
 - a. NSF International.
 - 1) NSF/ANSI Standard 51 for food zone - all food types.
 - 4. Manufacturer's certification of fabricator and installer.
- B. Installer Qualifications:
 - 1. Successfully installed at least five projects within the past four years, utilizing systems, materials and techniques as specified or required by product manufacturer.
- C. Manufacturer Certification of Fabricator and Installer:
 - 1. Certified by manufacturer.
 - 2. Submit prior to Shop Drawings.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Show location of each item, dimensioned plans and elevations, large scale details, attachment devices and other components.
 - 2. Show full size details, edge details, thermoforming requirements, attachments, etc.
 - 3. Show locations and sizes of furring, blocking, including concealed blocking and reinforcement.
 - 4. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, waste receptacle and other items installed in surface.
 - 5. Indicate dimensions, component sizes, fabrication details, attachment provisions and coordination requirements with adjacent work.
- B. Product Data:
 - 1. Manufacturer's product data sheets, details and installation instructions for Solid Surface Fabrications, components, and accessories.
- C. Samples:
 - 1. For each SSF color selected:
 - a. Minimum standard size sample in specified finish.
 - 2. Sealant colors for selection.
- D. Project Information:

1. Manufacturer's current certification of Fabricator and Installer prior to submittal of Shop Drawings.
- E. Contract Closeout Information:
1. Warranty.
 2. Maintenance data.
 - a. See Section 01 78 23.

1.4 WARRANTY

- A. Manufacturer's ten (10) year warranty including colorfastness and material defects.
1. Warranty shall provide material and labor to repair or replace defective materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Solid Surface Fabrications (SSF):
1. Base:
 - a. Corian by DuPont.
 2. Optional:
 - a. Avonite by Aristech Acrylics LLC.
 - b. Wilsonart Solid Surface.
- B. Sealant:
1. Base:
 - a. Color Rite.
 2. Optional:
 - a. As approved by SSF manufacturer.
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Solid Surface Materials:
1. Cast, non-porous, homogeneous, acrylic polymer composition with additional fire retardant fillers and pigments.
 - a. Prime product may not be coated, laminated or of composite construction.
 2. Defects with depth less than 0.010 inches shall be considered superficial.
 - a. Repair superficial damage by sanding and/or polishing.
 - b. Components with more severe defects shall be rejected.
 3. Physical properties:

Minimum Physical Properties		
Property	Method	Value
Tensile Strength	ASTM D638	5500 psi
Flexural Strength	ASTM D790	10 ksi
Hardness	Rockwell M Scale ASTM D785	Greater than 85
	Barcol Impressor ASTM D2583	55
Thermal Expansion	ASTM D696	1.8 x 10 ⁻⁵ inches/IN/deg F
Gloss (60 –degree Gardner)	IAPMO Z124	Matte = 5; Highly Polished = 75

Light Resistance	NEMA LD 3-2000 Method 3.3	No Effect (Xenon Arc)
Wear and Cleanability	IAPMO Z124	Pass
Stain Resistance	IAPMO Z124	Pass
Fungal Resistance	ASTM G21	Does not support growth
High Temperature Resistance	NEMA LD 3-2000 Method 3.6	No change
Boiling Water Resistance	NEMA LD 3-2000 Method 3.5	No visible change
Ball Impact Resistance; 1/2 pounds Ball	NEMA LD 3-2000 Method 3.5	36 inches drop 1/4 inches sheet
		144 inches drop 1/2 inches sheet
Water Absorption	ASTM D570	0.8% for 1/4 inches sheet
		0.6% for 1/2 inches sheet
Flammability	ASTM E84 and NFPA 255	Class I / Class A
Flame Spread Index		Less than 25
Smoked Developed Index		Less than 450

B. Backing materials (build down):

1. Finished or exposed edges: SSF material.
 - a. Profiles as indicated.
2. Concealed spaces and non-exposed edges:
 - a. Moisture resistant, medium density fiberboard (MDF) panels or moisture resistant plywood.
 - 1) Use at countertops with sinks.
 - 2) No added formaldehyde (NAF).
 - 3) Particleboard is not acceptable.
 - 4) Base Product: Medex by Roseburg.
 - b. Physical Properties, Based on 3/4 inches Thickness, ASTM D1037, Part A:
 - 1) Density: 48 pounds/FT³.
 - 2) Modulus of Rupture: 4,000 psi.
 - 3) Screw Holding: Required to pull 1 inch #10 sheet metal screw:
 - a) Face: 225 pounds.
 - b) Edge: 200 pounds.
 - c. Panel Thickness:
 - 1) As required for application, use a single thickness to achieve build down to cross sectional thickness.
3. Backer Sheets for knee spaces:
 - a. Plastic laminate in coordinating color
 - b. Grade 20 (VGP)
 - c. Apply to bottom side of backing material.
4. Backing materials adhesive:
 - a. Construction grade adhesive recommended by SSF manufacturer for backing materials with VOC content no greater than 70 g/L.

C. Joint Adhesive:

1. Manufacturer's standard one- or two-part adhesive as required for inconspicuous, non-porous joint with VOC content no greater than 80 g/L.

D. Sealant:

1. Mildew resistant silicone sealant in colors matching components.
2. Specifically formulated for applications indicated, including wet areas.
3. Shore A Hardness: 25.

4. Compatible with SSF specified.
 5. Compatible with gypsum wallboard, paint, laminates, and other materials being sealed.
 6. Sealant VOC content shall be no greater than 250g/L.
 7. Colors:
 - a. Colors to match specified SSF colors from no less than 400 standard color choices.
 - b. Number of different colors required for project shall not be limited.
 8. Base Products:
 - a. At solid colored SSF: Color-Sil by Color Rite; 100% silicone.
 - b. Where speckle colored SSF is specified: Poly-Sil by Color Rite; 100% silicone with suspended accent color particles.
 - c. Architect to select final colors and locations during submittals phase.
- E. Conductive Foil Tape:
1. Manufacturer's standard aluminum foil tape, with required thickness, for use with cutouts near heat sources.
- F. Insulating Felt Tape:
1. Manufacturer's standard for use with conductive tape in insulating solid surface material from adjacent heat source.

2.3 SHOP FABRICATION

- A. Shop Assembly
1. Fabricate components to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and manufacturer's instructions.
 2. Form joints between components using color matched Joint Adhesive in an inconspicuous manner.
 - a. Reinforce with 4 inches wide strip of SSF material.
 3. Provide factory cutouts for plumbing fittings and bath accessories as indicated.
 - a. Radius inside corners of cutouts as large as but not less than 1/4 inches.
 - b. Reinforce with SSF corner blocks to avoid stress cracking.
 - c. Sand edges and corners smooth and free of chips or nicks.
 - d. Utilize heat conductive aluminum tape around drop-in stoves and other heat sources to protect SSF from thermal stress.
 4. Rout and finish component edges with clean, sharp returns.
 - a. Rout cutouts, radii, and contours to template.
 - b. Smooth edges.
 - c. Repair or reject defective and inaccurate work.
 5. Fabricate coved splashes where indicated.
 6. Reinforce inside corners, narrow pieces, cantilevered overhangs, and stress points against breakage by laminating an additional thickness of SSF on concealed face.
 7. Laminate additional thicknesses of SSF and tool edge profiles indicated.
 8. Uniformly finish completed pieces according to SSF schedule.

2.4 FABRICATIONS

- A. SSF Countertops:
1. Configurations as indicated on Drawings.
 2. Composite thickness of countertop assemblies: 1-1/4 inches unless otherwise indicated.
 - a. Nominal Thickness of SSF material: Minimum 1/2 inches unless otherwise indicated.
 3. Radius exposed outside corners: Minimum 1-1/2 inches.

4. Join multiple pieces, where required, with Joint Adhesive to create inconspicuous seam.
 5. Backer:
 - a. Configure backing material as required for application:
 - b. Ladder frame at SSF countertops supported by base cabinets:
 - 1) Form ladders from approved backing material ripped into 3- 4 inches wide strips.
 - 2) Locate main runner strips (rails) along front and back edges of countertops.
 - a) Provide clearance for shrinkage and normal expansion and contraction.
 - 3) Space front-to-back supports (stiles) to align with line where base cabinet units adjoin. Locate stiles over other wall brackets and supports.
 - 4) Where base cabinets and supports exceed in 24 inches width: Include additional intermediate stiles so that maximum spacing does not exceed 24 inches.
 - 5) Provide additional intermediate stiles at seams in SSF countertop material.
 - 6) Join the stiles to rails using screwed or glued wooden biscuit seams, serrated dowels, or rabbeted seams.
 - 7) Overhangs: Configure backer material per SSF manufacturer's guidelines according to distance overhang projects past its support.
 - c. Countertops which span between supports 30 inches and wider:
 - 1) Fabricate backer from solid backing material (not stile and rail construction).
 - 2) Extend one piece, solid backer material, across entire span. Extend load bearing edges not less than 4 inches over edge of supporting cabinets (or similar support).
 - d. Portions of Countertops schedule to support countertop equipment:
 - 1) Provide full backing for the entire countertop cross section for the full width of the equipment.
 - 2) Extend 4 inches (min) beyond equipment width and as required for mounting.
 6. Backsplashes and Sidesplashes:
 - a. Provide where indicated.
 - b. Thickness: Minimum 1/2 inches (unless otherwise indicated).
 - c. Height: As indicated.
 - d. Fabricate from same material and color as top.
 - e. Backsplash Style: Integrally coved.
 - f. Sidesplash Style: Applied.
 7. Front overhang of Tops: 1-1/2 inches, unless otherwise indicated.
 8. Edge Treatments: As indicated on the drawings.
 9. Polish exposed faces.
 10. SSF color / finish: As listed in Interior Finish Legend.
- B. Integral SSF Sinks:
1. Material: Cast, homogenous material composed of polyester and acrylic resins, fire retardant filler materials, and coloring agents.
 2. Shapes complying with IAPMO Z124 standards for plastic sinks and lavatories.
 3. Mounting: Seamed under mount.
 4. Mounting hardware: Manufacturer's standard bowl clips, panel inserts and fasteners for attachment of undermount sinks/lavatories.
 5. Provide bowl size and depth as indicated on IC-series elevations.
 6. Base Product: Model # 810.
 7. Color: Cameo White.
- C. Sinks specified elsewhere:
1. Porcelain, enameled steel and/or stainless steel bowls: Specified in Section 22 42 00.

D. Faucets and Trim: Specified in Section 22 42 00.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with fabricator present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. Verify measurements, dimensions and drawing details before proceeding.
 - 2. Coordinate location of furring, nailers, blocking, grounds, and similar supports for attached work.
 - 3. Examine conditions under which work is to be installed.
 - 4. Correct unsatisfactory conditions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. General:
 - 1. Install components plumb, level, and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.
 - 2. Provide product in the largest pieces available.
 - 3. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.
 - a. Exposed joints/seams will not be allowed.
 - 4. Reinforce field joints with SSF strips extending a minimum of 1 to 2 inches on either side of the seam with the strip being the same thickness as the top.
 - 5. Cut and finish component edges with clean, sharp returns.
 - 6. Rout radii and contours to template.
 - 7. Anchor securely to base cabinets or other supports.
 - 8. Align adjacent countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop.
 - 9. Carefully dress joints smooth, remove surface scratches and clean entire surface.
 - 10. Install countertops with no more than 1/8 inches sag, bow, or other variation from a straight line.
 - 11. Units with sinks or lavatories shall withstand an applied vertical load of not less than 250 pounds on front edge of countertop.
- B. Countertops:
 - 1. Install plumb, level, true and straight.
 - a. Shim as necessary using concealed shims.
 - 2. Adhere tops to base cabinets with clear silicone sealant at 10 to 12 inches apart.
 - 3. Attach top securely to base unit or support brackets in accordance with manufacturer's instructions.
 - a. Supply additional wood supports, spaced no more than 18 inches apart or as otherwise required for adequate strength.
 - 4. Attach top securely to base unit or support brackets in accordance with manufacturer's instructions.
 - a. Ensure full contact with support brackets and backing for entire support length with mechanical fastening into backing material.
 - b. Provide fasteners of appropriate length. Do not allow screws to penetrate into SSF material.

- c. Supply additional supports or solid backing as required for adequate strength.
- 5. Where tops are abutted by walls at both ends:
 - a. Include 1/8 inches expansion gaps at both ends for every of 10 feet countertop.
 - b. Seal gaps with elastomeric sealant.
- C. Backsplashes and Sidesplashes:
 - 1. Integrally Coved Splashes:
 - a. Join coved items to countertops using color matched Joint Adhesive.
 - b. Adhere to walls and other substrates with clear silicone sealant.
 - c. Seal to walls and adjacent cabinets with color matched, elastomeric sealant.
 - 2. Applied Splashes:
 - a. Join adhered items to substrate using color matched, elastomeric sealant.
 - b. Adhere to walls and other substrates with clear silicone sealant.
 - c. Seal to walls and adjacent cabinets with color matched, elastomeric sealant.
- D. Integral SSF Sinks:
 - 1. Install SSF sink or lavatory bowls in locations shown on the drawings.
 - 2. Secure bowls to tops using Joint Adhesive and mounting hardware to maintain warranty.
 - 3. Drain connections: Specified in Section 22 42 00.
- E. Sinks:
 - 1. Install sinks per Section 22 42 00.
 - 2. Seal to Countertop with elastomeric sealant and mounting hardware provided.
 - 3. Drain and overflow connections: Specified in Section 22 42 00.
- F. Faucets and Trim:
 - 1. Install faucets and trim per Section 22 42 00.
 - 2. Plumbing connections: Specified in Section 22 42 00.
 - 3. Seal to Countertop with elastomeric sealant.

3.3 CLEANING AND PROTECTION

- A. Keep components clean during installation.
- B. Protect finished surfaces from damage.
- C. Remove adhesives, sealants, and other stains.
- D. Replace damaged work which cannot be repaired.

END OF SECTION

SECTION 12 36 65
ENGINEERED QUARTZ FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Engineered Quartz Fabrications, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Fabricator/Installer Qualifications:
 - 1. Firm that employs skilled workers who custom fabricate products similar to those required for this project and whose products have a record of successful in-service performance.
- B. Source Limitations:
 - 1. Obtain materials and products from single source.
- C. Reference Standards:
 - 1. IAPMO Z124 Plastic Plumbing Fixtures.
 - 2. ASTM International (ASTM):
 - 3. NSF/ANSI standards:
 - a. NSF/ANSI Standard 51 for food zone - all food types.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Location of each item, dimensioned plans and elevations, component sizes, fabrication details, large-scale details, attachment devices, attachment provisions and coordination requirements with adjacent work.
 - 2. Show locations and sizes of furring, blocking, including concealed blocking and reinforcement.
 - 3. Indicate locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, waste receptacle and other items installed in surface.
- B. Product Data:
 - 1. Manufacturer's product data sheets and details for Engineered Quartz Fabrications, components and accessories.
- C. Samples:
 - 1. For each EQF color selected:
 - a. Standard size sample in specified finish.
 - b. Indicate full range of color and pattern variation.
 - 2. Sealant colors for selection.
 - 3. Approved samples will be retained as a standard for work.
- D. Contract Closeout Information:
 - 1. Maintenance data.
 - a. See Section 01 78 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Engineered Quartz Fabrications (EQF):

1. Base:
 - a. Cambria
2. Optional:
 - a. DuPont
 - b. Formica
 - c. Wilsonart
 - d. Daltile

B. Sealant:

1. Base:
 - a. Same as EQF manufacturer
2. Optional:
 - a. See Section 07 92 16.

C. Other manufacturers desiring approval comply with section 01 61 00.

2.2 MATERIAL: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Engineered Quartz Fabrications (EQF):

1. Homogeneous, uncoated, engineered stone matrix.
 - a. Composition: 93% quartz and 7% resin binders and pigments.
 - b. Free of fissures and cracks, and impervious to water, moisture, or bacteria.
2. Base Product: Cambria engineered quartz
3. Physical properties:

Minimum Physical Properties		
Property	Method	Value
Freeze-Thaw Cycling	ASTM C1026	Unaffected
Point Impact	IAPMO Z124	Pass
Abrasion Resistance	ASTM C501	Less than 250
Density	--	150 pcf
Water Absorption	ASTM C373	0.12%
Flammability	ASTM E84 and NFPA-255	Class I / Class A
Flame Spread Index		0 to 25
Smoked Developed Index		Less than 250

B. Joint Adhesive:

1. Manufacturer's standard silicone or epoxy adhesive for inconspicuous, non-porous joints.

C. Sealant:

1. Silicone sealant in colors matching components.
2. Specifically formulated for applications indicated, including wet areas.
3. Sealant VOC shall be no greater than 250 g/L.
4. Colors:
 - a. Colors to match various EQF colors specified.

- b. Architect to select from unlimited palette.
 - c. Solid Colors: Color-Sil by Color Rite; 100% silicone, no suspended partials.
 - d. Speckled Colors: Poly-Sil by Color Rite; includes polymers suspended in 100% silicone.
 - e. Architect to select final colors and locations during submittals phase.
- D. Shop Assembly
 - 1. Fabricate components to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and manufacturer's instructions.
 - 2. Fabricated per manufacturer's instructions, the Dimension Stone Manual (by MIA) and using techniques consistent with fabrication of natural stone.
 - 3. Fabricate with water-cooled tools with hardened tips.
 - 4. Form joints between components using color-matched Joint Adhesive in an inconspicuous manner.
 - a. Reinforce joint as recommended by manufacturer.
 - b. Locate seams directly over supports; do not locate seams in the midspan region.
 - 5. Provide factory cutouts for plumbing fittings and bath accessories as indicated.
 - a. Radius inside corners of cutouts as large as but not less than 3/8 inches.
 - b. Reinforce to prevent stress cracking.
 - c. Tool edges and corners smooth and free of chips or nicks.
 - 6. Rout and finish component edges with clean, sharp returns.
 - a. Rout cutouts, radii and contours to template.
 - b. Smooth edges.
 - c. Repair or reject defective and inaccurate work.
 - 7. Fabricate coved splashes where indicated.
 - 8. Reinforce inside corners, narrow pieces, cantilevered overhangs, and stress points against breakage by laminating an additional thickness of EQF on concealed face.
 - 9. Laminate additional thicknesses of EQF and tool edge profiles indicated.
 - 10. Finishing: Ensure that completed pieces are uniformly finished according to EQF schedule.

2.3 FABRICATIONS

- A. EQF Countertops:
 - 1. Configurations as indicated on Drawings.
 - 2. Thickness: Minimum 3/4 inches unless otherwise indicated.
 - 3. Provide plywood backing material according to manufacturer's installation instructions.
 - 4. Backsplashes and Sidesplashes:
 - a. Provide where indicated.
 - b. Thickness: Minimum 3/4 inches (unless otherwise indicated).
 - c. Height: As indicated.
 - d. Fabricate from same material and color as top.
 - e. Seal to Countertops with color-matched elastomeric sealant.
 - 5. Front overhang of Tops: 1-1/2 inches.
 - 6. Edge Treatments: As indicated on the drawings.
 - 7. Finish exposed faces.
- B. Sinks (specified elsewhere):
 - 1. Porcelain, enameled steel and/or stainless steel bowls: Specified in Section 22 42 00.
- C. Faucets and Trim: Specified in Section 22 42 00.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with fabricator present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. Verify measurements, dimensions and drawing details before proceeding.
 - 2. Coordinate location of furring, nailers, blocking, grounds and similar supports for attached work.
 - 3. Examine conditions under which work is to be installed.
 - 4. Correct unsatisfactory conditions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. General:
 - 1. Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.
 - 2. Provide product in the largest pieces available.
 - 3. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.
 - a. Exposed joints/seams will not be allowed.
 - 4. Reinforce field joints with EQF strips extending a minimum of 1 to 2 inches on either side of the seam with the strip being the same thickness as the top.
 - 5. Cut and finish component edges with clean, sharp returns.
 - 6. Rout radii and contours to template.
 - 7. Anchor securely to base cabinets or other supports.
 - 8. Align adjacent countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop.
 - 9. Carefully dress joints smooth, remove surface scratches and clean entire surface.
 - 10. Install countertops with no more than 1/8 inches sag, bow or other variation from a straight line.
- B. Countertops:
 - 1. Install plumb, level, true and straight.
 - a. Shim as necessary using concealed shims.
 - 2. Adhere tops to base cabinets with dabs of a clear silicone sealant at 10 to 12 inches apart.
 - 3. Attach top securely to base unit or support brackets in accordance with manufacturer's instructions.
 - a. Supply additional wood supports, spaced no more than 12 inches apart or as otherwise required by installation instructions.
 - b. Restrict unsupported overhangs to 12 inches.
 - 4. Install 1/8 inches expansion gaps at both ends where tops are abutted by walls at both ends.
 - a. Increase to 1/4 inches for countertops over 10 feet long.
 - b. Seal gaps with elastomeric sealant.
 - 5. Units with sinks or lavatories shall withstand an applied vertical load of not less than 250 pounds on front edge of countertop.
- C. Backsplashes and Sidesplashes:
 - 1. Applied Splashes:

- a. Join adhered items to substrate using color-matched, elastomeric sealant.
 - b. Adhere to walls and other substrates with clear silicone sealant.
 - c. Seal to walls and adjacent cabinets with color-matched, elastomeric sealant.
- D. Sinks, specified elsewhere:
 - 1. Install sinks per Section 22 42 00.
 - 2. Seal to Countertop with elastomeric sealant and mounting hardware provided.
 - 3. Drain and overflow connections: Specified in Section 22 42 00.
- E. Faucets and Trim:
 - 1. Install faucets and trim per Section 22 42 00.
 - 2. Plumbing connections: Specified in Section 22 42 00.
 - 3. Seal to Countertop with elastomeric sealant.

3.3 CLEANING AND PROTECTION

- A. Keep components clean during installation.
- B. Protect finished surfaces from damage.
- C. Remove adhesives, sealants and other stains.

END OF SECTION



DIVISION 13

SPECIAL CONSTRUCTION



SECTION 13 45 13
BULLET RESISTIVE MATERIALS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Bullet Resistive Materials as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Manufacturer of bullet resistant products for a minimum of 5 years, including a minimum of 5 similar sized projects.
- B. Installer Qualifications:
 - 1. Installer of bullet resistant assemblies for a minimum of 5 years and shall be approved in writing by the manufacturer for this installation.
- C. Ballistic Standard:
 - 1. UL listed products complying with UL-752, ballistic level 3.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Show locations and extent of bullet resistive materials, installation details and relationships to adjoining work.
- B. Product Data:
 - 1. Bullet resistant product literature, including catalog cuts and manufacturer's specifications.
- C. Samples:
 - 1. 3 x 5 inches samples of Bullet-resistive materials.
- D. Project Information:
 - 1. Certification that products specified to be UL listed are approved for ballistic resistance level indicated.
- E. Contract Closeout Information:
 - 1. Maintenance data.
 - a. See Section 01 78 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Bullet Resistive Materials:
 - 1. Base:
 - a. Armortex.
 - 2. Optional:
 - a. Protective Structures.
 - b. Chicago Bullet Proof Systems.
 - c. Insulgard Security Products.
 - d. National Bullet Proof.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Bullet Resistive Fiberglass:

1. Non-ricochet type.
2. Multiple layers of starch-oil woven roving ballistic grade fiberglass cloth impregnated with thermoset polyester resin and compressed into flat rigid sheets.
3. Providing controlled internal delamination to permit capture of a penetrating projectile.
4. Maximum weight: 4.0 pounds/SF.
5. UL-752 protection levels:
 - a. Walls, where indicated on Floor Plans: UL Level 3.
 - b. Extend ballistic protection to 96 IN AFF.
6. Armortex O.F. 300 by Armortex
7. Maximum thickness: 1/2 inches.

B. Bullet Resistive Hollow Metal Door Package:

1. Hollow metal door and frame
 - a. Factory primed.
 - b. Field painted.
2. Fire rating: As indicated on Door Schedule
3. Protection level: UL Level 3
 - a. Non-ricochet type
4. Pre-hang door with heavy duty continuous geared hinge
 - a. Prep door/frame for hardware
 - b. Balance of hardware specified in Section 08 71 00 and Door Schedule.
5. Hollow metal frame:
 - a. 16 GA; Fully welded.
 - b. Lining: Armortex Bullet Resistive Fiberglass; foamed-in-place with urethane.
6. Hollow metal door:
 - a. Face plates and stile channels: 16 GA minimum.
 - b. Fully welded.
 - c. Core: Armortex Bullet Resistive Fiberglass; foamed-in-place with urethane.

C. Bullet Resistive Wood Door Package:

1. Wood door and hollow metal frame
2. Fire rating: As indicated on Door Schedule.
3. Protection level: UL 3.
 - a. Non-ricochet type.
4. Pre-hang door with heavy duty continuous geared hinge
 - a. Prep door/frame for hardware.
 - b. Balance of hardware specified in Section 08 71 00 and Door Schedule.
5. Hollow Metal Frame:
 - a. 16 GA; Fully welded.
 - b. Liner: Armortex Bullet Resistive Fiberglass; foamed-in-place with urethane.
 - c. Factory primed.
 - d. Field painted.

6. Wood door:
 - a. Core: Armortex Bullet Resistive Fiberglass; foamed-in-place with urethane.
 - b. 1-3/4 inches thick overall.
 - c. Particleboard laminations to achieve final thickness.
 - d. Door veneer:
 - 1) Plain sliced red oak.
 - 2) Matching hardwood edges.
 - 3) Deliver to site unfinished for staining in field to match other wood doors on project.
- D. Bullet Resistive Window:
 1. Non-ricochet.
 2. Armortex model: FW-HM-RS
 3. Protection level: UL 3
 4. Sizes as indicated.
 5. Lining:
 - a. Armortex Bullet Resistive Fiberglass; foamed-in-place with rigid urethane.
 - b. Same protection level as indicated for adjacent walls.
 6. Steel Frame:
 - a. 16 GA; fully welded steel frames
 - b. Factory primed.
 - c. Field painted.
 7. Glazing:
 - a. Include with frame as one unit.
 - b. Protection level: UL Level 3.
 - c. Armortex SP 1.25 Acrylic
 - 1) Cast acrylic.
 - 2) Abrasion resistance coated.
 - 3) Total Thickness: 1-1/2 inches.
 - d. Locate glazing stop on safe side.
- E. Bullet Resistant Transaction Window:
 1. Non-ricochet.
 2. Armortex Model: WI-TW-HM-RS
 3. Protection level: UL 3.
 4. Sizes as indicated.
 5. Lining:
 - a. Armortex Bullet Resistive Fiberglass; foamed-in-place with rigid urethane.
 - b. Same protection level as indicated for adjacent walls.
 6. Steel Frame:
 - a. Factory primed.
 - b. Jamb frames: Minimum 12 GA.
 - 1) Drilled in at least 4 points on each side for anchoring, with hole placement prohibiting removal of anchors or attachment of devices from opposite side of glazing.
 - c. Head and sill frames: Minimum 20 GA.
 7. Shelf:
 - a. High pressure laminated black plastic finish,
 - b. Thickness: 2 inches, minimum.

- c. Width: 12 inches.
 - d. Length: As indicated, with centered recessed dip tray.
- 8. Dip tray:
 - a. Armortex model: 1016 RMDT
 - b. 16 GA stainless steel, No.3 finish.
 - c. Width: 10 inches.
 - d. Length at top: 16 inches, minimum.
 - e. Depth at center under glazing: 1-5/8 inches.
- 9. Glazing:
 - a. Include with frame as one unit.
 - b. Protection level: UL Level 3.
 - c. Armortex SP 1.25 Acrylic
 - 1) Cast acrylic.
 - 2) Abrasion resistance coated.
 - 3) Total Thickness: 1-1/2 inches.
 - d. Locate glazing stop on safe side.
 - e. Glazing stop shall be located on safe side.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Examine substrates, areas, and conditions for compliance with requirements, including installation tolerances and effects on performance of systems.
- B. Correct unsatisfactory conditions before proceeding with installation.

3.2 INSTALLATION OF FIBERGLASS PANELS

- A. Install Bullet Resistive Fiberglass panels directly to metal studs, prior to installation of gypsum wall board.
 - 1. Utilize mastic and/or mechanical attachment as recommended by manufacturer.
 - 2. Where panels butt together, install a 4 inches wide batten at each horizontal and vertical seam.
 - a. Minimum of 2 inches overlap on each side.
 - b. Use same material as specified for walls.
 - c. Install behind butt joints on stud side of panels, not on side to be finished with gypsum wallboard.
 - 3. Extend panels to no less than 6 inches above the ceiling line.
 - 4. Coordinate with other trades for required openings.

END OF SECTION



DIVISION 14

CONVEYING EQUIPMENT



SECTION 14 24 24
HYDRAULIC ELEVATORS - MACHINE-ROOM-LESS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Hydraulic Elevators – Passenger, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. Hoistway Plans and Machine Room Plans and Sections clearly showing the following:
 - a. Structural Loads imposed on building superstructure.
 - b. Clearances and travel of car.
 - c. Hoistway and pit dimensions.
 - d. Location and sizes of access doors, hoistway entrances and frames.
 - e. Car, guide rails, buffers, and other components in hoistway.
 - f. Signal and operating fixtures, operating panels, and indicators.
 - g. Cab design, dimensions, and layout.
 - h. Hoistway-door and frame details.
 - i. Electrical characteristics and connection requirements.
 - j. Heat dissipation (BTU) of elevator equipment.
- B. Product Data:
 - 1. Include capacities, sizes, performances, operations, safety features, finishes, and similar information.
 - a. Car enclosures and hoistway entrances.
 - b. Operation, control, and signal systems.
 - c. Maximum noise rating for elevator, measured in-cab and in-shaft.
 - 2. Bio-based hydraulic fluid.
- C. Samples:
 - 1. Cab and entrance finishes.
- D. Refer to Section 01 81 33 - Cyber Security Requirements for required cyber security related submittals.
- E. Contract Closeout Information:
 - 1. Inspection and Acceptance Certificates and Operating Permits.
 - 2. Operation and Maintenance Data.
 - 3. Owner instruction report.
 - 4. Warranty.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Provide elevators manufactured by a firm with a minimum of 10 years of experience in fabrication of elevators equivalent to those specified.
- B. Optional manufacturers are responsible for, at no additional cost to Owner:

1. Costs for dimensional adjustments to fit their elevators to openings.
 - a. Hoistway inside dimensions or floor to floor heights shall not be changed.
 2. Provide or arrange for additional electrical wiring, energy, panels, transformers etc., required to accommodate their elevators.
- C. Installer Qualifications:
1. Installed by the manufacturer.
 2. Provide licenses and permits and perform required inspections and tests.
- D. Design elevator system maintainable by manufacturer approved, licensed elevator maintenance company:
1. Manufacturer provided or approved diagnostic devices, special tools, or instructions.
 2. Provide onsite capability to diagnose faults to circuit boards and components for the elevator controller.
 3. Provide detachable device for fault diagnosis.
 - a. Device and software shall remain property of manufacturer.
 4. Provide upgrades and/or revisions of software:
 - a. During the progress of the work.
 - b. Warranty period.
 - c. Term of the ongoing maintenance agreement between the Owner and original provider.
 5. Diagnostic equipment including:
 - a. Access codes.
 - b. Adjusters and set-up manuals including:
 - 1) Adjustment.
 - 2) Diagnosis.
 - 3) Troubleshooting of elevator system.
 - 4) Performance of routine safety tests.
- E. Reference Standards:
1. ASME A17.1 / CSA B44 - Safety Code for Elevators and Escalators.
 2. ANSI A117.1 Accessible and Usable Buildings and Facilities.
 3. ADA Standards for Accessible Design.
 4. ANSI/NFPA 70, National Electrical Code.
 5. ANSI/NFPA 80, Fire Doors and Windows.
 6. ANSI/UL 10B, Fire Tests of Door Assemblies.

1.4 WARRANTY

- A. Service Contract: 1-year Service Contract.
1. Service frequency: Monthly.
 2. Include examination, oiling, greasing, adjustment, and repairs as required.
 3. Normal work hour service.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Hydraulic Elevators - Passenger:
1. Base:
 - a. ThyssenKrupp Elevator.
 2. Optional:

- a. Otis Elevator
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 ELEVATORS - GENERAL PARAMETERS

- A. Quantity of Elevators in this Group: 1.
- B. Elevator Names / Mark Numbers: 1.
- C. Elevator Operating Equipment:
 - 1. Oil Hydraulic power unit and cylinder.
 - 2. Machine Room less
 - 3. Cylinder Configuration:
 - a. Twin, direct-acting cylinders without well hole.
- D. Cab Dimensions, Inside Clear, and Capacity Rating:
 - 1. 5 feet-5 inches Wide x 7 feet-10 inches Deep, 4,500 pounds.
- E. Cab Height:
 - 1. Standard height: 95 inches nominal.
 - a. Inside clear:
 - 1) 88 inches nominal.
- F. Speed:
 - 1. 125 fpm.
- G. Travel: 15 feet 0 inches.
- H. Number of Stops: 1.
- I. Hoistway Entrances:
 - 1. Quantity, per elevator:
 - a. Front: 2.
 - b. Rear: 0.
 - 2. Door Type:
 - a. Side opening.
 - 3. Door Opening Width (clear):
 - a. 48 inches.
 - 4. Door Height (clear):
 - a. 84 inches at standard height Cars.
 - 5. Model: Otis Hydrofit 4512

2.3 ELEVATOR MACHINE EQUIPMENT

- A. General:
 - 1. Hydraulic system: Compact design suitable for operation under the required pressure.
 - 2. Locate hydraulic tank and controller in hoistway.
 - 3. Main Power Supply: 480 VAC, 3 Phase, with a separate equipment grounding conductor.
 - 4. Secondary Power: 110 VAC, 1 Phase hydraulic power source to reposition elevator in the event of a system component failure.
 - 5. Car Lighting Power Supply: 120 VAC, 1 Phase, 15 Amp, 60 Hz.
 - 6. Speed: + 2 percent of specified speed under any loading condition or direction of travel.
 - 7. Stopping Accuracy: 1/4 inches under any loading condition or direction of travel.
 - 8. Electrical work: Provide necessary wiring to connect parts of equipment.

B. Power Unit:

1. Mount in the elevator pit.
2. Control valve shall include an integral check valve.
3. Control section shall direct the main valve and control up and down starting, acceleration, transition from full speed to leveling speed, up and down stops, pressure relief and manual lowering.
4. Include: Muffler, low-pressure switch, and a shut-off valve.
5. Mount motor and pump assembly on rubber isolated base.
6. Control valve assembly designed to reduce transmission of vibrations and noise to elevator car.
7. Metered bypass, check, relief, and manual lowering valves, and metered lowering and leveling devices.
8. Manual valve for lowering of car when power fails.

C. Controller:

1. Microprocessor-based control system to perform functions of safe elevator operation.
2. The system shall also perform car and group operational control.
3. Include necessary starting switches, relays, switches, solid-state components, and hardware required for car and door operation.
4. Provide 3-phase overload device to protect the motor against overloading.

D. Miscellaneous options required:

1. Low-oil control.
2. Pressure Switch.

E. Hydraulic fluid:

1. Non-toxic, biodegradable, fire-resistant fluid made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives and approved by elevator manufacturer for use with elevator equipment.

2.4 HOISTWAY EQUIPMENT

A. Hoistway Operating Devices:

1. Emergency stop switch in the pit.
2. Terminal stopping switches.

B. Cylinder:

1. Made of steel pipe of sufficient thickness and suitable for the operating pressure.
2. High pressure seal as well as an internal guide ring and self-adjusting packing.

C. Plunger:

1. Constructed of select steel tubing or pipe of proper diameter machined true and smooth with a fine polished finish.
2. Stop ring: Welded to plunger to prevent over extension.

D. Guide Rails:

1. Tee or Omega section steel rails with brackets and fasteners.
2. Use heavy-weight rail sections as required to span between structural supports indicated or include supplemental steel bracing/sub-frame as required.

E. Buffer:

1. Polyurethane or helical coil spring.

F. Wiring:

1. Wiring for hoistway electrical devices, hall panels, pit emergency stop switch, and traveling cable for elevator car.

G. Pit Ladders:

1. Coordinate pit ladders per ANSI/ASME-A17.1.
2. Ladders are specified in Section 05 50 00.

2.5 HOISTWAY ENTRANCES

A. General:

1. Fire Label: 1-1/2 hour UL B label.

B. Frames:

1. Bolted construction for complete one-piece unit assembly.
2. Securely fastened to fixing angles mounted in the hoistway and shall be of 14 GA sheet steel.
3. Material:
 - a. Type 301 or 304 Stainless Steel (non-magnetic).
 - 1) Finish:
 - a) #4, Brushed Satin.

C. Doors:

1. Flush, 16 GA hollow metal construction with vertical internal channel reinforcements and sound deadening material.
2. Material:
 - a. Type 301 or 304 Stainless Steel.
 - 1) Finish:
 - a) #4 Brushed Satin.

D. Sills:

1. Extruded aluminum with slip resistant wearing surface.
2. Supported on steel anchors secured to floor construction.
3. Elevator contractor to provide sill angles as required.

E. Entrance Markings:

1. Entrance jambs shall be marked with 4 x 4 inches plates having raised floor markings with Braille adjacent.
 - a. Markings shall be provided on both sides of the entrance.

F. Sight Guards: Finish compatible or matching door frames.

G. Fascia:

1. Galvanized sheet steel shall be provided at the front of the hoistway.
 - a. Include similarly at rear of hoistway where rear openings are indicated.
2. Include necessary supports, connections, and filler pieces.

2.6 CAR - GENERAL

A. Car frame:

1. Fabricated from formed or structural steel members and adequately braced to support the platform and car enclosures.
2. Slide guides.
3. Buffer striking plate on the underside of the car-frame platform must fully compress the spring buffer before the plunger reaches its lower limit of travel.

- B. Elevator Car Platform:
 - 1. All-steel construction with welded steel frame reinforced, as necessary.
 - 2. Floor: Minimum 12 GA sheet steel or 3/4 inches plywood with fireproofing on the underside.
 - 3. Fasten floor securely to frame and reinforcing members.
 - 4. Threshold Material: Extruded Aluminum.
- C. Load Weighing Device:
 - 1. Mounted under the platform.
 - 2. Platform load weighing device set to a predetermined maximum load in car.
 - 3. Car bypasses hall calls when device is actuated.
- D. Exhaust Fan:
 - 1. Mounted on car top.
- E. Emergency Car Lighting:
 - 1. Emergency power unit employing a 6 volt, sealed rechargeable battery.
 - 2. Purpose: To supply illumination of elevator car and alarm bell in the event of building power failure.
- F. Emergency Pulsating Siren:
 - 1. Mounted on top of the car and activated by Alarm button in the car operating panel.
 - 2. Rated sound pressure level: 80 dba @ 3 M.
- G. Provide 125 VAC, 20A, duplex receptacle with ground-fault interrupter protection connected to same circuit as car lights and fan.
- H. Provide accessibility code items.
- I. Exit Panel:
 - 1. Standard hinged type with lock.
 - 2. Coordinate location with ceiling and lighting.
- J. Two-way video and Telephone:
 - 1. Hands-free design complying with ADAAG requirements.
 - 2. Include wiring connected to the car traveling cable.
 - 3. Wire to PBX or Lobby Panel (as directed).
 - 4. Two-way digital emergency communication services, providing two-way voice, video and text messaging between passengers and emergency personnel. Compliant with IBC 3001.2 and ASME 17.1 (2019.)

2.7 CAB TYPE

- A. Panel Cab:
 - 1. Cab Frame:
 - a. 16 GA stainless steel, powder coated, pre-perforated for hardware to mount removable panels.
 - b. Finish:
 - 1) #4 brushed satin.
 - 2. Panel Type:
 - a. Vertical Panels.
 - b. Finish:
 - 1) #4 Satin Brushed stainless steel
 - 3. Car Top: Cold rolled steel with hinged exit.

2.8 CAR - FINISHES

- A. Car Front:
 - 1. 14 GA stainless steel:
 - a. Finish: #4 Satin Brushed.
- B. Car Doors:
 - 1. Match materials and finished indicated for Hoistway Doors (above).
- C. Floor covering:
 - 1. As noted in Interior Finish Floor Plan.
- D. Dropped Ceiling:
 - 1. Downlighting:
 - a. Metal panels with factory installed LED downlights.
 - b. Panel Finish:
 - 1) Stainless Steel, #4 Satin brushed.
- E. Metal Handrails:
 - 1. Locations: 3 walls, (Exception: Omit from rear wall where cars are rear-opening type).
 - 2. Mounting Height: 32 inches above cab floor.
 - 3. Material and finish:
 - a. Stainless Steel, #4 Satin brushed.
 - 4. Profile:
 - a. Flat Solid Metal:
 - 1) Size: 1/4 inches x 2 inches.
 - b. Curved end returns.
- F. Protective Pads:
 - 1. Quilted fire retardant protective pads.
 - 2. Include hooks/buttons.

2.9 FIXTURES AND DEVICES - GENERAL

- A. Car and Hall Fixtures – Design and Style:
 - 1. Traditional Fixtures:
 - a. Faceplates: Flush-mounted, with square corners.
 - 1) Material and Finish:
 - a) #4 Satin Stainless Steel.
 - b. Indicators: Red LED matrix for floor positions; lanterns for directional indication.
 - c. Raised and Braille markings.
 - d. White LED illuminated buttons with black halo.

2.10 FIXTURES AND DEVICES - HALLS

- A. Hall Call Stations:
 - 1. Located adjacent to hoistway entrance, combining landing buttons and key switches required for elevator operation.
 - 2. Raised markings shall be provided for each push-button.
 - 3. Quantity per landing: 1 centrally located fixture.
 - 4. Configurations:
 - a. Terminal Landings: Provide single button.
 - b. Intermediate Landing: UP and DOWN button.

5. At main lobby, include a keyswitch for Car to Lobby, integrated into Hall Call fixture.
- B. Hall Lantern and Chime:
 1. Locate directional lantern, visible from the corridor, in the hall entrance.
 2. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel, and a chime will sound.
- C. Hall Position Indicator:
 1. Display the car's current floor position.
 2. Integrate the features of Hall Position Indicator and Hall Lantern into one fixture.
 3. Provide at first floor lobby.
- D. Provision for Card Reader at Halls:
 1. Card Reader provided by Owner's Security Consultant.
 2. Location: As Shown on Drawings.
 3. Intended Purpose: Control of Elevator during non-business hours.

2.11 FIXTURES AND DEVICES - CAR OPERATING PANEL

- A. Fully integrated unit containing phone, push buttons, key switches, and message indicators for elevator operation including:
- B. Buttons:
 1. Individually mark with landings served, Emergency Call, Door Open, Door Close, and other accessories indicated or required.
 2. Emergency Stop Button.
- C. Switches:
 1. Lights, Inspection, Fan, Independent Service, and other accessories indicated.
- D. Car Position Indicator:
 1. Digital readout, displaying the current position of the car.
- E. Landing Passing Signal:
 1. Chime which sounds in the car to notify passenger that the car is either stopping at or passing a floor served by the elevator.
- F. Independent Service:
 1. When switch in car is actuated, car operates independently from car buttons only and hall calls are ignored.
- G. Telephone:
 1. Hands-free design complying with ADAAG requirements.
 2. Include wiring connected to the car traveling cable.
 3. Wire to PBX or Lobby Panel (as directed).
- H. Provision for Card Reader at Car Operating Panel:
 1. Card Reader provided by Owner's Security Consultant.
 2. Location: As Shown on Drawings.
 3. Intended Purpose: Control of Elevator during non-business hours.

2.12 DOOR OPERATION

- A. Door Control Features:
 1. Electrically operated, quietly and smoothly operate car and hoistway doors.
 - a. Doors manually operable in emergency.

2. Door control opens doors automatically when car arrives at landings in response to a normal hall or car call.
3. Re-opening Device/Safety:
 - a. Purpose:
 - 1) To stop and reopen the car and hoistway doors automatically if the doorway becomes obstructed by an object or person.
 - b. Primary Device:
 - 1) 2-dimensional, multi-beam array projecting across the car door opening.
 - 2) Normal Operation:
 - a) Detect object, 1-1/3 inches diameter or larger, between the car doors in the following detection zone; within 1 inch to 71 inches above the sill.
 - 3) Degraded Conditions (one or more blocked or failed beams):
 - a) Detect object, 4 inches diameter or larger, in the same detection zone.
 - 4) If the system performance is degraded to the point that the 4 inches object cannot be detected; maintain the doors in open position or permit closing only by nudging force conditions.
 - c. Secondary device:
 - 1) 3-dimensional, triangular infrared multi-beam array projecting across the door opening and extending into the hoistway door zone.
 - 2) Operation: Cause the doors to reopen when it detects a person or object in the area between the hoistway doors or the entryway area adjacent to the hoistway doors.
 - 3) Secondary protection zone: Size varies with door positions.
4. Door nudging operation to occur if doors are prevented from closing for an adjustable period of time.

2.13 OPERATION AND LOGIC

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
- B. General Operating Features:
 1. Independent Service: When switch in car is actuated, car operates independently from car buttons only and hall calls are ignored.
 2. Firefighters' Service Phase I and Phase II: Returns cars to designated floor by means of key operated switch located at a lobby designated by Fire Marshal.
 3. Top of Car Inspection: Disable car when inspection switch is activated.
- C. Simplex Collective Operation (1 car):
 1. General Description:
 - a. Microprocessor based controller.
 - b. Operation: Automatic by means of the car and hall buttons.
 - c. If calls in the system have been answered, the car shall park at the last landing served.
 2. Operating Logic:
 - a. Momentary pressing of car or hall call buttons automatically starts car (assuming hoistway doors are shut).
 - b. Car stops automatically at first stop for which car or corridor button has been pressed, corresponding to direction in which car is traveling.
 - c. Car stops automatically, in order, at stops for which such stops have been registered.
 - d. Car, when traveling in UP direction, answers UP calls, but passes stops where DOWN calls have been placed (unless DOWN call is at highest stop for which any button has been pressed).

- e. Pressing UP hall call button when car is traveling downward shall not intercept its travel unless UP call is at floor for which lowest stop is registered.
- f. When car has responded to its highest or lowest stop, and calls are registered for opposite direction, travel reverses automatically and answers those calls.
- g. Should farthest stop in either direction be in response to corridor call, entering passenger at that floor may choose travel direction during predetermined period of time.
- h. Should both UP and DOWN calls be registered at intermediate floor when car is traveling to floor beyond, reset only call corresponding to direction opposite to that which car is traveling.
- i. Doors open only when stopping in response to calls.

2.14 EMERGENCY POWER OPERATION

- A. Emergency Return Self-Contained Operation:
 - 1. Provide battery powered emergency return device to prevent passengers from being trapped in power outage.
 - 2. When activated, car will return to Lobby floor and open doors.
 - 3. Upon reaching Lobby, elevator will shut down and close doors.
 - 4. Doors will be capable of operation from within car.
 - 5. Power for emergency return power from suitable batteries automatically maintained at full charge with regulated charging voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Take field dimensions and examine conditions of substrates, supports, and other conditions under which this work is to be performed.
- B. Verify acceptability of hoistway to accept elevator and equipment.
- C. Do not proceed with work until unsatisfactory conditions are corrected.
- D. Start of installation constitutes acceptance of conditions and responsibility for performance.

3.2 ERECTION

- A. Erect sills, struts, hanger supports, hanger covers and unit frames, prior to erection of rough walls and set in proper relation to elevator car guides.
- B. Provide protective covering for finished frame and door surfaces.
- C. Projections into Hoistway exceeding 4 inches:
 - 1. Coordinate location of 75 degree bevels to meet elevator code requirements.
 - 2. GWB bevels: Specified in Section 09 29 00.
- D. Coordinate the installation of pit ladders ensuring that running clearances are maintained, location of ladder is optimal for servicing equipment, and in conformance with locally adopted codes.
- E. Grouting and Concrete Fill:
 - 1. Grout:
 - a. Specified in Section 03 31 00.
 - 2. Fully grout the following:
 - a. Sills and thresholds.

3.3 CLOSEOUT ACTIVITIES

- A. Refer to Section 01 81 33 - Cyber-Security Requirements for cyber security related closeout requirements.

3.4 DEMONSTRATION

- A. Assist Owner in inspection and certification of elevator.
- B. Ensure that control systems and operating devices are functioning properly and conform to locally adopted codes.
- C. Elevator manufacturer shall make a final check of each elevator operation with the Owner's representative prior to turning each elevator over for use.
- D. Submit report to verify Owner has been instructed for inspection, certification, function, and operation of each elevator.

END OF SECTION



DIVISION 21

FIRE SUPPRESSION



SECTION 21 10 00
FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Fire Protection Systems, as indicated, in accordance with provisions of Contract Documents.
- B. Fire Protection Systems Included:
 - 1. Water based:
 - a. Wet-pipe sprinkler system.
 - 2. Products:
 - a. Pipe, fittings, and supports.
 - b. Alarm and signal devices.
 - c. Backflow protection devices and test header.
 - d. Fire alarm system control panel.
 - e. Fire department connections.
 - f. Fire system valves.
 - g. Manual valves.
 - h. System accessories.
 - i. Sprinklers.
 - j. Flexible sprinkler hose fittings.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Use only new material of first-class construction, designed and guaranteed to perform service required.
 - 1. All grooved joint couplings, fittings, valves, and specialties shall be the product of a single manufacturer.
 - 2. All casings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality insurance and traceability.
- B. Provide fully operational systems.
- C. Provide complete fire protection systems as described in the Contract Documents and according to criteria of authority having jurisdiction (AHJ) and the Owner's insurance carrier.
 - 1. Where system requirements as described in the Contract Documents exceed those of the AHJ, meet requirements of both.
 - 2. Where discrepancies exist among the AHJ, Owner's insurance carrier, and Contract Documents, the most stringent requirements shall take precedence.
- D. Authorities Having Jurisdiction:
 - 1. Code Enforcement Agencies.
 - 2. Fire Marshal's Office.
 - 3. State Insurance Office.
 - 4. Water Supply Authority.
- E. Owners Insurance Carrier.
- F. Referenced Criteria (applicable as referenced by AHJ and Owner's insurance carrier):

1. Latest edition of referenced criteria applies unless an earlier edition is specifically indicated by the AHJ and Owner's insurance carrier.
2. National Fire Protection Association (NFPA).
3. Underwriter's Laboratories (UL).
4. Factory Mutual Engineering Commission (FM).

G. Designer qualifications:

1. The fire protection system shall be designed by a minimum NICET Certified Level III Sprinkler Designer.
 - a. Drawings and hydraulic calculations shall include certification NICET Certified Level III Designer.
 - b. The designer shall be responsible for understanding the construction of the building which includes but not limited to: building construction type, ceiling heights, beam depths, obstructions, other disciplines layouts (e.g. mechanical, electrical, etc.), and other features of the building that are required in order to provide a fire protection system that is fully code compliant.

H. Installer Qualifications:

1. Fire protection systems shall be installed by technicians under the direct supervision of the NICET Level III designer indicated above.
2. Fire Protection Installer shall be licensed and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity.
3. Use workmen skilled in this trade.
4. Provide documentation that welders, and welding operators are certified in accordance with American Welding Society Standard AWS D10.9.

I. Piping and Fittings: Per NFPA 13 and 21 10 00.

J. Outside Utilities: Division 33.

1.3 SUBMITTALS

A. Shop Drawings:

1. General
 - a. The fire protection design is a delegated design, and the Contractor shall review for project information and general conformance with Contract Documents.
 - b. Fire Protection submittals and Shop Drawings shall be made as a complete package which includes product data, drawings, and calculations. Incomplete/partial submittals will be returned without being reviewed.
 - 1) Shop drawings, hydraulic calculations, and product data submittal PDF's must be bookmarked.
 - a) Shop drawings must be bookmarked per sheet.
 - b) Hydraulic calculations must be bookmarked per remote area.
 - c) Product data must be bookmarked per product.
 - c. Submit Working Plans documentation after design has been approved by Authority Having Jurisdiction (AHJ) and before installation of system(s).
2. Backflow protection devices.
3. Wet-pipe sprinkler system.

B. Product Data:

1. Wet-pipe sprinkler system.

C. Project Information:

1. Submit detailed data and complete layout of fire protection systems approved by authorities having jurisdiction (including Owner's insurance carrier) and prepared in accordance with the requirements for Working Plans described in applicable NFPA standards.
 - a. Include calculations prepared in accordance with the requirements for Hydraulic Calculations described in applicable NFPA standards.
 2. Architect reviews for project information and general conformance with contract documents.
- D. Contract Closeout Information:
1. Letter, with Owner acceptance signature, stating spare parts and extra materials per NFPA requirements have been delivered.
 2. Operation and Maintenance Data.
 3. Owner instruction report.
 4. Test reports:
 - a. Certification that tests as indicated in FIELD QUALITY CONTROL (Part 3) have been successfully completed and approved by authorities having jurisdiction.

1.4 JOB CONDITIONS

- A. Arrange and pay for permits, fees and inspections required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Alarm and Signal Devices:
1. Potter Electric Signal
 2. System Sensor
- B. Backflow Protection Devices:
1. Ames Company, Inc.
 2. Conbraco Industries, Inc.
 3. FEBCO / Watts Technologies, Inc.
 4. Mueller Company
 5. Watts Regulator Company
 6. Zurn Wilkins Industries, LLC.
- C. Fire Department Connections and Test Headers:
1. Dixon Valve & Coupling Co., LLC.
 2. Elkhart Brass Mfg. Co., Inc.
 3. Fire End & Croker Corporation.
 4. Landsdale Calce Manufacturing Corporation.
 5. Potter Roemer Fire Products.
 6. Reliable Automatic Sprinkler Co., Inc.
 7. Smith Cooper International.
- D. Fire Protection Systems, Water Based:
1. Viking
 2. Victaulic
 3. Reliable Automatic Sprinkler Co., Inc.
 4. Tyco Fire Protection Products
- E. Sprinklers:
1. Reliable Automatic Sprinkler Co., Inc.

2. Tyco Fire Products, LP.
 3. Victaulic Co.
 4. The Viking Corporation.
- F. Flexible Sprinkler Hose Fittings
1. Allied Rubber & Gasket Co.
 2. Anvil International, LLC.
 3. EasyFlex, Inc.
 4. Gateway Tubing, Inc.
 5. Reliable Automatic Sprinkler, Inc.
 6. The Viking Corporation.
 7. Tyco Fire & Building Products.
 8. Victaulic Co.
- G. Submit other pipe materials, joining methods, and equipment not specified, but accepted by applicable NFPA standards and approved by Authority Having Jurisdiction, in accordance with Section 01 25 13.

2.2 DESIGN REQUIREMENTS

- A. Design fire sprinkler systems.
1. Obtain water supply fire flow test prior to designing systems.
 - a. Provide a fire hydrant flow test in accordance with NFPA 291 if one has not been completed within 12 months of the working plan submittal.
 2. Compare flow test results to those listed below and use lowest pressure of the two to design systems.
 - a. Date: 01/28/2025.
 - b. Static pressure: 65 PSIG.
 - c. Residual pressure: 60 PSIG.
 - d. Flow: 1,020 GPM.
 - e. Residual hydrant location: NW corner of S 9th Street & H Street: Hydrant B-40367.
 - f. Flowed hydrant location: SE corner of S 9th Street and H Street: Hydrant B-40417
 3. Design systems using adjusted water supply curve:
 - a. Adjust the flow test water supply curve to correspond with the low hydraulic grade line as provided by the water supplier.
 - b. Adjust the flow test water supply curve to correspond with the actual site elevation.

2.3 PIPE, FITTINGS, AND SUPPORTS

- A. Pipe and Fittings - General:
1. Meet or exceed applicable NFPA standards.
 2. Working pressure: Not less than 175 PSI.
 3. The following are not permitted:
 - a. Lightwall and Schedule 5 pipe.
 - b. Plain end, pressure fit type fittings.
 - c. Hole cut mechanical tee fittings.
 4. Fittings: galvanized where galvanized piping is used.
 5. Corrosion Resistance Ratio (CRR) of all pipe used: equal to or greater than one.
- B. Above ground pipe normally containing water:
1. Examples: Wet-pipe systems.
 2. Sprinkler piping 4 IN and greater:

- a. Black steel, Schedule-10:
 - 1) Welded joints.
 - 2) Mechanical coupling joints:
 - a) Rolled groove type (cut grooving not allowed).
 - 3. Sprinkler piping less than 4 IN:
 - a. Black steel, Schedule-40:
 - 1) Threaded joints.
 - 2) Welded joints.
 - 3) Mechanical joints:
 - a) Rolled groove type.
- C. Pipe, below ground:
- 1. Same as outside utility fire protection piping.
 - a. See Division 33.
- D. Fittings:
- 1. Threaded:
 - a. Black cast iron, Class 150.
 - b. Black malleable iron.
 - c. Galvanized malleable iron.
 - 2. Flanged:
 - a. Black cast iron, short body, Class 125.
 - b. Galvanized malleable iron.
 - c. Gaskets: Full face of 1/8 IN minimum red sheet rubber.
 - d. Flange bolts: ANSI-B18.2.
 - 1) Hexagon head machine bolts with heavy semi-finished hexagon head nuts, cadmium plated.
 - 3. Welded:
 - a. Black steel, standard weights.
 - 4. Mechanical: ASTM-A536.
 - a. Ductile iron, 300 PSI working pressure.
 - b. Coupling gasket material: Butyl rubber or EPDM rubber.
 - c. UL listed.
 - d. Approved by FM or NFPA-13.
 - e. Fittings shall be ductile iron conforming to ASTM A536, Grade 65-45-12. Short pattern, with flow equal standard pattern fittings.
 - f. Grooved joint couplings shall consist of two ductile iron housing segments, pressure responsive elastomer gasket, and ASTM A449 zinc-electroplated steel bolts and nuts.
 - 1) Rigid: Coupling housings with offsetting, angle pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with NFPA 13. Couplings fully installed at visual pad-to-pad offset contact. Couplings that require gapping of bolt pads or specific torque ratings for proper installation are not permitted. Installation-Ready, for direct stab installation without field disassembly.
- E. Pipe Supports:
- 1. All-purpose type, UL listed or FM approved.
 - 2. All hangers to be installed per NFPA 13.
 - 3. Supports, hanger rods, inserts, and clamps acceptable to NFPA.

2.4 ALARM AND SIGNAL DEVICES

- A. UL listed or FM approved.
- B. Coordinate electrical requirements with electrical installer.
- C. Alarm Devices:
 - 1. Local alarm devices:
 - a. General:
 - 1) Provide local alarm on systems of sufficient size as indicated in NFPA-13.
 - 2) Devices shall be weatherproof.
 - b. Alarm bell, electric:
 - 1) Shall provide audible alarm signal upon activation of fire protection system.
 - 2) Weatherproof bell.
 - 3) Provide backer plate to prevent birds and insects from entering inside of bell housing.
 - c. Visible light alarm:
 - 1) Semi-flush, 24 volt DC.
 - 2) Tamper-resistant white lexan lens, with "FIRE" imprinted in red.
 - 3) Light shall be mountable on either ceiling or wall.
- D. Signal Devices:
 - 1. Valve tamper switch: Furnished under Electrical Specification Divisions.
 - a. Shall signal Fire Alarm Control Panel upon valve movement.
 - 2. Waterflow detector:
 - a. Shall signal Fire Alarm System Control Panel when water flows in system.
 - b. Vane type flow switch with retard mechanism or manual adjustment to prevent false alarm.
 - c. 175 PSI rated.
 - d. Suitable for working pressure of 150 PSI with sensitivity adjusting screw.

2.5 BACKFLOW PROTECTION DEVICES AND TEST HEADER

- A. Provide on water supply at location indicated on drawings to prevent contamination of potable water system.
- B. Backflow Protection Device:
 - 1. Corrosion resistant materials.
 - 2. Totally rebuildable.
 - 3. Flanged or grooved ends.
 - 4. Rating: Water at 175 PSI working pressure and between 33 to 110 DEGF.
 - 5. Provide OS&Y or butterfly inlet and outlet isolation valves.
 - 6. Provide four test cocks.
 - a. Provide No. 1 test cock on inlet valve.
 - 7. Approved by authority having jurisdiction
 - 8. UL listed or FM approved.
 - 9. Double check:
 - a. Two independently operating check valves.
- C. Test Header:
 - 1. Outlet threads to be Lincoln Threads.
 - 2. Test header connection:

- a. Outside type.
- b. Inlet:
 - 1) Quantity:
 - a) As required to meet system demand.
 - 2) Size:
 - a) 2-1/2 IN.
- c. Outlet:
 - 1) Quantity:
 - a) One.
 - 2) Size:
 - a) As required to meet system demand.
- d. Finish:
 - 1) Polished chrome.
- e. Raised lettering:
 - 1) "BACKFLOW PREVENTER TEST HEADER"
- f. Connection style:
 - 1) Flush wall mounted.

2.6 FIRE ALARM SYSTEM CONTROL PANEL

- A. Fire alarm system control panel: Provided under Electrical Specification Divisions.

2.7 FIRE PROTECTION SYSTEMS, WATER-BASED

- A. Wet Pipe Fire Protection Sprinkler System:
 - 1. Description: Automatic system shall employ closed sprinklers attached to a piping system filled with pressurized water.
 - a. Normal operation:
 - 1) Actuation of sprinkler allows water to flow through actuated sprinkler.
 - 2) Waterflow in zone sends signal to Fire Alarm System Control Panel.
 - b. Failure of sprinkler allows water to flow through sprinkler.
 - 1) Waterflow in zone sends signal to Fire Alarm System Control Panel.

2.8 FIRE DEPARTMENT CONNECTIONS

- A. Components and assemblies UL listed or FM approved.
- B. Minimum 175 PSI non-shock cold-water working pressure.
- C. Inlet threads for connections to fit local fire department standards.
- D. Fire Department Siamese Connections.
 - 1. Outside type.
 - 2. Inlet:
 - a. Quantity:
 - 1) Two.
 - b. Size:
 - 1) 2-1/2 IN.
 - c. Fittings:
 - 1) Brass snoots, brass pin-lug swivels, brass pin-lug plugs, chains, and gaskets.
 - 3. Outlet:
 - a. Quantity:
 - 1) One.

- b. Size:
 - 1) 4 IN.
 - 4. Finish:
 - a. Polished chrome.
 - 5. Raised lettering:
 - a. "AUTOSPKR".
 - 6. Connection style:
 - a. Flush, wall-mounted, and drop clappers.
- E. Separate wall plate designating special service:
 - 1. Finish:
 - a. Chrome plated.
 - 2. Provide as indicated.

2.9 FIRE SYSTEM VALVES

- A. UL listed or FM approved.
- B. Body: Ductile or cast iron.
- C. Pressure rating: 175 PSI non-shock cold-water working pressure.
- D. 2 IN and smaller: Threaded.
- E. 2-1/2 IN and larger: Flanged or grooved.
- F. Trim to meet NFPA requirements.
- G. Trim to meet performance as indicated in descriptions of fire protection systems.

2.10 MANUAL VALVES

- A. Isolation Valves:
 - 1. Gate valves:
 - a. 2 IN and smaller: Gate valve, UL-FM, 175 PSI WWP, bronze body, union or screwed bonnet, solid wedge disc, OS&Y, threaded.
 - b. 2-1/2 IN and larger: Gate valve, UL-FM, 175 PSI WWP, cast iron body, bolted bonnet, resilient or solid wedge, OS&Y, flanged.
 - 2. Butterfly valves:
 - a. 2 IN and smaller: Butterfly valve, UL listed, 175 PSI WWP, bronze body, stainless steel stem and disc, Viton seal, threaded.
 - b. 2-1/2 IN and larger: Butterfly valve, UL-FM, 175 PSI WWP, ductile iron body, O-Ring seals, aluminum-bronze or ductile-iron disc, stainless steel stem, Buna-N seal, manual geared operator with visual position indicator, lugged.
 - 3. Butterfly valves with tamper switches:
 - a. 2-1/2 IN and smaller: Butterfly valve, UL listed, 175 PSI WWP, bronze body, stainless steel stem and disc, Viton seal, threaded with tamper switch.
 - b. 3 IN and larger: Butterfly valve, UL-FM, 175 PSI WWP, coated cast or ductile iron body, aluminum bronze or ductile iron disk with EPDM coating, manual geared operator with visual position indicator, grooved.
- B. Check Valves:
 - 1. 2 IN and smaller: Check valve, UL listed, 175 PSI WWP, bronze body, bronze swing disc and rubber seat, horizontal or vertical installation, threaded ends.
 - 2. 2-1/2 IN and larger: Check valve, UL-FM, 175 PSI WWP, cast iron or ductile iron body, ductile iron swing disc with rubber seat, horizontal installation unless listed for vertical upward flow, wafer or grooved.

C. Automatic Ball Drip Valve:

1. 1/2 IN straight or angle cast-brass ball drip shall close against pressure.
 - a. When pressure drops, valve shall open to drain pipe.

2.11 SPRINKLERS

- A. UL listed sprinklers of style and type required for service indicated.
- B. Finish of exposed parts: As indicated.
- C. Sprinkler types: Metallic fusible link or glass bulb.
- D. Sprinkler Styles:
1. Upright:
 - a. Finish: Standard bronze.
 2. Concealed pendent:
 - a. Ceiling plate flush with finished ceiling.
 - b. Housing: 1/2 IN adjustment.
 - c. Finish in wooden ceilings: Custom, Coordinate with Architect for final color selection.
 - d. Finish all other areas: White.
 3. Horizontal sidewall:
 - a. Finish: White.
 4. Dry pendent:
 - a. For coverage of vestibules and exterior area from interior wet-pipe system.
 - b. Finish: Match ceiling color.

2.12 FLEXIBLE SPRINKLER HOSE FITTINGS:

- A. Hose fittings – general
1. Hose fitting shall be stainless steel for use in connecting sprinkler heads in commercial suspended ceilings. A bracket attaches to the ceiling grid for supporting the hose.
- B. Hose fittings shall be braided stainless steel, hose fittings and accessories shall be FM 1637 approved.
- C. Hose fittings and accessories shall be braided or unbraided, fittings and accessories shall be UL 2443 listed.

2.13 SYSTEM ACCESSORIES

- A. Alarm Test Device:
1. Single device or unit that provides visual verification of waterflow in a fire sprinkler system and allows for draining of all or a portion of that system.
 2. Contains sight glass, inspector test valve, auxiliary drain valve and test orifice.
 3. UL listed or FM approved.
- B. Pressure Gauges:
1. UL listed or FM approved.
 2. Pressure range and gauge increments as required by NFPA-13.
- C. Spare Parts:
1. Sprinkler cabinet, Wall mounted:
 - a. Provide spare sprinklers of each type and sprinkler wrench for each type in quantities required by NFPA-13.
- D. Sprinkler Guards:
1. UL listed.

2. Heavy duty welded wire.
3. Red baked enamel finish.
4. Escutcheons and guards shall be listed and supplied for use with the sprinkler by the sprinkler manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate with other trades to ensure adequate space for equipment and piping placement.
- B. Review plans, specifications, and shop drawings of other trades to coordinate work.
- C. Do not begin installation until after Agency approvals have been submitted to Architect and Engineer for approval.
 1. Provide preliminary partial submittal to coordinate all sprinkler head locations.
- D. Test systems in accordance with System Standards, manufacturers' instructions, and applicable NFPA publications.
- E. Install systems in accordance with System Description, manufacturers' instructions, and approved shop drawings.
 1. Modifications to system design or arrangement after approval of drawings may only be made after receiving written approval of Architect and authority(ies) having jurisdiction.
 2. Such modifications do not include minor relocations in piping or sprinkler placement.
 3. Make revisions in accordance with NFPA.
- F. Maintain fire and smoke ratings where mechanical items penetrate fire and fire/smoke rated building elements in accordance with Section 07 84 00.
- G. Field quality control: Give advance notice and arrange for field tests and inspections by authority(ies) having jurisdiction.
- H. Provide sprinkler protection for exterior overhangs in accordance with NFPA-13.

3.2 PIPING, SPRINKLERS, AND SUPPORTS

- A. Piping - General:
 1. Install sprinkler piping within first 6 IN of space under roof construction.
 - a. Where conditions of construction require piping installation at a lower elevation, route piping to avoid interference with work of other trades.
 2. Offset, crossover and otherwise route piping to install system in available space.
 - a. Not every offset is indicated.
 3. Install chromed escutcheons on finished-area sides of pipe penetrations.
 - a. Secure escutcheons so they make contact with floor, wall, or ceiling.
 4. Pitch branch lines, cross mains, feed mains and risers to drains.
 5. Paint fire sprinkler piping, fittings, and supports with matching color in exposed areas in accordance with Section 09 91 23.
 6. Flush outside fire main piping prior to connected to inside system.
 7. Grooved joints: Install in accordance with the manufacturer's latest published installation instructions. Pipe ends shall be clean and free from indentions, projections and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service.
- B. Sprinklers - General:
 1. Install sprinklers to provide and maintain minimum 18 IN clear between bottom of deflector and top of storage, files, shelving, and cabinets.
- C. Supports:

1. Install in accordance with NFPA-13.
- D. Testing - General:
1. Test sprinkler and standpipe piping, including outside supplies, under hydrostatic pressure of 200 PSI or 50 PSI above system working pressure, whichever is greater, for 2 HRS.
 - a. Prove system tight to satisfaction of Architect.
 - b. Inside piping shall indicate no leakage.
 - c. Leakage in underground piping shall be in accordance with NFPA-24.
- E. Piping and Sprinkler - Application by room type:
1. Areas subject to freezing:
 - a. Sprinkler styles: Dry type sprinklers.
 2. Electrical rooms/closets:
 - a. Sprinkler styles: Upright, pendent, or horizontal sidewall.
 - b. Provide sprinkler guards.
 3. Finished rooms (rooms with ceilings):
 - a. Sprinkler styles:
 - 1) Concealed pendent.
 - 2) Horizontal sidewall.
 - b. Where ceiling exists in area subject to freezing, comply with requirements for areas subject to freezing.
 - c. Suspended ceilings:
 - 1) Do not install sprinklers through ceiling grid.
 - 2) Install sprinklers so that escutcheons and ceiling plates do not cover ceiling grid.
 - d. Locate sprinklers to coordinate with ceiling layout.
 - 1) Locate sprinklers centered in ceiling tile and in center of metal strip in linear metal ceilings, if such location makes added sprinklers necessary, provide added sprinklers as required to meet code.
 4. Mechanical equipment rooms:
 - a. Sprinkler styles: Upright, pendent, or horizontal sidewall.
 - b. Provide sprinkler guards.
 5. Telephone/Communication rooms/closets:
 - a. Sprinkler styles: Upright, pendent, or horizontal sidewall.
 - b. Provide sprinkler guards.
 6. Unfinished rooms (rooms without ceilings):
 - a. Sprinkler styles: Upright, pendent, or horizontal sidewall.

3.3 ALARM AND SIGNAL DEVICES

- A. Where multi-zone, wet-pipe fire protection sprinkler systems exist, provide waterflow detector at each zone take off immediately after isolation valve.
- B. Install valve tamper switch on each isolation valve indicated below:
1. Valves at fire system valves.
 2. Sprinkler-zone valves.
 3. Post indicator valves.

3.4 FIRE PROTECTION SYSTEMS

- A. Factory trained Engineer shall supervise installation of fire protection systems.
- B. Test completed alarm systems including control and signal circuits wired by Electrical installer.
1. Coordinate with electrical.

2. Complete testing prior to substantial completion.

3.5 FIRE DEPARTMENT CONNECTIONS AND TEST HEADERS

- A. Install fire department connections at height required by authority having jurisdiction.
 1. Position valve to allow 12 IN spanner wrench clearance for connecting hoses.

3.6 MANUAL VALVES

- A. Provide isolation valves at following locations:
 1. Fire system valves.
 2. Flow test system:
 - a. Inlet to hose valve manifold.
- B. Provide check valves at following locations:
 1. Fire department connection.
- C. Provide automatic ball drip at low points.
 1. Piping between outside fire department connection and check valve.

3.7 SYSTEM ACCESSORIES

- A. Drains:
 1. Permit complete draining of systems without disconnection of piping.
 2. Drain consists of dirt leg, valve, and piping.
 3. Extend drain piping to building exterior or nearest express drain.
 4. Required locations:
 - a. At low points of systems.
 - b. At fire system valves.
 - c. At bases of risers.
 5. Size drain valve and piping according to alarm test loop sizing criteria in this section.
 6. At offsets, plugs may be substituted for drains when approved by authority having jurisdiction.
- B. Pressure Gauges:
 1. Provide at following locations:
 - a. At service entrance to building.
 - b. At top of each sprinkler riser.
 - c. At other indicated locations.
 2. Provide shutoff valve and drain for each gauge.
- C. Sprinkler Cabinets:
 1. Install near sprinkler riser.

3.8 ELECTRICAL WIRING

- A. Provide Following:
 1. Wiring diagrams for devices.
 2. Wiring not specified but required to provide an operating system.
- B. Electrical Installer shall provide following:
 1. Alarm and signal device wiring:
 - a. Tamper switches: Supervised wiring to Fire Alarm System Control Panel.
 - b.
 - b. Waterflow detectors: Supervised wiring to Fire Alarm System Control Panel.

- c. Supervised wiring from waterflow detector to outside alarm bell.

END OF SECTION



DIVISION 22

PLUMBING



SECTION 22 08 16
PLUMBING SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The purpose of this section is to specify Division 22 responsibilities and participation in the commissioning process. Responsibilities and participation in the commissioning process shall comply with the requirements of specification Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.
- B. The Owner has contracted with a Commissioning Authority (CxA) to oversee certain commissioning activities on this project. While the CxA has the overall responsibility for planning and coordinating the commissioning process, all parties participate. This includes the owner, construction manager, facility operator, architect, engineer, general contractor, subcontractors, specialty subcontractors, equipment suppliers, vendors, building authorities, and other entities as required.
- C. The General Contractor and all Subcontractors shall each designate one person to represent their own company as Commissioning Coordinator (CC). Each Commissioning Coordinator shall participate as a member of the Commissioning Authority's 'Commissioning Team'.
- D. Commissioning and coordination with the Commissioning Authority are the responsibility of the Contractor (including subcontractors and vendors). The Contractor is responsible for providing all scheduling, coordination and support required for start-up, testing, and commissioning.

1.2 RELATED WORK

- A. Division 01 Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 22 10 16

PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Plumbing Piping, as indicated, in accordance with provisions of Contract Documents.
- B. Systems and Products Included:
 - 1. Systems:
 - a. Cold, hot, and circulating domestic water piping systems within building and to 5 feet outside building wall.
 - b. Drainage piping systems:
 - 1) Soil, waste, vent, indirect, and storm piping within building and to 5 feet outside building wall.
 - c. Pressure drainage piping.
 - 2. Products:
 - a. Backflow protection devices.
 - b. Cleanouts.
 - c. Drains:
 - 1) Air gap fittings.
 - 2) Downspout nozzles.
 - 3) Floor drains.
 - 4) Roof drains.
 - d. Valves:
 - 1) Balancing valves, constant flow control.
 - 2) Check valves.
 - 3) Manual valves, potable water.
 - e. Water hammer arresters.
 - f. Water meters.
- C. Definitions:
 - 1. Drainage piping: Soil, waste, vent, indirect, and storm piping.
 - 2. Brazing: High temperature soldering.
 - 3. Pressure drainage piping: Branch piping from discharge of sump pump or sewage ejector to connection with gravity drainage piping.
- D. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Outside Utilities: See Site Civil Plans.
- B. Pipe and fittings standards: See Section 23 11 00.
- C. Valve standards: See Section 23 05 23.
- D. American Water Works Association Standard AWWA C601: Sterilization Standard.
- E. Plumbing and Drainage Institute Standard WH201: Water hammer arrester standard.
- F. Plumbing and Drainage Institute Standard G10: Grease interceptor standard.

- G. Comply with NSF 61 for potable domestic water piping and components that meet potable water requirements.

1.3 SUBMITTALS

A. Product Data:

- 1. Include sufficient information to verify compliance with specifications:
 - a. Backflow protection devices.
 - b. Drains.
 - c. Valves.
 - d. Water hammer arresters.
 - e. Water meters.

B. Contract Closeout Information:

- 1. Pressure test reports.
- 2. Disinfection test report.
- 3. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Reduced Pressure Principle Backflow Protection Device:

- 1. Base:
 - a. Cla-Val.
- 2. Optional:
 - a. Watts Regulator.
 - b. Febco.
 - c. Hersey Measurement.
 - d. Wilkins Regulator.

B. Cleanouts and Drains:

- 1. Base:
 - a. Wade Division/Tyler Pipe.
- 2. Optional:
 - a. Watts Drainage - Ancon.
 - b. Josam Company.
 - c. JONESPEC Plumbing Products.
 - d. Jay R. Smith Manufacturing Co.
 - e. Zurn Industries, Inc.
 - f. Mifab.

C. Constant Flow Control Balancing Valves:

- 1. Base:
 - a. Griswold Controls COMBO.
- 2. Optional:
 - a. Flow Design Inc. - Autoflow.
 - b. Preso.

D. Pressure Reducing Valves:

- 1. Base:
 - a. Cla-Val.

- 2. Optional:
 - a. Watts Regulator.
 - b. Fisher.
 - c. Wilkins Regulator.
- E. Water Hammer Arresters:
 - 1. Base:
 - a. Wade Division/Tyler Pipe.
 - 2. Optional:
 - a. Jay R. Smith Manufacturing Co.
 - b. Josam Company.
 - c. Zurn Industries, Inc.
- F. Water Meters:
 - 1. Base:
 - a. Hersey Measurement.
 - 2. Optional:
 - a. Badger Meter.
 - b. Sensus Technologies.
- G. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 PIPE AND FITTINGS

- A. Domestic Water Piping:
 - 1. Domestic water piping at service entrance from 1 foot inside building to 5 feet outside:
Same as indicated for outside utilities.
 - 2. 2 inches and smaller after service entrance:
 - a. Above grade:
 - 1) Copper, type L, with solder joints, and wrought copper or cast brass fittings.
 - b. Below grade:
 - 1) Copper, type K soft, with brazed joints and wrought copper or cast brass fittings.
 - 2) Where below grade run of piping is shorter than 50 feet, below-grade joints are not acceptable.
- B. IDrainage piping (soil, waste, vent, indirect, and storm):
 - 1. Above grade:
 - a. Cast iron hubbed pipe and fittings with elastomeric push joints, as allowed by code.
 - b. Cast iron, hubless pipe, fittings, and elastomeric sealing sleeves with stainless steel or cast iron clamps, as allowed by code.
 - c. Copper (type DWV or heavier), with soldered joints and wrought copper or cast brass drainage and vent fittings, as allowed by code.
 - 2. Below grade:
 - a. 2 inches diameter or larger.
 - b. Cast iron, hubbed pipe and fittings with elastomeric push joints, as allowed by code.
- C. Pressure drainage piping:
 - 1. Cast iron pressure pipe and fittings, with mechanical joints.

2.3 BACKFLOW PROTECTION DEVICES

- A. Backflow protection devices, general:
 - 1. Approved by local Public Utilities Bureau and the state Environmental Protection Agency.

B. Reduced Pressure Principle Backflow Preventer (BFP):

1. Two check valves, test cocks, pressure differential relief valve, isolation valves and accessories assembled as an integral unit, horizontally mounted. Tested and certified in conformance with ASSE Standard No. 1013.
2. Threaded ends: DN50 2 inches and smaller.
3. Flanged ends: DN65 2-1/2 inches and larger.
4. Provide DN20 3/4 inches drain line from relief to floor drain, floor sink, mop sink, or service sink.
5. Isolation valves:
 - a. DN50 2 inches and smaller: Ball valve.
 - b. DN65 2-1/2 inches and larger:
 - c. Provide No. 1 test cock on inlet valve.
6. Size BFP's to have a pressure loss less than 14 psi at flows indicated below (refer to plans for pipe sizes):
 - a. DN15 pipe: 0.130 l/s 1/2 inches pipe: 2.2 gpm.
 - b. DN20 pipe: 0.370 l/s 3/4 inches pipe: 6 gpm.
 - c. DN25 pipe: 0.800 l/s 1 inch pipe: 13 gpm.
 - d. DN32 pipe: 1.380 l/s 1-1/4 inches pipe: 22 gpm.
 - e. DN40 pipe: 2.200 l/s 1-1/2 inches pipe: 35 gpm.
 - f. DN50 pipe: 4.700 l/s 2 inches pipe: 75 gpm.
 - g. DN65 pipe: 7.800 l/s 2-1/2 inches pipe: 125 gpm.
 - h. DN80 pipe: 10.7 l/s 3 inches pipe: 170 gpm.
 - i. DN100 pipe: 19.8 l/s 4 inches pipe: 315 gpm.
 - j. DN150 pipe: 45 l/s 6 inches pipe: 720 gpm.
 - k. DN200 pipe: 78 l/s 8 inches pipe: 1250 gpm.
 - l. DN250 pipe: 120 l/s 10 inches pipe: 1965 gpm.

2.4 CLEANOUTS

A. General:

1. Provide flashing collars and clamps for CO bodies installed in floors with finishes installed over waterproofing.
 - a. Coordinate with Division 09 and Room Finish installers.
2. Dimensions are nominal.
3. Body material (unless indicated otherwise): Coated cast iron.
4. Cleanout plugs:
 - a. Extra heavy, threaded, tapered, brass plug with solid hexagonal nut.
 - b. Comply with Plumbing Code.
 - c. Provide with Unified Thread Standard.
5. Cleanouts on lines completely accessible from within pipe chases do not require covers.
6. Cleanouts in exposed piping in equipment rooms do not require special covers.

B. Interior Floor Mounted Cleanouts:

1. Extra heavy, flanged, cast iron ferrule, tapped for cleanout plug with spigot or inside caulk outlet.

C. Example:

1. Two piece, threaded, adjustable housing.
 - a. ANSI load class: Light duty, unless noted otherwise.
 - b. Example: Wade 6000.

2. Top and cover as specified below by floor finish.
 - a. Resilient tile and sheet finish: Round flange top with scoriated cover.
 - b. Ceramic tile finish: Square flange top with scoriated cover.
 - c. Poured finish: Round, wide flange top with scoriated cover.
 - d. Carpet finish: Round top with standard top tapped for carpet marker bolt.
 - e. Terrazzo finish: Round top with recessed for terrazzo cover.
 - f. Quarry tile finish: Square, heavy duty top with heavy duty scoriated cover.
 - g. Concrete finish in unfinished areas:
 - 1) Heavy, round frame; satin bronze, scoriated tractor top.
 - 2) ANSI load class: Heavy duty.
 - 3) Example: Wade 6000Z.
- D. Cleanouts in vertical piping:
 1. Tapped cleanout tee.
 2. Extra heavy, threaded, brass plug with solid hexagonal nut.
- E. Cleanouts in hubs of combination wye and eighth bends or wyes.
 1. Tapped spigot.
 2. Extra heavy, threaded, brass plug with solid hexagonal nut.
- F. Cleanouts at ends of hubless combination wye and 1/8th bends or wyes.
 1. Blind plug.
- G. Covers over cleanouts in concealed vertical piping:
 1. Square, nickel bronze frame with secured, smooth, stainless steel access cover.
 2. 6 x 6 inches for pipe sizes DN100 4 inches and less.
 3. 9 x 9 inches for pipe sizes DN125 5 inches and larger.
 4. Example: [Wade W-8480-S](#).
- H. Exterior cleanouts: See Drawings.

2.5 DRAINS

- A. Drains - General:
 1. Provide flashing clamps with seepage openings for drain bodies with flashing collars being installed in floors with finishes installed over waterproofing.
 - a. Coordinate with Division 09 and Room Finish installers.
 2. Provide underdeck clamps for drain bodies except those installed in slabs on grade.
 3. See Schedule on Drawings for Drains

2.6 FLASHINGS

- A. On floors above grade, allow for flashings provided by others at penetrations in floors with finishes installed over waterproofing.
 1. Coordinate with Division 09 and Room Finish installers.

2.7 TRAPS

- A. Traps, general:
 1. Cast brass or cast iron, one piece pattern, 3 inches minimum seal.
 2. Same material, coating, and finish as piping system into which they are installed except traps DN50 2 inches NPS and under, not buried in earth, shall be cast brass with union and cleanout.
 3. Place trap cleanouts in accessible locations.

- B. Provide deep seal traps for drain bodies in ventilation housings: Traps need to maintain seal against static pressure in fan housing.
- C. Traps for drains with buried outlet: Cast iron P-traps, unless otherwise indicated.

2.8 VALVES

- A. Balancing valves, constant flow control:
 - 1. Factory calibrated, direct acting, automatic pressure compensating.
 - 2. Control flow rates within 5 percent of flow rating over operating pressure differential range.
 - a. Set flow rating according to pipe sizes indicated on plans:
 - 1) 1/2 inches: 1.0 gpm.
 - 2) 3/4 inches: 2.5 gpm.
 - 3) 1 inch: 6 gpm.
 - 4) 1-1/4 inches: 9 gpm.
 - 3. Pressure differential range:
 - a. 1-14 psiD.
 - 4. Threaded brass or copper sweat body with stainless steel internal parts.
 - 5. Provide a metal identification tag with chain for each installed valve.
 - a. Identify zone or location, valve model number, flow rate, direction of flow, and differential pressure range.
 - 6. Provide with integral unions to allow field exchange of internal components without removing valve body from pipeline.
 - 7. Provide manual valve upstream and downstream of each valve.
- B. Check Valves:
 - 1. 2 inches and smaller: V-24 or V-25.
 - 2. 2-1/2 inches and larger: V-28 or V-29.
- C. Manual Valves, Potable Water:
 - 1. 2 inches and less: V-13 or V-14.
 - 2. 2-1/2 to 4 inches:
- D. Pressure Reducing Valves:
 - 1. Use pilot operated or direct acting PRV based on pipe size indicated on plans.
 - a. 2 inches and smaller: direct acting.
 - b. 3 inches and larger: pilot operated.
 - 2. Direct acting PRV.
 - a. Bronze bodied, diaphragm and spring type valve with integral thermal bypass and removable, stainless steel strainer.
 - b. Size PRV's to have a maximum fall off pressure of 15 psiG at flows indicated below (refer to plans for pipe sizes):
 - 1) 1/2 inches pipe: 2.2 gpm.
 - 2) 3/4 inches pipe: 6 gpm.
 - 3) 1 inch pipe: 13 gpm.
 - 4) 1-1/4 inches pipe: 22 gpm.
 - 5) 1-1/2 inches pipe: 35 gpm.
 - 6) 2 inches pipe: 75 gpm.
 - 3. Pilot operated PRV.
 - a. Hydraulically operated, pilot controlled diaphragm type valve.
 - 1) Pilot control: Direct acting, adjustable, spring loaded, normally open.

- b. Single removable seat and resilient disc.
- c. Fixed orifice in control system.
- d. Pressure rating: 125 class.
- e. Temperature rating: 180 deg F.
- f. Valve body: Cast iron ASTM A48.
- g. Stainless-steel trim.
- h. Provide thermal relief if PRV is installed on cold-water side of water heater.
- i. Adjustment range: 100 to 500 kPa 15 to 75 psi.
- j. Pipe size indicated on plans: DN80 3 inches.
 - 1) Min PRV flow rate: 15 gpm.
 - 2) Normal maximum flow rate: 150 gpm.
 - 3) Maximum intermittent flow rate: 260 gpm.
- k. Pipe size indicated on plans: 4 inches.
 - 1) Min PRV flow rate: GPM.
 - 2) Normal maximum flow rate: 310 gpm.
 - 3) Maximum intermittent flow rate: 475 gpm.
- l. Pipe size indicated on plans: 6 inches.
 - 1) Min PRV flow rate: 50 gpm.
 - 2) Normal maximum flow rate: 720 gpm.
 - 3) Maximum intermittent flow rate: 1000 gpm.
- m. Pipe size indicated on plans: 8 inches.
 - 1) Min PRV flow rate: 115 gpm.
 - 2) Normal maximum flow rate: 1250 gpm.
 - 3) Maximum intermittent flow rate: 1870 gpm.
- n. Pipe size indicated on plans: D10 inches.
 - 1) Min PRV flow rate: 200 gpm.
 - 2) Normal maximum flow rate: 1965 gpm.
 - 3) Maximum intermittent flow rate: 2950 gpm.

2.9 GALLGALGALLGALWATER HAMMER ARRESTERS

- A. Engineered, and certified in accordance with Plumbing and Drainage Institute (PDI) Standard WH-201.
- B. Type and construction:
 - 1. Bellows type and constructed entirely of stainless steel.
 - 2. Piston type is not acceptable.
- C. Water hammer arrestors shall be bellows type and constructed entirely of stainless steel.

2.10 WATER METERS

- A. Use threaded fittings on meters 2 inches and less in size.
- B. Provide valve on each side of meter.
- C. Public utility water meter:
 - 1. Provide type and size approved by local utility.
 - 2. Provide full size bypass line around meter with a sealed valve.
 - 3. Provide capped tee immediately downstream of meter.
 - a. Verify size with local utility.

PART 3 - EXECUTION

3.1 GENERAL

A. General:

1. Install piping as indicated and to provide fixtures and items of equipment with proper drainage, vent, and water connections as required by governing codes.
2. Hold piping as close to structure as possible to maintain maximum head room.
3. Run piping concealed wherever possible.
4. Under no circumstances reduce pipe size indicated without written consent of Architect.
5. Size branches to individual fixtures as scheduled.
6. Consult the following before roughing in piping:
 - a. Manufacturer's data.
 - b. Large scale Architectural, and Mechanical Drawings of rooms containing equipment and plumbing fixtures.
7. Stub piping through wall directly behind item being served (e.g., equipment, plumbing fixtures, vending machines).
 - a. Cap and protect until such time as installation is performed.
 - b. Exception: Upon approval of Architect, piping mains and/or branches may be run in lab benches, in built in counters, and in cabinet work.
8. Plug or cap piping immediately after installation.
9. Install chromed escutcheons on finished area sides of pipe penetrations.
 - a. Secure escutcheons so they make contact with floor, wall, or ceiling.
10. Install equipment in accordance with manufacturer's instructions.
11. Connect equipment furnished by Owner or other divisions in accordance with Section 23 05 00.
12. Install piping supports, sleeves, and seals as indicated in Section 23 05 29.

3.2 DOMESTIC WATER PIPING SYSTEMS

A. General:

1. Install plumbing without cross or inter connections between potable and non-potable lines.
2. Provide unvalved system drains on trapped portions of systems: See Section 23 05 19.
3. Provide thermometers and pressure gauges where indicated on drawings: See Section 23 05 19.

B. Service entrance installation through floor:

1. Provide reaction anchorage at buried elbow where water service turns up below the floor.
2. Terminate top of exterior piping material with flange connection.
 - a. Tie flange back to buried elbow with tie rods of same diameter as flange bolts.
 - b. Permanently protect below grade tie rods against corrosion.
 - c. Provide minimum of one tie rod for each two flange bolt holes.

C. Backflow Protection Devices.

1. Provide at following locations:
 - a. At fixtures and equipment as indicated and required by Code.
2. Pipe drain from reduced pressure principle backflow preventers to drain or mop sink.

D. Balance Hot Water Circulation System.

E. Provide manual isolation valves at following locations.

1. To isolate groups of fixtures and equipment on branch runouts from piping mains.
2. On each branch serving a rest room.

3. On inlet and outlet of each equipment.
 4. On each branch to hose bib or wall hydrant.
 5. At main feed points to domestic water pipe risers.
 6. As indicated and as required to adequately service parts of systems and equipment.
- F. Wire isolation valves on emergency showers open and tag "Do Not Close".
- G. Provide water hammer arresters on hot and cold water lines in accordance with PDI Standard WH-201 sizing and placement data; the Contractor shall be responsible for sizing of water hammer arrestors in accordance with this standard.
- H. Testing of Domestic Water System:
1. Upon completion of system or a section of system, test piping hydrostatically to pressure not less than 50 percent in excess of pipe's working pressure, but in no case less than 150 psi.
 - a. System shall hold pressure for 24 hours.
 2. Repair leaks or replace defective pipe disclosed by tests.
 3. Repeat tests until piping indicates tight.
- I. Sterilization of Domestic Water System:
1. Sterilize system as indicated or in accordance with AWWA C652 or C651.
 2. Thoroughly flush potable water systems.
 3. After flushing, introduce chlorine or chlorine compound into system with dosage sufficient to give an initial residual chlorine content of 50 PPM.
 4. Collect samples from various taps and fixtures throughout buildings during introduction of chlorine to assure uniform distribution.
 5. Open and close valves several times.
 6. After a 24 hour contact period, flush traces of heavily chlorinated water from systems.
 7. After flushing is complete, indicate effectiveness of disinfection by submitting laboratory reports of bacteriological tests on samples taken from system.
 8. If unsatisfactory results are obtained, repeat disinfection process until satisfactory.
 9. Do not put system into service until tests are approved by Plumbing Inspector.

3.3 DRAINAGE PIPING SYSTEMS

- A. General:
1. Changes of direction and junctions: Make with wye fittings and eighth bends.
 - a. Use sanitary tee fittings in vertical pipe only.
 - 1) Sanitary crosses not allowed.
 2. Provide P-trap for each direct waste pipe connection to equipment.
 3. Trap fixtures as required by governing code.
 4. For ice makers, provide either of the indirect drain options listed below:
 - a. Floor sink.
 - b. Dedicated, under counter P-trap.
 5. Provide air gaps at indirect drains.
- B. Slopes:
1. Install horizontal soil, waste, and storm lines with following slopes:
 - a. DN75 3 inches and smaller pipes:
 - 1) 1/4 inches/FT.
 - b. 4 inches and larger pipes:
 - 1) 1/8 inches/FT.

- c. 6 inches and larger pipes: 1/16 inches/ FT.
 - d. Slopes indicated on plans override those indicated here.
- C. Vents:
 - 1. Run vent stacks parallel to soil and waste stacks to receive branch vents from fixtures.
 - a. Each vent stack shall originate from a soil or waste stack at its base.
 - 2. To permit proper flashing, offset through the roof piping away from walls on roof before passing through roof.
 - 3. Carry vent stacks 4 inches and larger full size through roof.
 - 4. Install vent lines so they will drain and not trap water.
 - 5. Where possible combine soil, waste, or vent stacks before passing through roof to minimize roof openings.
 - 6. Where minimum vent through roof size is larger than vent size, provide increaser minimum of 305 mm 12 inches below roof line.
 - a. Minimum vent through roof size:
 - 1) 4 inches.
 - 7. Extend vent stacks at least 12 inches above roofing.
- D. Provide cleanouts on drainage piping as indicated below and on plans.
 - 1. Locations:
 - a. At dead ends.
 - b. At changes of direction greater than 45 degrees.
 - c. At junction of building drain and building sewer.
 - d. 36 inches to 48 inches above finished floor in vertical piping that connects to horizontal soil, waste, or storm piping immediately below in ceiling space or under grade.
 - e. As test tee to receive test plugs in each riser at least every other floor.
 - f. At maximum 50 feet intervals in horizontal 4 inches and smaller drains.
 - g. At maximum 100 feet intervals in horizontal, 5 inches and larger drains.
 - 2. Sizes:
 - a. 4 inches diameter and smaller piping: Match pipe size.
 - b. 5 inches diameter and larger piping: Not less than 4 inches.
 - 3. Where cleanouts occur in concealed spaces, provide with extensions to wall or to floor above.
 - a. Make extensions using long sweep ells or wye and eighth bends.
 - 4. Where cleanouts are indicated in ceiling spaces above critical areas, extend cleanouts through floor above.
 - 5. Install carpet marker bolts after carpet installation.
- E. Install piping and drains to allow for flashings provided under Roofing System section.
 - 1. Coordinate with Roofing installer.
- F. Area Drains, Floor Drains and Floor Sinks:
 - 1. At locations with waterproofing: Set top of flashing collar 1/2 inches below level of waterproofing.
 - 2. At locations without waterproofing: Place drain integrally with poured concrete. Set top of drain flush with finished floor.
 - 3. Set over P-traps.
- G. Testing of Drainage Piping Systems:
 - 1. Do not insulate, conceal, or install furring around pipe until it has been tested to satisfaction of Owner and Plumbing Inspector.

- a. If inspection or test indicates defects, replace such defective work or material, and repeat inspection and tests.
- 2. Test piping at completion of installation of each stack or section of piping.
 - a. Fill system with water to highest point and check joints and fittings for leaks.
 - b. Eliminate leaks before proceeding with work or concealing piping.
 - c. Minimum test height: 10 feet.
 - d. Make repairs to piping with new material.
 - e. Peening and chiseling of holes or screwed joints is not allowed.

END OF SECTION

SECTION 22 11 13

FACILITY WATER DISTRIBUTION PIPING (Olsson)

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for water service.

1.2 DEFINITIONS

- A. Contamination Source: Including, but not limited to, sanitary sewer pipe and man-holes, storm sewer pipe and manholes, septic tanks, and subsoil treatment systems.
- B. NPS: Nominal Pipe Size.
- C. PVC: Polyvinyl chloride plastic.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.
- B. As-built drawing files of all piping, fittings and connections for Owner records.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements of Lincoln Water System. Include tapping of water mains and backflow prevention.
 - 2. Comply with requirements of Lincoln Water System for potable-water-service piping, including materials, installation, testing, and disinfection.
 - 3. Comply with requirements of Lincoln Water System for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- E. NSF Compliance:
 - 1. Comply with NSF 14 for plastic potable-water-service piping.
 - 2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.
 - 2. Protect valves against damage to threaded ends and flange faces.

3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.8 PROJECT CONDITIONS

- A. Field verify all existing facilities and utilities prior to starting work to identify all conflicts with the work.
- B. Work in City of Lincoln Right of Way requires a Right of Way Construction Permit from Lincoln Transportation & Utilities. Contractor to obtain and adhere to permit requirements.
- C. Contractor to provide Traffic Control Plan and Traffic Control Measures in accordance with Lincoln Transportation & Utilities requirements.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

- A. PVC, AWWA Pipe: AWWA C900, DR 14, with bell end with gaskets conforming to ASTM D3139 and ASTM F477, and with spigot end.
 1. Comply with UL 1285 for fire-service mains if indicated.
 2. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.2 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
 1. Nonrising-Stem, Resilient-Seated Gate Valves:
 - a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Mechanical joint.

4) Interior Coating: Complying with AWWA C550.

2.3 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 1/4 inches in diameter.
 - 1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- B. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

Indicator post shall have tamper switch, per local code.

2.4 FIRE HYDRANTS

- A. Dry-Barrel Fire Hydrants:
 - 1. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
 - a. Fire hydrant shall match specifications of City of Lincoln Water System standard fire hydrant.
 - b. Standards: UL 246, FMG approved.
 - c. Pressure Rating: 150 psig minimum.
 - d. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
 - e. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
 - f. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
 - g. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

2.5 PIPE ACCESSORIES

- A. Tracer Wire:
 - 1. Tracer wire shall be THNN, 12-gauge copper wire.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Review layout of work for conflicts with existing facilities or utilities.
 - 1. Coordinate any necessary layout revisions with Engineer before starting work.

3.2 PROTECTION

- A. Protect existing facilities and utilities.
- B. Protect existing landscaping and other features remaining as final work.

3.3 EARTHWORK

- A. Refer to Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.4 PIPING INSTALLATION

- A. Water-Main Connection: Water service taps to be performed by City of Lincoln Water System. Contractor to coordinate schedule in advance.
- B. Comply with NFPA 24 for fire-service-main piping materials and installation.
- C. Install PVC, AWWA pipe according to ASTM F 645, AWWA M23 and AWWA C605.
- D. Bury piping with depth of cover over top at least 5 feet.
- E. Provide 18" minimum vertical clearance and 10 feet minimum horizontal clearance between the outside edge of the water pipe and the outside edge of a contamination source.
 - 1. Install a full length of pipe at crossings so both joints will be as far from the contamination source as possible with the preference to have the water pipe above the contamination source.
 - 2. Any variance with minimum separation distances shall be approved by the reviewing authority.
- F. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.5 TRACER WIRE INSTALLATION

- A. Install tracer wire with all PVC water pipe to facilitate detection of the pipe.
- B. Tracer wire shall be secured to the top of the pipe by tape at a minimum of three locations in each section of pipe.
- C. A continuous loop shall be installed to the top of all valve boxes.
- D. All wire shall be joined by use of a wire clamp and all connections shall be sealed and taped to create a watertight connection.
- E. Terminate tracer wire inside all buildings. See Mechanical for details.

3.6 PIPE CUTTING

- A. Comply with manufacturer's recommendations and AWWA M23.
- B. Cuts shall be smooth, straight, and at right angles to the pipe axis.
- C. After cutting, the end of the pipe shall be dressed to remove all roughness and sharp corners and shall be beveled in accordance with the manufacturer's recommendations.

3.7 FITTINGS INSTALLATION

- A. Install fittings in accordance with manufacturer's recommendations and AWWA C600.

3.8 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
 - 1. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.

3.9 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 - 1. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
 - 2. Fire-Service-Main Piping: According to NFPA 24.
- C. Thrust blocks shall be poured-in-place concrete and shall extend from the fitting to solid, undisturbed earth.
 - 1. All joints shall be accessible for repair.
 - 2. Dimensions of thrust blocks shall be as shown on Lincoln Standard Plans.
 - 3. If the absence of a suitable solid vertical excavation face is due to improper trench excavation, the Contractor shall furnish and install acceptable metal harness anchorages using ductile iron pipe of the appropriate class at no additional cost to the Owner.

3.10 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. Valves to be set in concrete collar, in accordance with construction drawing details.

3.11 CONNECTIONS

- A. Connect water-distribution piping to interior domestic water and fire-suppression piping.

3.12 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water. Fill and flush pipeline as needed to remove trapped air.
- B. Hydrostatic Tests: Test according to AWWA C600 for ductile iron pipe and AWWA C605 for PVC pipe.
- C. Prepare reports of testing activities.
- D. Contractor shall be responsible for all costs associated with the piping tests.
- E. Owner will furnish reasonable quantities of water without charge for use by the Contractor for purposes of testing.

3.13 IDENTIFICATION

- A. Install continuous underground tracer wire during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping.

3.14 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use purging and disinfecting procedure prescribed by City of Lincoln Water System.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION

SECTION 22 11 23

PLUMBING PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Plumbing Pumps, as indicated, in accordance with provisions of Contract Documents.
- B. Systems Included:
 - 1. Circulating pumps.
 - 2. Sump pumps.
- C. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Circulating pumps.
 - a. Include pump curves with point of operation indicated.
 - 2. Sump pumps.
 - a. Include pump curves with point of operation indicated.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - 2. Owner instruction reports.

1.3 QUALITY ASSURANCE

- A. Pipe and fittings standards: See Section 23 11 00.
- B. Manual-valve and check-valve standards: See Section 23 05 23.
- C. Standards:
 - 1. UL 778: Motor Operated Water Pumps.

1.4 WARRANTY

- A. Eighteen (18) months from start-up.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Circulating pumps:
 - 1. Base:
 - a. Bell & Gossett, ITT.
 - 2. Optional:
 - a. Armstrong Pumps.
 - b. Grundfos.
 - c. Taco.
 - d. Thrush.
 - e. Aurora.
- B. Sump Pumps. Submersible, simplex for hydraulic elevators.
 - 1. Base:

- a. Stancor.
- 2. Optional:
 - a. Liberty.
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Pumps - General:
 - 1. Motors: Section 23 05 00.
 - 2. Motor data: As scheduled.
 - 3. Pump capacities: As scheduled.
 - 4. Provide disconnects.
 - 5. Basins: As detailed.

2.3 CIRCULATING PUMPS

- A. Circulating Pumps:
 - 1. In-line centrifugal.
 - 2. Pump casing and impeller: Bronze, designed for domestic water circulating.
 - 3. Fractional-horsepower pumps: Seal-less.

2.4 SUMP PUMPS

- A. Submersible, Simplex Sump Pump to serve hydraulic elevator pits.
 - 1. Provide pump and control systems capable of pumping water while containing oil.
 - 2. The system shall function automatically and shall provide for an alarm under the below conditions.
 - a. The presence of oil in the pump
 - b. High liquid in the sump
 - c. High amps or a locked rotor condition.
 - 3. Motor.
 - a. Thermal and overload protection.
 - b. Capable of operating continuously or intermittently.
 - c. Motor Housing: Constructed of #304 stainless steel.
 - d. Mechanical seals: Housed in a separate compartment.
 - 4. Control system:
 - a. UL 508 and UL 778 compliant.
 - b. NEMA 4X enclosure with stainless steel hinged hardware and 8 pin twist lock electrical receptacle.
 - c. Dual oil sensing relays with variable sensitivity settings.
 - d. Magnetic contactor with separate over current relay.
 - e. Self-cleaning stainless steel sensor probe,
 - f. Dual floats
 - g. Clearly marked terminal board and remote monitoring contacts (for "oil present" and "sump high level").
 - h. Provide mating power cable, probe cable, high level alarm cable, junction box and accessories required for connecting pump to control panel.
 - i. The control unit, pump, floats and sensor probe shall be factory assembled as a complete, ready to use system and shall be tested and approved by nationally recognized testing laboratory.

B. Basins:

1. Size: As detailed.
2. Inlet and outlet sizes: As indicated on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated and in accordance with manufacturer's instructions and recommendations.
- B. Furnish piping, isolation valves, check valves, and fittings per manufacturer recommendation.
- C. Provide manual isolation valves at following locations:
 1. On inlet and outlet of each circulating pump.
 2. On outlet of each sump pump.
- D. Provide check valve at outlet of each pump.
- E. Valve Requirements:
 1. See Section 22 10 16.

END OF SECTION

SECTION 22 13 13
FACILITY SANITARY SEWERS (Olsson)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Cleanouts

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Pipe.
 - 2. Fittings.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.5 PROJECT CONDITIONS

- A. Comply with the requirements of the City of Lincoln Plumbing Code and Lincoln Wastewater System.
- B. Contractor shall notify Lincoln Wastewater System and schedule inspection of proposed connection prior to tapping of existing public sanitary sewer main.
- C. All work shall be performed under a Plumber's Permit.
- D. Contractor is required to obtain a Right of Way Construction Permit for private utility construction within City of Lincoln Right of Way. All permits required by the City of Lincoln for the performance of such work shall be secured and paid for by the Contractor.
- E. Contractor shall provide a traffic control plan and install and implement traffic control measures for all construction which causes any lane of traffic, sidewalk or bike trail to be closed or obstructed. All traffic control plans and measures shall be in accordance with the following requirements:
 - 1. Part 6 of the Manual of Uniform Traffic Control Devices
 - 2. Chapter 15 of the City of Lincoln Standard Specifications
 - 3. Lincoln Standard Plan, L-99
 - 4. Lincoln Traffic Control Guidelines

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

- A. PVC Type PSM Sewer Piping: NPS 4 to NPS 15.
 - 1. Pipe: ASTM D 3034, SDR 26, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM D 3034, PVC with bell ends or ductile iron with mechanical joints.
 - 3. Gaskets: ASTM F 477, elastomeric seals.

2.2 CLEANOUTS

- A. Cast-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 1. Top-Loading Classification(s): Heavy Duty.
 - 2. Sewer Pipe Fitting and Riser to Cleanout: ASTM 2241, SDR 26

2.3 MANHOLES

- A. Standard Precast Concrete Manholes:
 - 1. Provide pre-cast concrete manhole meeting requirements of City of Lincoln Standard Plan, LSP 200
 - 2. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 3. Diameter: 48 inches minimum unless otherwise indicated.
 - 4. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 - 5. Base Section: 8-inch minimum thickness for floor slab
 - 6. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
 - 7. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
 - 8. Joint Sealant: Profile gasket complying with ASTM C442
 - 9. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
 - 10. Steps: Individual FRP steps

PART 3 - EXECUTION

3.1 PREPARATION

- A. Review layout of work for conflicts with existing facilities or utilities.
 - 1. Coordinate any necessary layout revisions with Engineer before starting work.
- B. Precast concrete manhole sections and grade rings shall be inspected before installation.
 - 1. All cracked, and otherwise visibly defective units shall be rejected.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.3 PIPING INSTALLATION

- A. Sewer Main Connection: Sanitary sewer service taps to be reviewed by City of Lincoln Waste Water System. Contractor to coordinate schedule in advance.
- B. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

- C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- D. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- E. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- F. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
- G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.4 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

3.5 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches for cleanouts, and use PVC soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Heavy-Duty, top-loading classification cleanouts in all areas.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 6 inches deep.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.6 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.7 CONNECTIONS

- A. Make connections to existing sewer main in accordance with City of Lincoln Wastewater System requirements
 - 1. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.

- b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of Lincoln Wastewater System
 - 3. Schedule tests and inspections by City of Lincoln Wastewater System with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
 - 6. Deflection Tests: Test all flexible pipes for deflection.
 - a. Test shall be conducted after final backfill has been in place at least 30 days.
 - b. Use a rigid ball or mandrel with a diameter equal to 95% of the inside diameter of the pipe.
 - c. Perform test without mechanical pulling devices.
 - d. No pipe shall exceed a deflection of 5%.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.9 CLEANING

- A. Clean dirt and superfluous material from interior of piping. Flush with potable water if necessary and approved by the Engineer.

END OF SECTION

SECTION 22 33 00
DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Domestic Water Heaters, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Water heaters.
- B. Contract Closeout Information:
 - 1. Owner instruction report.
 - 2. Operation and Maintenance Data.
 - a. See Section 01 78 23.

1.3 QUALITY ASSURANCE

- A. Factory testing: Subject tank and elements to hydrostatic test pressure, 150 percent in excess of working pressure. Certify that components are free of leaks.
- B. Manufacturing standard: ASME Pressure Vessel Code.
- C. Comply with NSF 61 for potable domestic water piping and components that come in contact with potable water.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Electric Storage Water Heater.
 - 1. Base:
 - a. AO Smith Water Products.
 - 2. Optional:
 - a. Rheem Water Heaters.
 - b. Ruud Water Heater.
 - c. State.
- B. Temperature/Pressure Relief Valves.
 - 1. Base:
 - a. Watts.
 - 2. Optional:
 - a. A W Cash.
 - b. Wilkins.
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS - GENERAL: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Unless indicated otherwise, water pressure drop through heater shall not exceed 10 psi.

2.3 ELECTRIC STORAGE WATER HEATER

A. Electric Storage Water Heater.

1. Factory-assembled, packaged commercial water heater with storage tank, heating elements, controls, and other components as indicated.
2. Completely factory assemble water heater so that installation involves only setting, leveling, anchoring, and connection of piping and electrical services.
3. Designed for potable water service.
4. UL listed and NSF approved.

B. Storage Tank:

1. Labeled ASME Code construction.
 - a. Minimum working pressure of 865 kPa 125 psi for tanks 245 L 65 gallons and larger.
 - b. Minimum working pressure of 1040 kPa 150 psi for tanks smaller than 245 L 65 gallons.
2. Vertical, floor-mounted.
3. Minimum pressure rating:
 - a. 1040 kPa 150 psi working pressure.
 - b. 2080 kPa 300 psi test pressure.
4. Tank handhole cleanout.
5. Brass drain valve.
6. Insulation: R-16, minimum.
7. Steel outer jacket with manufacturer's standard enamel finish.

C. Heating Elements:

1. Heavy duty and resistant to oxidation and scaling.
2. Easily replaceable.
3. Fused in accordance with NEC and UL.

D. Controls:

1. Fused, 120V control circuit.
2. Adjustable leaving water temperature range: Off and 35-60 deg C 95-140 deg F.
 - a. Provide one thermostat per heating element.
3. High-temperature limit with adjustable set point.
4. Low-water cut-off.
5. Immersion thermostat.
6. Magnetic contactors.

E. Other Components:

1. Temperature/pressure relief valve.
2. Pressure gauge.
3. Temperature gauge.
4. Expansion tank, see schedule on drawings.
5. Digital mixing valve, see schedule on drawings.

2.4 TEMPERATURE/PRESSURE RELIEF VALVES

A. Temperature/Pressure Relief Valves.

1. AGA and ASME-approved, tight-shutoff, self-closing, bronze-bodied.
2. Threaded inlet and outlet.
3. Capacity: Same power as water heater. See schedule.
4. Relief setting: 99 deg C/1040 kPa 210 deg F/150 psig unless otherwise required by code.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install water heating units, expansion tank and digital mixing valve in accordance with manufacturer's instructions.
- B. Install units to allow complete access for servicing including removal of heater sections.
- C. Set thermostat so heater will deliver scheduled leaving water temperature.

END OF SECTION

SECTION 22 42 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Plumbing Fixtures, as indicated, in accordance with provisions of Contract Documents.
- B. Definitions:
 - 1. Aerator: Device that mixes room air with faucet's water stream.
 - 2. Ledge mounted faucet: Faucet with body mounted on top of faucet ledge and covered by faucet housing or single escutcheon.
 - 3. Bottom-mounted faucet: Faucet with body mounted beneath faucet ledge; each penetration is covered by single escutcheon.
 - 4. Semi-cast: Fittings, return bends, and nuts are cast brass. Waste arms and wall bends are tubular.
- C. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Assemble submittals by mark number. Include sufficient information to verify compliance with descriptions.
 - 2. Where model numbers differ from descriptions, submit to meet description requirements:
 - a. Electric water coolers.
 - b. Lavatories.
 - c. Mixing valves.
 - d. Sinks.
 - e. Standpipe and supply boxes.
 - f. Urinals.
 - g. Wall hydrants.
 - h. Water closets.
 - i. Undersink protective covers.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - a. See Section 01 78 23.

1.3 QUALITY ASSURANCE

- A. Manual Valve Standards:
 - 1. See Section 23 05 23, for valves .
- B. Design and Installation Standards:
 - 1. ASSE 1016: Individual Thermostatic Pressure Balancing, and Combination Pressure Balancing and Thermostatic Control Valves for Individual Fixture Fittings.
 - 2. ASSE 1017: Temperature Actuated Mixing Valves for Hot Water Distribution Systems.
 - 3. ASSE 1070: Performance Requirements for Water Temperature Limiting Devices.
 - 4. NSF standard: Comply with NSF 61: "Drinking Water System Components-Health Effects", for fixture materials that will be in contact with potable water.
- C. Accessibility Manufacturing and Installation Standards:

1. Americans with Disabilities Act (Public Law 101-336).
2. ANSI-A117.1, current edition.
3. Local authorities.
4. State authorities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Electric Water Coolers and Drinking Fountains:

1. Base:
 - a. Halsey-Taylor.
2. Optional:
 - a. Elkay Manufacturing.
 - b. Haws Corporation.
 - c. EBCO Manufacturing (Oasis).
 - d. Sunroc.

B. Sensor Operated Faucets:

1. Base:
 - a. Sloan Valve.
2. Optional:
 - a. Chicago Faucet.
 - b. Hydrotek.

C. Molded Stone, Precast Terrazzo, Fiberglass Reinforced Polyester Fixtures:

1. Base:
 - a. Fiat.
2. Optional:
 - a. Creative Industries Terrazzo Products.
 - b. Stern and Williams.
 - c. Swan.
 - d. Mustee & Sons, EL.

D. Stainless Steel Fixtures:

1. Base:
 - a. Elkay Manufacturing.
2. Optional:
 - a. [Just Manufacturing](#).
 - b. Southern Kitchens.

E. Vitreous China Fixtures:

1. Base:
 - a. [American Standard Plumbing](#).
2. Optional:
 - a. Eljer Plumbingware.
 - b. Kohler.

F. Fixture Carriers:

1. Base:
 - a. Wade.

2. Optional:
 - a. Watts/Ancon.
 - b. Jonespec.
 - c. Josam.
 - d. J R Smith.
 - e. Zurn Industries.

G. Flow Control Devices:

1. Base:
 - a. Same as installed faucet or shower head.
2. Optional:
 - a. American Standard Plumbing.
 - b. Chicago Faucet
 - c. Crane Plumbing.
 - d. Coyne & Delany.
 - e. Delta Commercial.
 - f. Eljer Plumbingware.
 - g. Hydrotek.
 - h. Kohler.
 - i. Omni.
 - j. Sloan Valve.
 - k. T&S Brass & Bronze Works.

H. Flushometer Valves:

1. Base:
 - a. Sloan Valve.
2. Optional:
 - a. Coyne & Delany.
 - b. Zurn Industries.

I. Thermostatic Mixing valves:

1. Base:
 - a. Symmons.
2. Optional:
 - a. Lawler Manufacturing.
 - b. Leonard Valve.
 - c. Powers.

J. Wall and Yard Hydrants:

1. Base:
 - a. Wade.
2. Optional:
 - a. Watts-Ancon.
 - b. Jonespec.
 - c. Josam.
 - d. J R Smith.
 - e. Woodford Manufacturing.
 - f. Zurn Industries.

K. Water Closet Seats:

1. Base:
 - a. Beneke.
2. Optional:
 - a. Bemis.
 - b. Centoco.
 - c. Church.
 - d. Olsonite.
 - e. Sperzel.

L. Undersink Protective Covers:

1. Base:
 - a. Truebro.
2. Optional:
 - a. McGuire.

M. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Construct or equip fixtures with air gap or anti-siphon devices to prevent siphoning non-potable water into potable water supply system.
- B. Piping exposed in finished areas including fittings and trim:
 1. See Section 22 10 16.
- C. Dimensions:
 1. Dimensions are Nominal.
 2. Multiple dimensions:
 - a. First dimension: Side-to-side.
 - b. Second dimension: Front-to-back.
 - c. Third dimension: Top-to-bottom.
- D. Manufacture accessible fixture assemblies to meet requirements of accessibility standards.
- E. Faucets - General:
 1. Following general conditions apply unless detailed otherwise in specific descriptions:
 - a. Renewable cartridges with integral seats (or renewable seats and stems).
 - b. Materials:
 - 1) Brass, bronze, copper, stainless steel, ceramic.
 - 2) Plastic components are not acceptable.
 - c. Finish:
 - 1) Chrome.
 - d. Gooseneck spouts:
 - 1) Discharge at least 5 inches above rim of fixture.
 - e. Electric, sensor-operated faucets:
 - 1) Mount transformer and control panel in concealed but accessible location.
 - 2) Coordinate with Electrical and Casework contractors.
 - f. If mixing valve is not included in faucet description, provide a tempering, under-counter mixing valve. Mechanical mixing valves shall not be used.

- g. Comply with NSF 61- "Drinking Water System Components – Health Effects" for fixture materials that will be in contact with potable water.
 - 2. Metering valve faucets:
 - a. Adjustable run time.
 - b. Self-closing.
- F. Flow Control Devices - General:
- 1. Provide flow control devices with indicated maximum flow rates on listed fixtures:
 - a. Public lavatory:
 - 1) Non-metering: 0.5 gpm.
 - 2) All locations shall be considered public, except as specifically identified above for private.
 - b. Sinks: 2.2 gpm at 60 psi.
 - 2. Material: Brass.
 - 3. Finish: Chrome.
 - 4. Accomplish controlled flow without aeration of water stream. Aerators are not acceptable unless specifically identified in the faucet description.
 - 5. Flow control devices shall be disinfectable.
 - 6. Comply with NSF 61- "Drinking Water System Components – Health Effects" for fixture materials that will be in contact with potable water.
- G. Lavatory Fixtures - General:
- 1. Following general conditions apply unless detailed otherwise in specific descriptions:
 - a. Vitreous china and enameled, cast-iron fixtures:
 - 1) Color: White.
 - 2) Overflows: Integral.
 - b. Stainless steel fixtures:
 - 1) Finish: Softsatin.
 - 2) Type: 302 (18-8) or 304 (18-8).
 - 3) Thickness: 20 GA.
 - 4) Sound deadening that covers complete underside of bowl.
 - c. Provide integral faucet ledge with holes:
 - 1) Coordinate hole quantities, locations, and centering with faucet types indicated in fixture descriptions.
 - 2) Provide exact number of holes necessary.
 - a) Use of faucet hole covers is not acceptable.
- H. Mixing Valves - General:
- 1. Following general conditions apply unless detailed otherwise in specific descriptions:
 - a. Materials:
 - 1) Brass, bronze, copper, stainless steel, ceramic.
 - 2) Thermostatic mixing valves:
 - a) Thermostat may contain plastic parts.
 - 3) Escutcheon may be pot metal.
 - b. Finish of exposed surfaces:
 - 1) Chrome.
 - c. Hot/cold color coding.
 - d. Coordinate number of ports with trim indicated in fixture descriptions.
 - 1) Four-port valves:

- a) If diverter spout is indicated in fixture description, provide built in choke.
 - b) If external diverter valve is indicated in fixture description, provide without choke.
- e. Comply with NSF 61- "Drinking Water System Components – Health Effects" for fixture materials that will be in contact with potable water.
- f. Tempering Type Mixing Valve:
 - 1) ASSE 1016 Type: T/P.
 - 2) Integral checks and service stops on inlets.
 - 3) Inlet screens: stainless steel.
 - 4) Adjustment: adjustable locking type.
 - 5) Connections:
 - a) 3/8 inches.
 - 6) Example:
 - a) Powers model e480.
- g. Pressure Balanced Mixing Valves:
 - 1) Renewable stainless steel piston with brass seat.
 - 2) Integral checks and service stops on inlets.
 - 3) Temperature control with built-in shut off; opens from cold to hot.
 - 4) Single lever handle.
 - 5) Adjustable, temperature-limit stops.
 - 6) "OFF-COLD-HOT" marking in block type letters minimum 7/32 inches high.
- h. Thermostatic Mixing Valves:
 - 1) ASSE 1017 compliant.
 - 2) Renewable thermostatic and pressure-balance elements.
 - 3) Compensates for changes in both temperature and pressure.
 - 4) Integral checks and service stops.
 - 5) Temperature control with built-in shut off; opens from cold to hot.
 - 6) Single lever handle.
 - 7) Adjustable, temperature-limit stops.
 - 8) "OFF-COLD-HOT" marking in block type letters minimum 7/32 inches high.
- 2. Mixing Valve Trim - General:
 - a. Cabinets:
 - 1) Stainless steel construction.
 - 2) Hinged doors:
 - a) Removable when in the open position.
 - b) Hinge on side.
 - 3) Size cabinets to hold valve and accessories as required in each description.
 - b. Thermometers:
 - 1) 3-1/2 inches dial.
 - 2) Hermetically sealed.
 - 3) Bimetal element.
 - 4) Range: Minus 0 to 140 deg F.
 - 5) Construction: Welded stainless steel.
 - 6) White-faced, three-color dial.
 - c. Vacuum breakers and valves:
 - 1) See "Faucets, general" in Article 2.01.

3. Semi-cast P-traps and Continuous Wastes:

- a. P-trap:
 - 1) Semi-cast:
 - 2) 1-1/4 or 1-1/2 inches NPS cast brass return bend with clean out.
 - 3) 17 GA x 1-1/4 or 1-1/2 inches OD copper tube tailpiece.
 - 4) Nuts: Cast brass.
- b. Continuous Waste:
 - 1) Semi-cast:
 - 2) 1-1/2 inches NPS cast brass tee.
 - 3) 17 GA x 1-1/2 inches OD copper tube tailpieces.
 - 4) Nuts:
 - a) Cast brass.

I. Sink Fixtures - General:

1. Following general conditions apply unless detailed otherwise in specific descriptions:

- a. Vitreous china: White.
- b. Stainless steel:
 - 1) Finish: Softsatin.
 - 2) Type: 302 (18-8) or 304 (18-8).
 - 3) Sound deadening that covers complete undersides of each bowl.
 - 4) Thickness:
 - a) Sink depth less than or equal to 10 inches: 18 GA.
 - b) Sink depth greater than 10 inches: 16 GA.
- c. Molded stone and terrazzo:
 - 1) Marble chips in reinforced Portland cement.
 - a) 7-day compressive strength:
 - (1) 3000 psi.
 - b) Exposed surfaces:
 - (1) Ground smooth, grouted and sealed to resist staining.
 - 2) Drain body opening: Integrally cast.
 - 3) Color:
 - a) As selected from manufacturer's standard line by Architect.
- d. Enameled cast-iron:
 - 1) Color: White.
- e. Countertop sinks:
 - 1) Self-rimming.
- f. Provide integral faucet ledge with holes:
 - 1) Coordinate hole quantities, locations, and centering with the following:
 - a) Faucets and trim indicated in fixture descriptions.
 - b) Hot-water dispensers.
 - c) High-purity water faucets.
 - 2) Provide exact number of holes necessary.
 - a) Use of faucet hole covers is not acceptable.

2.3 PLUMBING FIXTURES

A. See Plumbing Fixtures on Drawings

PART 3 - EXECUTION

3.1 GENERAL

- A. Install fixtures in first class manner with proper connections to water, drainage, and vent systems.
- B. Install fixtures at manufacturer's suggested height unless noted otherwise.
- C. Install fixtures in accordance with manufacturers' instructions.
- D. See that proper grounds are set to form a secure base and an absolutely rigid setting for each fixture.
- E. Provide guards and boxing as may be required to protect fixtures against damage from operations of other trades.
- F. Where pipes penetrate walls, floors, or ceilings, conceal penetrations with chrome escutcheons or stainless steel plates.
- G. Connect exposed traps and supply pipes for fixtures and equipment to rough piping systems at wall, unless otherwise specified.
- H. Where plumbing fixtures abut to walls, floors, and countertops, seal with silicone sealant: See Section 07 92 16.
- I. On flushometer valves with pipe supports, mount pipe support to wall two-thirds of flush-valve height above fixture spud.
- J. Provide undersink protective covers on water supply and waste lines exposed beneath accessible fixtures.

3.2 FIXTURE CARRIER LEVELING

- A. Level fixture carriers by shimming floor anchors with steel washers of varying thicknesses.

3.3 ACCESSIBLE FIXTURES

- A. Install accessible fixture assemblies to meet requirements of accessibility installing standards.

3.4 WATER CLOSET FIXTURE CARRIERS

- A. Install each carrier to accept accessible and standard-height water-closet installations so that future change from one height to the other can be accomplished by adjusting only the position of the face plate.

3.5 ADJUST AND CLEAN

- A. Valves with adjustable temperature-limit stop: Adjust stop to deliver maximum 110 deg F.
- B. Remove dirt from fixtures, fittings, and traps.
- C. Secure escutcheons against wall.

END OF SECTION



DIVISION 23

HEATING, VENTILATING, AND AIR
CONDITIONING (HVAC)



SECTION 23 05 00
SPECIAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Special Mechanical Requirements, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.
- C. Systems Included:
 - 1. Special mechanical requirements.
 - 2. Products:
 - a. Access doors, panels, and frames.
 - b. Covers for exposed vertical piping.
 - c. Equipment guards.
 - d. Motors and controls.
 - e. Rain hoods and counter flashings.
 - f. Penetrations.
- D. Drawings Use and Interpretation:
 - 1. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except when specifically dimensioned or detailed.
 - 2. For exact locations of building elements, refer to dimensioned architectural/structural drawings.
 - 3. Field measurements take precedence over dimensioned drawings.
 - 4. Piping and ductwork plans are intended to indicate size, capacity, approximate location, direction, and general relationship of one work phase to another, but not exact detail or arrangement.
 - 5. Field verify locations and arrangement of existing systems and equipment.
- E. Installation of Systems and Equipment:
 - 1. Installation is subject to clarification as indicated in reviewed Shop Drawings and Field Coordination Drawings.
 - a. Generally, lay out piping requiring gravity drainage first; then lay out large pipe mains, ductwork, and electrical conduit.
 - b. This procedure is intended to promote orderly installation, but not to establish trade precedence.
 - c. Dimensions indicated are limiting dimensions.
 - d. Do not use equipment exceeding dimensions indicated on detail drawings or arrangements that reduce required clearances or exceed specified maximum dimensions.
 - e. In mechanical equipment room aisles, maintain clear head room between floor and underside of ducts, pipes, and equipment to allow for future replacing of equipment and major components (e.g., coils, fans, heat exchangers, pumps).
- F. Description of Systems:
 - 1. Provide materials resulting, upon completion, in functioning systems in compliance with performance requirements specified, and modifications resulting from reviewed Shop and Field Coordination Drawings.

1.2 SUBMITTALS

A. Shop Drawings:

1. Structural steel support drawings and calculations signed and sealed by Specialty Structural Engineer.

1.3 QUALITY ASSURANCE

A. Perform work in accordance with following codes:

1. State and local building, plumbing and mechanical codes.
2. National Electrical Code.
3. Authorities Having Jurisdiction (AHJ).

B. Use only prime quality, new materials, apparatus, and equipment.

1.4 JOB CONDITIONS

A. Avoid interference and interruption of existing utilities and services.

1. Schedule work which will cause interference or interruption in advance with Owner, Construction Manager, Architect, authorities having jurisdiction, and affected contractors.

B. Keep roads clear of materials and debris.

C. Examine Contract Documents to determine how other work will affect execution of mechanical work.

D. Examine site and become familiar with existing local conditions affecting work.

E. Determine and verify locations of existing utilities on or near site.

F. Make arrangements for and pay for necessary permits, licenses, and inspections.

G. Record drawings:

1. Keep a complete set of mechanical drawings in job site office for indicating actual installation of mechanical systems and equipment.
2. Use this set of drawings for no other purpose.
3. Where material, equipment, or system components are installed differently from that indicated, indicate such differences clearly and neatly.
4. At project completion, submit record set of drawings in accordance with Division 01.

H. Operation and Maintenance Data:

1. See Division 01.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Motors:

1. Base:
 - a. Reliance Electric.
2. Optional:
 - a. Baldor.
 - b. Century Electronics; E-Plus.
 - c. General Electric; Energy Saver.
 - d. Westinghouse Motor.

B. Shaft grounding ring for motors:

1. Base:
 - a. Aegis.

C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MOTORS AND CONTROLS

A. Motors:

1. Provide motors indicated in Mechanical Specification Divisions.
2. Ball or roller bearing type, premium efficiency type.
3. Starting and running characteristics consistent with torque and speed requirements of driven machine.
4. Motor efficiency:
 - a. NEMA Standard MG-1, part 31.
 - b. Indicate full load efficiency on each nameplate.
5. Rated in accordance with NEMA performance standards to carry full nameplate load continuously at maximum temperature rise of 40 degrees C above ambient with service factor of 1.15.
6. Motor powers as scheduled.
7. Do not allow power requirements of driven machine to exceed nominal nameplate rating of motor furnished.
8. Do not include service factor when selecting motor power.
9. Motors 1/2 hp and over: 460/3/60.
10. Motors less than 1/2 hp: 115/1/60.
11. Provide for items which require electric drive.

B. Motors for use with variable frequency drives (VFDs):

1. Provide with following to prevent bearing current damage:
 - a. Shaft grounding ring:
 - 1) Discharges shaft currents to ground through use of frictionless conductive microfibers surrounding motor shaft.
 - 2) Maintenance required: none.
 - 3) Design to last for service life of motor.
 - 4) RPM limitation: none.
 - 5) Manufacturer: Aegis SGR.
2. Motors used with variable frequency drives and controls, shall be Inverter Duty with cast iron housing and 1.15 service factor at varying speeds with adjustable frequency. Provide transient spike resistant winding insulation varnish. These motors shall be selected by variable frequency drive manufacturer and supplied by manufacturer of the controlled equipment.
 - a. Insulated isolated bearings integral to the motor.

C. Motor controls and wiring for controls:

1. Provide complete installation of controls and wiring for controls for Mechanical Specification Divisions packaged/pre-wired equipment.
 - a. Include line voltage controls, low voltage controls, control switches, starters, disconnects, conduit, and wiring.
 - b. Locate disconnects on outside of equipment enclosures or guards.
2. Starters, disconnects, conduit, and wiring furnished under Mechanical Specification Divisions shall comply with applicable Electrical Specification Divisions.
3. Where equipment is specified with packaged/pre-wired controls but is furnished instead with loosely shipped components that require field wiring, coordinate complete installation and assume costs.

2.3 RAIN HOODS AND COUNTER FLASHINGS

- A. Rain hoods and counter flashings not exposed to view:
 - 1. Stainless steel: Minimum 20 GA.
 - 2. Sheet copper: Minimum 24 oz/SF.

2.4 PENETRATIONS

- A. Maintain fire and smoke ratings where mechanical items penetrate fire and fire/smoke rated building elements.

2.5 STRUCTURAL STEEL FOR SUPPORTS

- A. Assume engineering responsibility for design of steel supports.
- B. Engineer Qualifications: Comply with Section 01 71 21, Specialty Engineering Requirements
- C. Design units and connections to satisfy requirements of applicable Building Codes.
- D. Design units and connections capable of withstanding the following design loads as shown on structural drawings within limits and under conditions indicated:
 - 1. Include effect from adjacent attached construction.
 - 2. Wind pressure, and/or earthquake lateral forces.
 - 3. Live Loads.
 - 4. Dead load of unit plus superimposed loads.
- E. Structural Steel for Supports:
 - 1. Comply with ASTM A36.
 - 2. Galvanize members installed in fan plenums or areas of high humidity or condensation, and outside.
 - 3. Furnish other members with shop coat of rust inhibiting primer.
 - 4. Shop fabricate for field assembly using bolts.
 - 5. Minimize field welding.
 - 6. Retouch primer after field welding.

PART 3 - EXECUTION

3.1 GENERAL

- A. When changes in location of work are required, obtain approval of Architect before making change.
 - 1. Make changes at no extra cost.
- B. Provide necessary offsets and crossovers in piping and ductwork, whether indicated or not.
- C. Install piping and ductwork parallel to walls and vertically plumb.
- D. Do not change indicated sizes without approval of Architect.
- E. Electrical equipment:
 - 1. Maintain space above electrical equipment rooms and closets clear of ductwork and piping.
 - 2. Maintain space above panelboards, switchboards, motor control centers, or motor control panels clear of ductwork and piping.
- F. In elevator machine rooms, install no piping except floor drains and fire protection piping that specifically serves the room.
- G. Roof penetrations:
 - 1. Make penetrations through roofs prior to installation of roofing.
 - 2. For penetrations required after installation of roofing:

- a. In built up roofing (BUR), provide curbs, cants, and counter flashings.
- b. In elastic sheet roofing (ESR), arrange and pay for flashing work by authorized roofer; provide counter flashings.
3. Repair and replace roof construction which is damaged by this work in manner which will not nullify roof warranty.

3.2 LOCATING SERVICEABLE DEVICES

- A. Install devices, which may require adjustment or service maintenance, in accessible locations or provide flush-mounted access doors.
 1. Such devices include but are not limited to equipment, valves, filters, motors, drives, compressors, unions, traps, strainers, thermometers, gauges, switches, measurement devices, coils, detectors, dampers, sensors, monitors, backflow prevention devices, drains, floor sinks, cleanouts, test stations, signal devices, sprinkler heads, air vents, expansion joints, and system drains.
 2. Arrange piping, conduit, ducts, and related work to facilitate maintenance.
 3. Relocate items which interfere with access.

3.3 EXCAVATING AND BACKFILLING

- A. See Section 31 23 00 - Trenching.
- B. Perform excavating and backfilling for work in accordance with Section 31 23 00.
- C. Perform excavating and backfilling for work in accordance with Section 31 23 00.

3.4 INSTALLATION OF EQUIPMENT

- A. Install equipment in accordance with manufacturer's recommendations and as specified.
- B. Provide necessary anchoring devices and supports.
 1. Use structural supports suitable for equipment, or as indicated.
 2. Check loadings and dimensions of equipment with shop drawings.
 3. Do not cut building structural members.
 4. Provide equipment supports even though not detailed on architectural and structural drawings.
- C. Equipment Bracing:
 1. See Section 23 05 48.
- D. Coordinate fit of equipment support with layouts indicated.
 1. Where substitute equipment is used, revise indicated supports to fit.
- E. Arrange for necessary openings to allow entry of equipment.
 1. Where equipment cannot be installed as structure is being erected, provide and arrange for building in of boxes, sleeves, or other devices to allow later installation.
- F. Install rain hoods and metal counter flashings as indicated, and to make penetrations of mechanical work through walls and roofs water and weathertight.
 1. Furnish clamps, waterproofing material, and labor.
 2. Where metal flashings are applied over concrete, paint concrete with 1/8 inches of mastic cement first.
 3. Set flashing in mastic cement, watertight.
- G. Provide concrete foundations (isolation pads) or housekeeping pads for mechanical equipment as follows unless indicated otherwise:
 1. Install 4 inches high concrete housekeeping pads. Outside dimension of pad shall be at least 4 inches larger in all directions than base of equipment or 9 inches from center of anchor, whichever is greater.

2. Use 3,000 psi concrete.
3. Reinforce with No.4 bars, 12 inches on-center each way, with short No.4 dowels into floor at 24 inches on-center each way.
4. Chamfer top edges 3/4 inches.
5. Make faces smooth.
6. Set anchor bolts for equipment.

3.5 FIELD QUALITY CONTROL

- A. Perform indicated tests to demonstrate workmanship, operation, and performance.
 1. Conduct tests in presence of Architect and, if required, inspectors of agencies having jurisdiction.
 2. Arrange date of tests in advance with Architect, manufacturer, and installer.
 3. Give inspectors minimum of 24 hours' notice.
 4. Furnish or arrange for use of electrical energy, steam, water, or gas required for tests.
 5. Furnish materials required for test.
- B. Repair or replace equipment and systems found inoperative or defective and retest.
 1. If equipment or system fails retest, replace it with products conforming to Contract Documents.
 2. Continue remedial measures and retests until satisfactory results are obtained.
- C. Test equipment and systems for each item, unless otherwise recommended by manufacturer.
 1. Tests specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC need not be duplicated under other sections.

3.6 ADJUST AND CLEAN

- A. Inspect equipment and put in satisfactory working order.
- B. Clean exposed and concealed items: See Section 01 74 23 Cleaning.
 1. Clean air surfaces of coils, fans (including fan wheels and motors), air handler plenums and air filter frames.
 2. Clean floor drains, cleanouts, and plumbing fixtures.
 3. Clean specialties such as traps and strainers and equipment surfaces such as pumps, motors, boilers, chillers, etc.
 4. Clean piping of tags, debris, and other construction materials before insulating or painting.
 5. Clean debris including dirt and sand out of ductwork.

3.7 PUTTING SYSTEMS IN OPERATION - START-UP

- A. Prior to substantial completion and building occupancy, at time agreed to by Owner and Architect, put systems into satisfactory operation.
 1. At first heating or cooling season following substantial completion, put systems not yet operated under their seasonal loads into satisfactory operation.
- B. Operate systems in satisfactory working order for period of 10 working days.
 1. After the 10 days, clean debris including dirt and sand out of ductwork.

3.8 PROTECTION

- A. Provide covering and shielding for equipment provided to protect from damage.
- B. Repair, restore and replace damaged items.
- C. Protect nameplates on motors, pumps, and similar equipment.
- D. Protect plumbing fixtures and brass or chromium plated trim, valves, and piping from damage.

- E. Keep dirt and debris out of pipes and ducts by capping or plugging open ends.
 - 1. Keep plug or cap in place until final connections are made.

END OF SECTION

SECTION 23 05 10
MECHANICAL ACCESS PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Access Panels, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Project Information:
 - 1. Manufacturer of listed products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Access Panels:
 - 1. Base:
 - a. Milcor.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Sizes: 300 mm x 300 mm 12 inches x 12 inches minimum; as indicated; or as required to allow inspection of items served.
- B. Wall access panel: Type 3.
 - 1. Frame 1.5 mm 16 GA, panel 0.9 mm 20 GA insulated.
 - 2. Continuous hinge with stainless steel pin.
 - 3. Self latching, automatic closing mechanism, inside release.
 - 4. Key operated cylinder lock with 2 keys.
 - 5. Factory attached masonry anchors for masonry, 13 mm x 100 mm 1/2 inches x 4 inches studs for concrete, 2 per side.
 - 6. Baked enamel prime coat over phosphate coated steel.
 - 7. 1.5 hour fire rated.
- C. Ceiling access panel: Type 4.
 - 1. Frame 1.5 mm 16 GA, panel 1.9 mm 14 GA, 0.75 mm 22 GA casing bead.
 - 2. Two concealed spring loaded hinges allowing panel to open 175 degrees.
 - 3. Two screwdriver operated cam locks and 2 key operated cylinder locks, 2 keys.
 - 4. 80 mm 3-1/8 inches wide expansion casing bead, 32 mm 1-1/4 inches ground.
 - 5. Finish: Cleaned, rust inhibitive treated, baked prime paint.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions where work is to be installed.
- B. Report unsatisfactory conditions.

C. Do not start work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Install as indicated on Drawings and where else required. Coordinate locations in field with Architect.

END OF SECTION

SECTION 23 05 15
VARIABLE FREQUENCY DRIVES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Variable Frequency Drives and Controls in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 RELATED WORK

- A. Furnish drives, as indicated in drawing equipment schedules.
 - 1. Refer to Section 23 31 13 for installation.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings:
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VFD. Provide schematic wiring diagram for each type of VFD. Clearly identify all terminal blocks for interface with Section 25 10 00.
- C. Project Information:
 - 1. Certificates: Burn in time and factory performance tests for drives.
 - 2. Start-Up Report.
 - 3. Demonstration and Instruction Statement from Owner.
 - 4. Operation and Maintenance Data submitted to owner prior to equipment delivery.
 - 5. Special Warranty: Provide five year manufacturer's warranty on entire package from day of start-up. Include all materials, parts, and labor.
 - 6. Technical drawings, programming and codes as required by Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: Furnish set of three of each type and rating.
 - 2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Allen Bradley.
- B. Asea Brown Boveri (ABB).
- C. GE.
- D. Square D.
- E. Yaskawa.

2.2 SYSTEM DESCRIPTION

- A. Variable speed drives for each piece of equipment as scheduled.
- B. Control signals from BAS to each variable speed drive shall automatically sequence units and modulate speed in response to system dynamics.
 - 1. Refer to Section 25 10 00.
- C. Components and accessories as required for BAS interface and control per Section 25 10 00 and the Contract Drawings for a complete and operable system.

2.3 GENERAL REQUIREMENTS

- A. Standard Operating Conditions:
 - 1. Power: Voltage per equipment motor schedule, 3-Phase, 60 Hertz.
 - 2. Voltage Variation: +10 percent to -15 percent.
 - 3. Frequency Variation: ± 2 percent.
 - 4. Ambient Relative Humidity: 0 to 95 percent, non-condensing.
 - 5. Altitude: To minimum 3300 feet above sea level.
 - 6. Ambient Temperature: -10 to 40 deg C (14 to 104 deg F).
 - 7. Overload Capability: 115 percent of rated FLA (Full Load Amps) for 60 seconds; 150 percent of rated FLA, instantaneously.
 - 8. VFD shall include a power loss ride through of 2 seconds.
 - 9. Driven motors shall be inverter duty, premium efficiency type with class F insulation.
- B. Source Quality Control:
 - 1. Factory test components for proper function. Integrated circuits shall have a minimum burn in time of 125 hours. Actuate completed unit for a minimum of 24 hours for performance verification prior to shipment.
 - 2. Completed unit shall comply with latest applicable standards of NEC, NEMA, IEEE and ANSI.
- C. Drive Features:
 - 1. VFD shall incorporate a PWM (pulse width modulation) power modulation system incorporating IGBT technology. VFDs serving motors rated 100 hp and greater will be provided with 12 pulse rectifier inputs. For motors less than 100 hp, six pulse rectifier inputs are acceptable. Provide 5 percent input line reactors.
 - 2. NEMA 1 enclosure for wall mounting or freestanding applications, with integral main disconnect, fused switch with lockable handle.
 - 3. Copper compression lugs for power terminations. T&B 54,000 or Burndy.
 - 4. Speed range output: 6 to 70 Hz.
 - 5. Displacement Power Factor: 0.98 over entire range of operating speed and load.
 - 6. Minimum Efficiency: 98 percent at full speed, 96 percent at half speed.
 - 7. Starting Torque: 100 percent starting torque available from 1 to 60 Hz.

8. Adjustable acceleration/deceleration rate.
9. Electronic thermal overload protection for both the drive and motor. The electronic thermal motor overload shall be approved by UL. If the electronic thermal motor overload is not approved by UL, a separate UL approved thermal overload relay shall be provided in the VFD enclosure.
10. Phase loss protection, over frequency protection, AC input line under voltage protection, DC over voltage protection, short circuit protection, ground protection, line surge protection, over temperature protection.
11. Disconnecting means with operating handle lockable in the off position. Disconnecting means will disconnect operating and control power to the unit.
12. VFDs must have a minimum short circuit rating of 65K amps RMS (100K amps RMS with a DC bus reactor) without additional input fusing.
13. Status and Fault Indicator Display.
14. Hand/Off/Auto switch with either a manual speed potentiometer or "Increase/Decrease" buttons on the operator keyboard.
15. For supply fan applications, provide an outside and discharge air isolation damper control circuits in accordance with contract documents. Upon a start signal from BAS when drive is either in the Auto mode, or in the local Hand mode, control circuit shall immediately energize the outside air isolation damper power circuit. Once outside air damper is open and proven open by the damper limit switch, which is hardwired into the VFD, VFD shall slowly ramp the fan to 15 Hz. VFD shall use the BAS control signal in the Auto mode or the local speed switch when VFD is in the hand mode. Once fans speed is above 15 Hz (adjustable), VFD shall command the discharge isolation damper open. Once discharge damper is open and proven open by the damper limit switch, which is hardwired into the VFD, VFD shall allow the fan to increase in speed above 20 hertz (adjustable). Damper circuits shall be operable in hand, and auto positions. Coordinate with BAS contractor for safety interlock requirements.

D. VFD Control Features:

1. VFD shall employ microprocessor based inverter logic.
2. VFD shall include a front mounted, sealed keypad operator, with an English language illuminated LCD display. The operator will provide complete programming, program copying, operating, monitoring, and diagnostic capability. Keys provided shall include industry standard commands for Hand, Off, and Remote Start functions.
3. Provide manual selection method to locally adjust output speed through a potentiometer mounted on the drive face.
4. Display shall provide readouts of; output frequency in hertz, PID feedback in percent, output voltage in volts, output current in amps, output power in kilowatts, D.C. bus voltage in volts, interface terminal status, and fault codes. All displays shall be viewed in an easy-to-read illuminated LCD with International language selection.
5. Meters to estimate use of energy:
 - a. Elapsed Time Meter.
 - b. Kilowatt Meter.
 - c. Kilowatt Hour Meter.
6. VFD shall include PI control logic, to provide closed loop setpoint control capability, from a feedback signal, eliminating the need for closed loop output signals from a building management system. The PI controller shall have a differential feedback capability for closed loop control of fans and pumps for pressure, flow, or temperature regulation in response to dual feedback signals.
7. VFD shall include loss of input signal protection, with a selectable response strategy including speed default to a percent of the most recent speed.
8. VFD shall include electronic thermal overload protection for both the drive and motor. The electronic thermal motor overload shall be approved by UL. If the electronic thermal motor

overload is not approved by UL, a separate UL approved thermal overload relay shall be provided in the VFD enclosure.

9. VFD shall include the following program functions:
 - a. Critical frequency rejection capability: Three selectable, adjustable deadbands.
 - b. Auto restart capability upon return of power source: 0 to 10 attempts with adjustable delay between attempts.
 - c. Ability to close fault contact after the completion of all fault restart attempts.
 - d. Stall prevention capability.
 - e. "S" curve soft start capability.
 - f. Bi-directional "Speed search" capability, in order to start a rotating load.
 - g. 4 preset and 1 custom volts per hertz pattern.
 - h. Heatsink over temperature speed fold back capability.
 - i. Terminal status indication.
 - j. Program copy and storage in a removable digital operator.
 - k. Current limit adjustment capability, from 30 percent to 200 percent of rated full load current of the VFD.
 - l. Input signal or serial communication loss detection and response strategy.
 - m. Anti "wind-milling" function capability.
 - n. Undertorque/Overtorque Detection.
 - o. Critical frequency avoidance capability.

E. RFI Compliance:

1. Line filters in accordance with FCC regulations on RFI/EMI emissions for Class A devices.

2.4 BUILDING AUTOMATION SYSTEM (BAS) AND CONTROL INTERFACE

- A. All connections to be by a quick disconnect, removable control I/O terminal block to simplify control wiring procedures.
- B. VFD shall include two independent analog inputs. One shall be 0-10 VDC. The other shall be programmable for either 0-10 VDC or 4-20 mA. Either input shall respond to a programmable bias and gain.
- C. VFD shall include a minimum of seven multi-function digital input terminals, capable of being programmed to determine the function on a change of state. These terminals shall provide up to 30 functions, including, but not limited to:
 1. Remote/Local operation selection.
 2. Detection of external fault condition.
 3. Remote Reset.
 4. Multi-step speed commands.
 5. Run permissive.
- D. VFD shall include two 0-10 VDC analog output for monitoring, or "speed tracking" the VFD. The analog output signal will be proportional to output frequency, output current, output power, PID (Proportional, Integral, Derivative control) feedback or DC bus voltage.
- E. VFD shall provide terminals for remote input contact closure, to allow starting in the automatic mode.
- F. VFD shall include at least one external fault input, which shall be programmable for a normally open or normally closed contact. These terminals can be used for connection of firestats, freezestats, high pressure limits or similar safety devices. Design unit so that when operating in hand position, any actuated safety device will disable unit.
- G. VFD shall include two form "A" contacts and one form "C" contact, capable of being programmed to determine conditions that must be met in order for them to change state. These

output relay contacts shall be rated for at least 1A at 250 VAC. One set of contacts shall be programmed to transfer upon any of the following conditions:

1. Missing frequency reference detection.
 2. Overtorque/Undertorque detection.
 3. Loss of Load.
 4. Drive Faulted.
- H. Contacts wired to shut down unit on signal from remote disconnect.
- I. VFD shall have embedded Building Automation System (BAS) protocols for network communications; Johnson Metasys N2, Alerton or Automated Logic Corporation. These protocols shall be accessible via an RS-422/485 communication port. Coordinate with the Section 25 10 00 for appropriate BAS manufacturer.
- J. BAS System Interface (Each Drive):
1. Coordinate with Section 25 10 00 to provide compatible isolated or non-isolated I/O points.
 2. Following signals shall be hardwired from BAS Controller to VFD:
 - a. Fan start permissive (digital input).
 - b. Speed control signal for fan applications (analog input).
 3. Following signals, as a minimum, may use the network interface for direct communications, or provide for hardwired connections per point:
 - a. Provide system alarm circuit for remote alarm signal of general failure (digital output).
 - b. Individual fan status, based on positive feedback on load side of motor (digital output) to BAS via current sensing relays. Relays to be provided with drive. Current switch to distinguish between low speed and a broken belt.
 - c. Output frequency or percent speed output (analog output).
 - d. VFD H-O-A in Auto Position (digital output).
 - e. KWH (totalized signal).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide wiring from control centers to drives and from control centers to instrumentation.

3.2 SYSTEM START-UP

- A. Provide services of manufacturer's representative for a minimum of 8 hours.

3.3 DEMONSTRATION AND INSTRUCTIONS

- A. Provide services of manufacturer's representative for a minimum of 8 hours.

END OF SECTION

SECTION 23 05 19

PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Piping Specialties, as indicated, in accordance with provisions of Contract Documents.
- B. Systems Included:
 - 1. Pressure gauges.
 - 2. System drains.
 - 3. Thermometer wells and test gauge connections.
 - 4. Thermometers.
 - 5. Wye strainers for hydronic systems.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Comply with applicable UL, ANSI and ASTM Standards.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Layout of piping showing expansion joints and manufacturer recommended locations for pipe anchor and guide locations.
 - 2. Include axial, lateral, and vertical stresses at anchors as calculated by expansion joint manufacturer. Stresses shall be compliant with ASME B31.1 requirements.
- B. Product Data:
 - 1. Pressure gauges.
 - 2. Thermometers.
 - 3. Wye strainers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pressure gauges:
 - 1. Base:
 - a. Weiss Instruments.
 - 2. Optional:
 - a. Terice, HO.
 - b. Marsh Instrument.
 - c. US Gauge.
 - d. Weiss Instruments.
 - e. Weksler Instruments.
 - f. Weston and Ernst.
 - g. Winters.
- B. Thermometers and Pressure Gauges:
 - 1. Base:
 - a. Weiss Instruments.

2. Optional:
 - a. Marsh Instrument.
 - b. Marshalltown Instrument.
 - c. Palmer Instruments.
 - d. Taylor Environmental Instruments.
 - e. Terice, HO.
 - f. Weiss Instruments.
 - g. Weksler Instruments.
 - h. Weston and Ernst.
 - i. Ashcroft.
 - j. Winters.
- C. Wye strainers:
 1. Base:
 - a. Armstrong International.
 2. Optional:
 - a. Armstrong International.
 - b. Spirax Sarco.
 - c. Keckley, OC.
 - d. Metraflex.
 - e. Mueller Steam Specialty.
 - f. Spence Engineering.
 - g. Victaulic of America.
- D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 PRESSURE GAUGES

- A. Pressure gauges:
 1. Steam systems and water systems operating above 150 degrees F 65 degrees C:
 - a. Case and twist ring: 4-1/2 inches 115 mm diameter, anodized aluminum.
 - b. Socket: brass.
 - c. Bourdon tube: Phosphor bronze.
 - d. Movement: Bushed Brass Rotary.
 - e. Dial: White aluminum, black markings.
 - f. Pointer: Black or red anodized aluminum, slotted adjustable.
 - g. Window: Glass.
 - a. Siphon and gauge cock (low pressure steam): brass.
 - b. Siphon and needle valve (medium and high pressure steam): brass.
 - c. Accuracy: 1.0% full scale, ASME B40.1 Grade 1A.
 - d. Range: Operating pressure to occur in middle half (25 % to 75%) of the full scale range of the fluid being measured.
 - e. Connections: 1/4 inches 6 mm or 1/2 inches 12 mm NPT.
 2. Compressed air systems and water systems operating below 150 degrees F 65 degrees C
 - a. Case and Ring: 4 inches 100mm diameter, liquid filled, type 304 stainless steel case with polished stainless steel bayonet ring.
 - b. Fill liquid: Glycerin.
 - c. Socket: Brass with push-in restrictor.
 - d. Bourdon tube: Phosphor Bronze.

- e. Movement: Brass rotary type with bushings.
 - f. Dial: White aluminum with black markings.
 - g. Pointer: Black or red anodized aluminum, adjustable.
 - h. Window: Clear acrylic.
 - i. Snubber and needle or ball valve: Chrome plated brass.
 - j. Accuracy: 1.0% full scale, ASME B40.1 Grade 1A.
 - k. Range:
 - 1) Refer to pressure range schedule except as follows:
 - a) Pump suction gauges for open piping systems where elevation difference between pump center line and liquid level of open system is less than 50 feet: Compound type, indicating at least -100 kPa to 210 kPa 30 inches Hg to 30 psiG.
 - b) Fuel oil pump suction: Compound type, indicating -100kPa to 210kPa 30 inches Hg to 30 psiG.
 - l. Connections: 6 mm 1/4 inches or 12mm 1/2 inches NPT.
3. Pressure gauge range schedule:

	Range kPa	Fig. Interval kPa	Inter. Gradu- ations kPa	Bldg. Height Stories
Chilled/condenser water	0-400	50	5	to 4
Chilled/condenser water	0-700	100	10	over 4
Heating hot water	0-700	100	10	to 4
Heating hot water	0-1200	200	20	over 4
Fire	0-3000	500	50	
Cond. pump discharge	0-700	100	10	
LP Steam	0-400	50	5	
MP Steam	0-700	50	10	
HP Steam	0-2000	200	20	
Boiler feed pump disch.	0-2000	200	20	
Flash tank	0-400	50	5	
Distilled water	0-400	50	5	
Compressed air	0-1200	200	20	
Domestic hot water	0-1500	300	20	
Domestic cold water	0-1500	300	20	
Fuel Oil Pump Discharge		0-700	100	10
	Range PSIG	Fig. Interval PSIG	Inter. Gradu- ations PSIG	Bldg. Height Stories
Chilled/condenser water	0-60	5	1	to 4
Chilled/condenser water	0-100	10	1	over 4
Heating hot water	0-100	10	1	to 4
Heating hot water	0-160	20	2	over 4
Fire	0-400	50	5	
Cond. pump discharge	0-100	10	1	
LP Steam	0-60	5	1	
MP Steam	0-100	5	1	
HP Steam	0-300	25	5	
Boiler feed pump disch.	0-300	25	5	
Flash tank	0-60	5	1	
Distilled water	0-60	5	1	
Compressed air	0-160	20	2	

Domestic hot water	0-200	20	2
Domestic cold water	0-200	20	2
Fuel Oil Pump Discharge	0-100	10	1

2.3 SYSTEM DRAINS

- A. Valved drains (nonpotable water):
 - 1. Piping DN50 2 inches and smaller:
 - a. DN15 1/2 inches V-13, or V-14 with male hose-thread outlet and brass cap.
 - 2. Piping DN65 2-1/2 inches and larger:
 - a. DN40 1-1/2 inches V-13 or V-14 ball valve with DN40 1-1/2 inches fire hose adapter and cap.
- B. Valved drains (potable water):
 - 1. DN15 1/2 inches V-13 with plugged outlet.
- C. On nonpotable systems, label system drains as nonpotable.
- D. Valve standards: See section 23 05 23.

2.4 THERMOMETER WELLS (SOCKETS) AND TEST GAUGE CONNECTIONS

- A. Temperature sensing wells (sockets) and test gauge connections:
 - 1. Brass or stainless steel.
 - 2. Provide extension necks for insulated piping.

2.5 THERMOMETERS

- A. BiMetal Thermometers:
 - 1. Case: Type 304 Stainless Steel.
 - 2. Window: Shatterproof glass or acrylic.
 - 3. Stem assembly: Stainless steel all welded construction and 12 mm 1/2 inches NPT connection.
 - 4. Element fluid: Silicone.
 - 5. Dial: Heavy gauge aluminum, white finish, black or red graduation lines and numerals.
 - 6. Accuracy: 1% of scale range.
- B. Liquid filled thermometers:
 - 1. Case: Industrial type molded polyester or die cast aluminum.
 - 2. Window: Shatterproof glass or acrylic.
 - 3. Liquid: Blue reading, non-mercury.
 - 4. Scale: 225 mm 9 inches scale minimum, black lines and numbers.
 - 5. Accuracy: 1% of scale range.
 - 6. Angle adjustment: variable with angle adjusting screw.
- C. Digital Thermometers:
 - 1. Case: High-impact ABS.
 - 2. Display: 13mm 1/2 inches LCD digits.
 - 3. Sensor: Glass passivated thermistor.
 - 4. Ambient Operating conditions: -35 degrees C to 60 degrees C -30 degrees F to 140 degrees F.
 - 5. Accuracy 1% of reading or 1 degree C 1 degree F.
 - 6. Resolution: .1 degrees C .1 degrees F between -28 degrees C and 93 degrees C -20 degrees F and 200 degrees F.
 - 7. Recalibration: Through case potentiometer adjustment.

8. Lux rating: 10 Lux (one foot candle).
9. Update span: 10 seconds.
10. Range: -45 degrees C to 150 degrees C -50 degrees F to 300 degrees F. Switchable from Metric to English scale.
11. Ambient temperature error: Zero.
12. Maximum ambient humidity: 100%.
13. Power: Solar.

D. Thermometers range schedule:

	Range degC	Division degC
Domestic hot water	0-90	1
Domestic cold water	0-40	1
Heating hot water	10-150	1
Condensate pump disc	10-150	1
Compressed air	10-150	1
LP steam	10-150	1
Boiler feed water	10-150	1
Blow down	10-210	2
Fuel oil	10-210	2
Chilled water at coils	0-60	1
Chilled water at pumps and chiller	0-40	1
Condenser water	0-40	1
	Range degF	Division degF
Domestic hot water	32-180	2
Domestic cold water	32-100	1
Heating hot water	50-300	2
Condensate pump disc	50-300	2
Compressed air	50-300	2
LP steam	50-300	2
Boiler feed water	50-300	5
Blow down	50-400	5
Fuel oil	50-400	5
Chilled water at coils	32-130	1
Chilled water at pumps and chiller	32-100	1
Condenser water	32-100	1

2.6 WYE STRAINERS FOR HYDRONIC SYSTEMS

A. Wye strainers.

1. Screwed or flanged.
2. Body:
 - a. DN50 2 inches and smaller:
 - 1) Cast bronze, ASTM B62, screwed ends.
 - b. DN65 2-1/2 inches and larger:
 - 1) Cast iron, flanged ends.
 - 2) Coating: Rust inhibiting.
3. Working pressure, non shock: 1040 kPa 150 psiG.
4. Screens:
 - a. Water: Bronze, monel or stainless steel.
 - 1) DN50 2 inches and less: 1.2 mm 3/64 inches perforations.

- 2) DN65 2-1/2 inches and larger: 3.2 mm 1/8 inches perforations.
- b. Steam: Stainless steel or brass.
 - 1) 1.2 mm 3/64 inches perforations.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install piping specialties according to manufacturer instructions and as specified.

3.2 PRESSURE GAUGES

- A. Install filter type pressure snubbers at pumps and chillers.
- B. Install siphons on steam gauges.
- C. Install brass tee handle cock and DN8 1/4 inches hard tempered tubing from gauge to pipe connection.
- D. Install additional brass tee handle cock at gauge for panel mounted gauge.
- E. Calibrate and zero gauges at job site.

3.3 SYSTEM DRAINS

- A. At low points of piping systems, provide valved drains to allow complete drainage of each system.
- B. Neither terminate nor run drains over electrical equipment.

3.4 THERMOMETER WELLS AND TEST GAUGE CONNECTIONS

- A. Provide test thermometer well adjacent to each point where a temperature sensing device is required by control specifications and where piping schematics indicate thermometers.
- B. Placement and sizing:
 - 1. For DN100 4 inches piping and larger, place tee in piping to create perpendicular flow-to-stem measurement.
 - a. Size stem length based on pipe size as indicated below:
 - 1) DN100 and DN125 pipe: 90 mm stem 4 and 5 inches pipe: 3-1/2 inches stem.
 - 2) DN150 and DN200 pipe: 150 mm stem 6 and 8 inches pipe: 6 inches stem.
 - 3) DN250 and DN300 pipe: 230 mm stem 10 and 12 inches pipe: 9 inches stem.
 - 4) DN350 pipe and larger: 300 mm stem 14 inches pipe and larger: 12 inches stem.
 - 2. For piping smaller than DN100 4 inches, place oversize piping well and tee in 90-degree piping turn to create parallel flow-to-stem measurement.
 - a. Stem length: 300 mm 12 inches.
 - b. Piping well length: 350 mm 14 inches.
 - c. Size piping well and tee based on pipe size as indicated below:
 - 1) DN15 and DN20 pipe: DN32 well and tee 1/2 and 3/4 inches pipe: 1-1/4 inches well and tee.
 - 2) DN25 pipe: DN40 well and tee 1 inch pipe: 1-1/2 inches well and tee.
 - 3) DN32 and DN40 pipe: DN50 well and tee 1-1/4 and 1-1/2 inches pipe: 2 inches well and tee.
 - 4) DN50 pipe: DN65 well and tee 2 inches pipe: 2-1/2 inches well and tee.
 - 5) DN65 and DN80 pipe: DN100 well and tee 2-1/2 and 3 inches pipe: 4 inches well and tee.

3.5 THERMOMETERS

- A. Where temperature control requires a temperature transmitter, a thermometer is not required in same location unless specifically required in equipment specifications.

- B. Where 2 or more pumps are headered, provide one thermometer in suction header and one in discharge header.

3.6 WYE STRAINERS

- A. Provide wye strainers as indicated in piping-system sections.
- B. Connections to suit piping system.
- C. Provide blow-down valves:
 - 1. Strainers DN150 6 inches and larger: DN40 1-1/2 inches blow-down valve.
 - a. Pipe blow down to drain.
 - 2. Strainers DN50 to DN125 2 to 5 inches: DN25 1 inch blow-down valve with DN20 3/4 inches hose end connection and brass cap.
 - 3. Strainers DN40 1-1/2 inches and smaller: DN15 1/2 inches blow-down valve with DN20 3/4 inches hose end connection and brass cap.

END OF SECTION

SECTION 23 05 23

MANUAL VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Manual Valves, as indicated, in accordance with provisions of Contract Documents.
- B. Definitions:
 - 1. Class: ANSI Class.
 - 2. WOG: Water/Oil/Gas non-shock working pressure.
 - 3. WWP: Cold water non-shock working pressure.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. This specification lists a variety of valves that may be applicable to the project. Not all valves listed are applicable to the project, refer to appropriate specs sections for project applicability.
- B. Boiler system valves: ASME Boiler Code Specifications.
- C. Valves for Potable Water: Shall comply with provisions called for by the Safe Drinking Water Act as amended by S3874 (the "Lead Free Law") or any subsequent amendments or addendums thereto.
- D. Valve bodies, shells and seats: Designed, manufactured, and tested in accordance with the following:
 - 1. Butterfly valves: MSS SP-67.
 - 2. Cast iron gate valves, flanged and threaded ends: MSS SP-70.
 - 3. Cast iron swing check valves, flanged and threaded ends: MSS SP-71.
 - 4. Cast iron plug valves, flanged and threaded ends: MSS SP-78.
 - 5. Bronze gate, globe, angle and check valves: MSS SP-80.
 - 6. Valve pressure testing methods: MSS SP-82.
 - 7. Ball valves--threaded, socket-welding, solder joint, grooved, and flared ends: MSS SP-110.
- E. Standard Specification for Composition of Bronze or Ounce Metal Castings: ASTM-B62.
- F. Valve stems: ASTM-B371, Alloy C69400; ASTM-B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.
- G. Indicate following information on valves:
 - 1. Stamped or cast into body:
 - a. Manufacturer's name or trademark.
 - b. Pressure rating as Class, SWP, WOG, or WWP.
 - c. "UL-FM" for UL-FM valves.
 - 2. Permanently attached to body:
 - a. Valve's country of origin.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Valves.
 - a. In addition to submittal requirements of Section 01 33 00, submittal shall include the following:

- 1) For submittals with model numbers not listed in this section, include published cross reference sheet. Indicate association between submitted model number and the listed model number on the cross reference sheet.
 - 2) For each valve submitted indicate in which specification section(s) and in which system(s) the valve will be used.
- b. When valve assembly includes components other than the base valve body and handle (e.g., operator, valve box), include data on entire valve assembly.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ball valves:

1. Base:
 - a. Milwaukee Valve.
 - b. Nibco.
2. Optional:
 - a. Apollo.
 - b. Crane Valves.
 - c. Hammond Valve.
 - d. Jamesbury.
 - e. Jenkins Valves.
 - f. Stockham.

B. Butterfly valves:

1. Base:
 - a. DeZurik.
 - b. Milwaukee Valve.
 - c. Stockham.
 - d. Victaulic of America.
2. Optional:
 - a. CenterLine Inds.
 - b. Crane Valves.
 - c. Jamesbury.
 - d. Hammond Valve.
 - e. Keystone Valve.
 - f. Lunken.
 - g. Mueller Steam Specialty.
 - h. Nibco.
 - i. Powell.
 - j. Walworth.

C. Check valves:

1. Base:
 - a. Apco Valve & Primer.
 - b. Nibco.
 - c. Stockham Valves & Fittings.
2. Optional:
 - a. Crane Valves.
 - b. Hammond Valve.

- c. Kennedy Valve.
- d. Milwaukee Valve.
- e. Mueller Steam Specialty.
- f. Powell.
- g. Victaulic of America.
- h. Viking.
- i. Walworth.
- j. Waterous.

D. Globe valves:

- 1. Base:
 - a. Stockham.
- 2. Optional:
 - a. Crane Valves.
 - b. Hammond Valve.
 - c. Jenkins Valves.
 - d. Lunken.
 - e. Milwaukee Valve.
 - f. Nibco.
 - g. Powell.
 - h. Walworth.

E. Balancing valves (globe style):

- 1. Base:
 - a. Tour and Andersson.
- 2. Optional:
 - a. Armstrong.
 - b. Wheatley.
 - c. Mepco.

F. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Ball valves:

- 1. Port size: Standard.
- 2. Ball and stem material: 316 Stainless Steel unless noted otherwise in specific valve description.
- 3. Blow-out proof stems.
- 4. Reinforced Teflon (PTFE) (PTFE) seats.
- 5. Teflon (PTFE) (PTFE) seals.
- 6. Adjustable packing.
- 7. 3-piece valves:
 - a. May be standard port.
 - b. Repairable in line.

B. Butterfly valves:

- 1. Ninety degree operation.

2. Bubble-tight shut off, suitable for bi-directional dead-end service at rated pressure without use of downstream flange.
3. 50 mm 2 inches extended neck.
4. Lugs shall be drilled and tapped.
5. Operators:
 - a. DN65 to DN100 2-1/2 to 4 inches: Position lock handle. Memory stops to be provided for valves used as balancing valves.
 - b. DN125 5 inches and larger: gear operator with 4-arm or wheel handle. Memory stops to be provided for valves used as balancing valves.
6. Bronze:
 - a. Viton seals.
 - b. Pressure rating: Refer to valve listings under Part 2.3.

2.3 VALVES

- A. General:
 1. Example model numbers may indicate a general series, or may be abbreviated. They may not reflect all features described. Provide valves with described features.
 2. Specified requirements are minimums. Valves that meet or exceed specifications may be submitted.
 3. Where valves are installed in piping systems using ring seal crimped pipe joining systems acceptable manufactures who manufacture valves designed for connection to ring seal crimped systems are acceptable. Refer to specification sections 22 10 16 Plumbing Piping and 23 21 13 Hydronic Piping Systems for acceptable applications of Ring Seal Crimped piping systems..
- B. Globe valve, Class 150, bronze body, union bonnet, renewable Teflon (PTFE) disc, solder.
Example: Stockham B-24T.
- C. Ball valve, 1035 kPa 150 psi SWP, 2760 kPa 400 psi WOG bronze body, adjustable memory stop, 3-piece construction, extended stem, solder. Example: Milwaukee UPBA-350S.
- D. Ball valve, same as V-11 except threaded. Example: Milwaukee UPBA-300S.
- E. Check valve, in-line pattern, spring-operated double doors, Class 250, cast iron body, renewable bronze doors and Viton-A seal, Inconel springs, stainless steel trim, flat faced wafer.
Example: Stockham WG-976.
- F. Butterfly valve, 1400 kPa 200 psi WWP; 10 kPa 27 inches Hg vacuum; cast or ductile iron body; EPT (EPDM) sleeve; stainless steel stem; aluminum-bronze or stainless steel disc; lugged.
Example: Stockham L#-7#2.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to individual sections for specific valve installation requirements.
- B. Keep valves clear of pull spaces.
- C. Install valves in accessible locations for operation, removal, inspection, and repair of valves and equipment.
- D. Install gate and globe valves with stem in vertical upright to horizontal position.
- E. Install butterfly valves with stem in horizontal position.
- F. Support valves individually to relieve pipe stress and allow equipment removal.
- G. Follow manufacturer's recommendation for disassembly of valves for end joining method employed.

- H. Provide globe valve in bypass around control valves. Coordinate with Controls Contractor.
- I. Provide shut off valve on each side of control valve. Coordinate with Controls Contractor.

END OF SECTION

SECTION 23 05 29
PENETRATIONS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Penetrations and Supports, as indicated, in accordance with provisions of Contract Documents.
- B. Systems Included:
 - 1. Penetrations.
 - 2. Pipe hangers and supports.
 - 3. Pipe and equipment anchors.
- C. Definitions:
 - 1. UCSS: Universal Channel Strut System.
- D. Completely coordinate with work of other trades.
- E. Concrete Anchoring:
 - 1. Cracked concrete is the baseline condition for the design of cast-in-place and post-installed anchors in alignment with both ACI 318 and International Building Code.

1.2 QUALITY ASSURANCE

- A. Pipe hanger standards:
 - 1. Manufacturers Standardization Society (MSS) SP-58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
 - 2. ASME/ANSI B31.1 Code for Pressure Piping.
 - 3. ACI 318: Building Code Requirements for Reinforced Concrete.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Pipe hangers:
 - a. Identify each hanger according to systems, pipe sizes, and orientations on which it will be used.
 - 2. Concrete Anchors:
 - a. Document Manufacturer approval or listing for cracked concrete application
 - 1) Drop-In Anchors are NOT cracked concrete rated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pipe hangers:
 - 1. Base:
 - a. PHD Manufacturing.
 - 2. Optional:
 - a. Anvil International.
 - b. Cooper B-Line.
 - c. Tolco Inc.
 - d. Erico International.
- B. Concrete inserts, pre-pour:

1. Base:
 - a. Hilti.
 2. Optional:
 - a. Simpson.
 - b. Powers Fasteners.
 - c. Tolco.
 - d. B-line.
- C. Concrete inserts, post-pour:
1. Base:
 - a. Hilti.
 2. Optional:
 - a. Simpson.
 - b. Powers Fasteners.
- D. Factory-fabricated supports for insulated pipe:
1. Base:
 - a. Pipe Shields.
 2. Optional:
 - a. B-Line Systems.
 - b. Power Piping.
- E. Freestanding roof supports:
1. Base:
 - a. PHP Systems.
 2. Optional:
 - a. Miro Industries, Inc.
 - b. MIFAB, Inc.
 - c. Erico International.
- F. Pipe and equipment anchors:
1. Base:
 - a. Shop fabricated.
 2. Optional:
 - a. Field fabricated.
- G. Factory-fabricated pipe supports at plumbing fixtures:
1. Base:
 - a. Sioux Chief Manufacturing.
 2. Optional:
 - a. B-Line Systems.
 - b. Holdrite.
 - c. Sumner.
- H. Insulation Saddles:
1. Base:
 - a. PHD Manufacturing.
 2. Optional:
 - a. Buckaroos, Inc.

- I. Elastomeric Pipe Insulation Saddles:
 - 1. Base:
 - a. Armacell engineered foams.
- J. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 PENETRATIONS

A. Penetrations - General:

- 1. For concrete walls, floors, roofs, foundations, footings and grade beams, provide openings sufficiently sized to allow free movement of piping with insulation continuous through sleeve.
- 2. Create openings by placing sleeves prior to pouring of concrete in accordance with requirements indicated on structural drawings.
- 3. Core drilling or cutting will not be permitted without prior written approval by structural engineer.
- 4. Opening diameters:
 - a. Minimum 3 inches.
 - b. Bare pipe: Minimum 1 inch larger than outside diameter of pipe.
 - c. Insulated pipe: Minimum 1-1/2 inches larger than outside diameter of insulation.
 - d. Diameter suitable for construction tolerances and to receive sealant.
- 5. Openings for future work: Same as this work.
- 6. Coordinate detailing of roof, foundation wall, and slab-on-grade penetrations with roofing, waterproofing, and vapor retarder installers. Protect continuity of roofing, waterproofing, and vapor retarder systems.

B. Pipe entrance wall sleeve and anchoring:

- 1. Provide steel, heavy wall welded or seamless pipe sleeve full circle continuously welded water stop plate.
- 2. Provide sleeve full length of wall thickness and protect with a primer coat.
- 3. Structurally secure pipe to withstand water hammer force.
 - a. Extend exterior piping material into building a minimum of 305 mm 12 inches.
 - b. Provide a mechanical joint on interior end of pipe and mechanical tie in back to adjoining structural, exterior, wall.
- 4. Provide "Link-Seal" on pipe at exterior side of sleeve.

C. Water dams:

- 1. Construct water dams to meet either of the following criteria:
 - a. Steel pipe with flange water dam:
 - 1) Construct water dam by welding together Schedule 40 steel pipe and steel flange to be water tight.
 - 2) Cut flange from flat steel of same thickness as pipe wall. Flange ring width shall be 25 mm 1 inch minimum.
 - 3) Inside diameter of dam shall be approximately 25 mm 1 inch larger than outside diameter of piping or its insulation, which ever is larger.
 - 4) Install top of water dam to be 100 mm 4 inches above the finished floor.
 - 5) Permanently anchor dam flange to the floor, and seal the flange-to-floor joint water tight.
 - b. Steel water dam:
 - 1) Construct dam by inserting end of Schedule 40 steel pipe or sheet steel fully into a groove approximately 13 mm 1/2 inches deep.
 - 2) Seal the joint between dam and floor water tight.

D. Sealants:

1. Seal annular space around piping.
2. Maintain fire and smoke ratings at pipe penetrations of fire and fire/smoke rated building elements.
3. For non-rated floors and walls see Section 07 92 16.
4. For exterior and foundation walls: Use synthetic rubber seals, "Link-Seal" water proof material or system.
 - a. Optional sealing of pipe with oakum stop and caulk on exterior side is acceptable.
5. Seal water dams to floor in accordance with Section 07 92 13.

2.3 PIPE HANGERS

A. Pipe hangers - General:

1. MSS SP-58 for materials, design, manufacture, selection, application, and installation requirements.
2. ACI 319 for attachment requirements to concrete.
3. Hangers and channels, angles, and supporting steel: Galvanized unless indicated otherwise.
4. Pipes running parallel may be supported on trapezes.
5. Hanger rods of continuous thread type: Galvanize after threads are cut.
6. Galvanize structural steel, angles, rods, channels, and hardware located in boiler, mechanical, and fan rooms and on roofs.
7. Where grooved couplings are used, place hanger within 2 feet each side of fittings or refer to manufacturer's pipe support and anchorage guide.
8. Screw threads on hangers and fittings: Conform to Class 2A and 2B of ANSI/ASME-B1.1.

B. Structural considerations:

1. Steel or concrete roof/floor system including slabs or roof deck shall be in place and complete before installation of mechanical piping system.
2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe hanger loading".
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers larger than 1/2 inches diameter to bottom of concrete filled floor or roof deck.
5. Individual hanger loads exceeding 1000 pounds attached to the same deck span shall not be spaced closer than 5 feet on center.
6. The sum of all hangers supported by a slab span in a 5 feet by 5 feet area shall not exceed 1000 pounds.
7. Attach hangers to beams whenever possible.

C. Pipe hanger spacing:

1. Locate hangers at each change of direction.
2. Space hangers at or within following maximum limits:

Pipe Diameter	Standard Steel		Copper	
	Fluid	Vapor	Fluid	Vapor
1/2 - 1 inch	7 feet	8 feet	5 feet	6 feet
1-1/4 - 2 inches	7 feet	9 feet	6 feet	9 feet
2-1/2 - 3 inches	11 feet	14 feet	9 feet	13 feet

3-1/2 - 4 inches	12 feet	16 feet	10 feet	15 feet
5 - 6 inches	12 feet	19 feet	10 feet	18 feet
8 - 14 inches	12 feet	24 feet	10 feet	23 feet
16 inches	12 feet	24 feet	--	--

3. For pipe larger than 16 inches diameter, see mechanical drawing for location of hanger supports.
 - a. If not shown on plans, provide shop drawings for approval showing location of hangers and method of support from structure.
4. Fire protection piping: See Section 21 10 00.
5. For cast iron pressure piping, space maximum 12 feet on-center.
 - a. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.
6. For cast iron soil piping, space maximum 10 feet on-center.
 - a. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.
 - b. Provide bracing of 5" and larger horizontal cast iron pipe per manufacturer & CISPI.
 - c. Provide sway bracing of 4" and larger drainage piping per IPC 308.6 and NSPC for horizontal cast iron pipe.
7. For piping materials not covered in this spec, space hangers according to manufacturer's recommendations.

D. Pipe hanger rod loading:

1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 inches	560 pound
1/2 inches	890 pound
5/8 inches	1460 pound
3/4 inches	2030 pound

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

E. Pipe hangers for uninsulated pipe:

1. Independent hangers: MSS SP-58 type 1, 3, 4, 5, 7, 9, 10, 11, 12, 24, 41, 43, 44, 45, or 46.
 - a. Types 7 and 10: Not allowed on pipe sizes greater than DN150 6 inches.
2. Hangers used with trapezes:
 - a. MSS SP-58 type 24 or 26.
 - b. Hanger designed as part of UCSS.
3. Hangers supporting bare copper pipe:
 - a. Copper plated or electro-galvanized hangers. Provide factory-applied felt or plastic padding to eliminate contact between support and copper pipe.
4. Hangers supporting bare glass pipe:
 - a. For horizontal piping, use electro-galvanized supports with factory-applied felt or plastic padding to eliminate contact between metal and glass.
 - b. For vertical piping, use electro-galvanized supports with factory-applied 7 mm 1/4 inches thick solid neoprene or Buna-N pads to eliminate contact between metal and glass.

F. Pipe hangers for insulated pipe:

1. Hangers shall support piping from outside diameter of insulation.

2. Independent hangers: MSS SP-58 type 1, 3, 7, 9, 10, 41, 43, 44, 45, or 46.
 - a. Types 7 and 10: Not allowed on pipe sizes greater than DN150 6 inches.
 3. Hangers used with trapezes:
 - a. Pipe sizes DN50 2 inches and smaller: MSS SP-58 type 26.
 - b. Pipe sizes DN65 2-1/2 inches and larger:
 - 1) MSS SP-58 type 24 or 26.
 - 2) Hanger designed as part of UCSS.
 4. Pipe sizes 2 inches and smaller: Use hanger with insulation protection shield: MSS SP-58 type 40.
 5. Pipe sizes 2-1/2 inches and larger: Use hanger with factory-fabricated support:
 - a. 100 psi, waterproofed calcium silicate fully encased in sheet metal shield.
 - 1) Pipe supported on rod hangers: Pipe Shields Models A1000, A2000, A3000, A4000 and A9000.
 - 2) Pipe supported on flat surfaces: Pipe Shields Models A1000, A2000, A5000, A6000 and A7000.
 - 3) Pipe supported on pipe rolls: Pipe Shields Models A3000, A4000, A5000, A6000 and A8000.
 - b. Extend insulation inserts 1 inch beyond shields on refrigerant and chilled water lines.
 - c. For steam piping 8 inches and larger, provide supports with slide bases.
 6. For piping systems insulated with Elastomeric pipe insulation, composite Elastomeric and high density insert may be used:
 - a. Jacket: 30 mils stainless steel.
 - b. Basis: Armacell Armafix NPH pipe hanger inserts.
 - c. Coordinate with section 23 07 00 Pipe, Duct and Equipment Insulation for applicability.
 7. Steam pipe sizes 8 inches and larger: Use MSS SP-58 hanger type 41, 43, 44, 45, or 46 with support indicated for pipe sizes 2-1/2 inches and larger.
- G. Pipe hangers in other situations: See MSS-SP-58.
- H. Trapezes:
1. Suspend trapezes from concrete inserts, approved structural clips or beam clamps.
 2. Construct trapezes of galvanized angle iron, UCSS channels, or other structural shapes with flat surfaces for point of support.
 3. See pipe hanger paragraphs for hanger types allowed with trapezes.
- I. Vertical pipe supports and guides for mechanical piping:
1. Support vertical pipe runs in pipe chases from the top and every other floor down.
 2. Provide pipe guides for lateral movement on alternating floors of pipe supports.
- J. Vertical pipe supports and guides for plumbing piping:
1. Provide vertical plumbing piping support at vertical distances as follows:
 - a. Cast Iron pipe: 15 ft.
 - b. Copper pipe: 10 ft.
 - c. PVC pipe: 10 ft. (for piping 2" and smaller, provide a guide at mid span).
 - d. CPVC pipe: 10 ft (for 2" and smaller, provide a guide at mid span).
 - e. Polypropylene pipe: 10 ft (for 2" and smaller, provide a guide at mid span).
- K. Concrete inserts:
1. Pre-pour concrete inserts:
 - a. Continuous-slot or individual concrete inserts for use with hangers for piping and equipment exposed in labs and classrooms, and as required.

- b. Provide inserts in time for installation in concrete.
- c. Continuous-slot inserts:
 - 1) B-Line Figure B22I, B32I, B42I or B52I.
- d. Individual inserts:
 - 1) Grinnell Figure 282, or 281.
 - 2) Do not exceed manufacturer's recommended load on insert.
- 2. Post-pour concrete inserts:
 - a. Approved for cracked concrete applications. Drop-In Anchors SHALL NOT be used.
 - b. At concrete slabs on steel deck, install anchor in top of deck flute.
 - c. Minimum embedment depth and base material thickness per anchor size shall be according to the following schedule:

Anchor Size IN	Minimum Base Material Thickness IN	Minimum Embedment Depth IN
1/4	3	1
3/8	3-1/8	1-9/16
1/2	4	2
5/8	5-1/8	2-9/16
3/4	6-3/8	3-3/16

- L. Beam clamps:
 - 1. Pipe size 3 inches and smaller:
 - a. MSS SP-58 types 19 or 23.
 - 2. Pipe sizes larger than 3 inches but smaller than 8 inches:
 - a. Malleable-iron beam clamp: MSS SP-58 type 30.
 - b. Iron beam clamp: B-Line B3055 or equal.
 - 3. Pipe sizes 8 inches and larger:
 - a. Forged steel beam clamps: MSS SP-58 type 28 or type 29.
 - b. Steel Beam clamps: B-Line B3291 through B3298 or equal.
- M. Attachments to wood structure:
 - 1. Provide angle clips and lag screws or side beam connectors: PHD figure 920 or 905.
 - 2. Strap type hangers not acceptable.

2.4 PIPE AND EQUIPMENT ANCHORS

- A. Pipe Anchors:
 - 1. Approved for cracked concrete applications.
 - 2. Provide as indicated and required to permit complete installation of system.
 - 3. Do not anchor piping to plaster or gypsum wallboard partition walls.
 - 4. Provide anchoring devices at locations indicated.
 - 5. General arrangement subject to review and approval of the Structural Engineer of Record.
 - 6. Assume engineering responsibility for design of pipe anchors and connection of anchor to structure.
 - 7. Engineer Qualifications: Comply with section 01 71 21 Specialty Engineering Requirements
 - 8. Design anchors to satisfy requirements of applicable Building Codes.
 - 9. Design for stresses determined by expansion joint manufacturer. Adjust stresses at structure connection point for distance between anchor and structure connection point.
 - a. See section 23 05 19.
- B. Anchors:

1. Angle iron and rods with turnbuckles, unless detailed otherwise.
- C. Anchors for ductwork, equipment and piping hanger rods:
 1. Post-pour concrete inserts:
 - a. Approved for cracked concrete applications. Drop-In anchors SHALL NOT be used.
 - b. Hard-metal, self-drilling tapped for threaded rods and designed not to depend on lead or wood for holding power.

2.5 FREESTANDING ROOF SUPPORTS

- A. Support piping on roof with engineered prefabricated supports designed for installation without roof penetrations, flashing or damage to the roofing material.
- B. Base:
 1. Stainless steel, or injection molded high density / high impact polypropylene with UV-inhibitors and anti-oxidants.
 2. Provide base with foam pad.
 3. Provide base with swivel for slope adjustment.
- C. Steel framing:
 1. Channel: Minimum 12 gage, 1-5/8 inches or 1-7/8 inches, as required for loading conditions.
 2. Finish: Hot tip galvanize in accordance with ASTM A123 after fabrication, free of roughness, unsightly spangles, droplets, and other surface blemishes.
- D. Supports:
 1. Pipe sizes 2-1/2 inches and smaller: Adjustable height single roller supports for piping subject to expansion and contraction; 3-sided channels and pipe clamps.
 2. Pipe sizes 3 inches and larger: Adjustable height rollers, clevis hangers, or band hangers, to allow for expansion and contraction without movement of the bases or framing.
 3. Finish: Hot-dip galvanized in accordance with ASTM A153.
- E. Attachment when required for seismic application: No base mechanically attachment to roof deck.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install components as indicated and in accordance with manufacturer's instructions and recommendations.

3.2 PENETRATIONS

- A. Coordinate locations of openings in structural systems with Architect.
- B. Maintain fire and smoke ratings at pipe penetrations of fire and fire/smoke rated building elements.
- C. Set sleeves plumb or level, in proper position, tightly fitted into work.
- D. Provide water dams around pipes penetrating the floor in wet areas such as the following:
 1. Mechanical room.
 2. Boiler rooms.
 3. Kitchens and Food Service areas.
 4. Laundry Rooms.

3.3 PIPE HANGERS

- A. Glass piping:

1. Horizontal glass piping:
 - a. Install supports on horizontal lines to allow sideways movement of piping.
 - b. Provide supports at each change of direction.
 - c. Maximum support spacing: 2.400 M 8 feet.
 - 1) Provide minimum of one support per pipe section within 610 mm 24 inches of joint.
 - 2) Provide support at branch connections.
 - d. Place support no closer than 1.830 M 6 feet from connection to vertical stack.
2. Vertical glass piping:
 - a. DN50 2 inches and smaller: Support at every other floor.
 - b. DN80 3 inches and larger: Support at every floor.
 - c. On stacks, install clamp below bottom coupling of stack, and below coupling on every third floor.
 - 1) Install clamps to restrict lateral as well as downward movement.

END OF SECTION

SECTION 23 05 50
MECHANICAL SOUND AND VIBRATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Mechanical Sound and Vibration Control, as indicated, in accordance with provisions of Contract Documents.
- B. Systems Included:
 - 1. Vibration isolators.
 - 2. Piping connections.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Comply with ASHRAE, ASTM and AASHO standards.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit drawings for each piece of isolated equipment.
 - 2. Include drawings of vibration isolators with equipment submittal. Include information specified in ANSI/ASA S2.8 or, at minimum, the following information:
 - a. Isolator physical dimensions.
 - b. Deflection.
 - c. Compressed height.
 - d. Solid height.
 - e. Point location of each isolator.
 - f. Calculated load at each point.
 - g. Field static deflection.
 - h. Calculated horizontal loading and bolt requirements.
 - i. Indicate base clearance.
 - j. Installation instructions and drawings.
- B. Product Data:
 - 1. Vibration isolators, bases, and piping connections for equipment: Include with equipment submittal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Mechanical Sound and Vibration Control:
 - 1. Base:
 - a. Mason Industries.
 - 2. Optional:
 - a. Vibration Mountings and Controls.
 - b. Vibration Eliminator.
 - c. Korfund Dynamics.
 - d. Amber/Booth.
 - e. California Dynamics.

- f. Vibro-Acoustics.
 - g. Kinetics Noise Control.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Provide piping and equipment isolation systems as specified.
- B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.
- C. Provide vibration isolation equipment including isolators, bases, and flexible piping connections from a single manufacturer of vibration isolation equipment.
- D. Coat vibration isolation systems exposed to moisture and an outdoor environment as follows:
 - 1. Hot dip galvanize steel parts.
 - 2. Coat springs with neoprene.
 - 3. Zinc-Nickel plated hardware.

2.3 VIBRATION ISOLATORS

- A. Spring Isolators:
 - 1. Type 3 isolator:
 - a. Similar to ASHRAE Type 3 spring isolator.
 - b. Free standing and laterally stable without housings, snubbers, or guides.
 - c. Provide 7 mm 1/4 inches thick neoprene acoustical friction pads between baseplate and structure.
 - d. Provide leveling bolts for rigid attachment to equipment.
 - e. Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
 - f. Spring shall have minimum additional travel to solid equal to 50 percent of rated deflection.
 - 2. Type 3 isolator for suspended supports:
 - a. Similar to ASHRAE Type 3 spring hanger.
 - b. Provide Steel spring and neoprene cup element in series inside bottom of hanger frame.
 - 1) Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
 - c. Provide integral extension bushing on neoprene element where it contacts hanger frame to prevent metal to metal contact between frame and hanger rod.
 - d. Minimum additional spring travel to solid: 50 percent of rated deflection.
 - e. Spring diameter and hanger frame's lower hole size shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting hole and short circuiting spring.
 - 3. Type 3N isolator for suspended supports:
 - a. Similar to ASHRAE Type 3 spring hanger.
 - b. Provide Steel spring and molded neoprene element in series inside bottom of hanger frame.
 - 1) Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
 - c. Provide color coded neoprene-stock elements for easy identification of rated load capacity inside top of hanger frame.
 - d. Provide integral extension bushing on neoprene elements where they contact hanger frame to prevent metal to metal contact between frame and hanger rod.
 - e. Minimum additional spring travel to solid: 50 percent of rated deflection.

- f. Spring diameter and hanger frame's lower hole size shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting hole and short circuiting spring.
- 4. Type 3P isolator for suspended supports:
 - a. Similar to ASHRAE Type 3 spring hanger.
 - b. Same as Type 3N except spring is pre-compressed to rated deflection so piping/equipment is maintained at a fixed elevation during installation.
 - c. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
- 5. Type 4 isolator:
 - a. Similar to ASHRAE Type 4 restrained spring isolator.
 - b. Free-standing, laterally stable spring isolator.
 - c. Provide resilient vertical limit restraints to prevent spring extension during weight changes.
 - 1) During normal operation, restraints shall not contact spring assembly. (Minimum clearance: 13 mm 1/2 inches.
 - d. Provide acoustical neoprene separator between spring(s) and base plate to prevent short circuiting through baseplate anchor bolts.
 - e. Installed height shall equal operating height.
- 6. Type 5 thrust restraint:
 - a. Similar to ASHRAE Type 5 thrust restraint.
 - b. Same as Type 3 isolator for suspended supports except with angle-iron and rod attachments configured for mounting across flexible duct connection.

2.4 PIPING CONNECTIONS

A. Pipe Connections:

- 1. Flexible pipe connectors (FPC):
 - a. Flexible neoprene/EPDM:
 - 1) Straight connectors: Twin sphere type.
 - 2) Elbow connectors: Single sphere type.
 - b. Multiple plies of friction nylon tire cord with EPDM cover and liner.
 - c. Do not use steel wire or rings as pressure reinforcement.
 - d. Connectors:
 - 1) DN50 2 inches NPS and smaller: Threaded or flanged ends.
 - 2) DN65 2-1/2 inches NPS and larger: Floating galvanized steel flanges.
 - e. Minimum pressure ratings:
 - 1) Twin spheres: 1720 kPa at 77 deg C 250 psi at 170 deg F and 1140 kPa at 120 deg C 165 psi at 250 deg F.
 - 2) Elbows and reducing twin spheres: 1520 kPa at 77 deg C 220 psi at 170 deg F and 1000 kPa at 120 deg C 145 psi at 250 deg F.
- 2. Flexible pipe hoses (FPH):
 - a. Braided, stainless-steel type.
 - b. Stainless steel braid: Type 321.
 - c. Fittings: Carbon steel.
 - d. Connections:
 - 1) DN65 2-1/2 inches NPS and smaller: Male nipples or copper sweat to match specified piping joints.
 - 2) DN80 3 inches NPS and larger: Flanged.
 - e. Minimum transverse motion: ± 10 mm $\pm 3/8$ inches with no permanent misalignment.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL

- A. Install vibration control equipment in accordance with manufacturer's installation instructions and as specified.
- B. Select vibration control equipment as specified, and size in accordance with weight distribution, pull, and torque imposed by equipment being isolated.
 1. Base selection on equipment with Architect approved submittals.
 2. Minimum static deflections may be revised subject to prior approval.
- C. Provide revised vibration control equipment to match revised or substituted equipment.

3.2 VIBRATION ISOLATORS, BASES, AND PIPING CONNECTIONS

- A. Provide vibration isolators, bases, and piping connections as indicated in the following tables.
 1. Superscript numbers in parentheses refer to notes at the end of the tables.

MOUNTED ON GRADE SUPPORTED SLAB					
Equipment	Horsepower & Other	Isolator Type	Minimum Deflection	Base Type	Pipe Connection Type (1,4)
Air Handling Units With internal (blower) isolation	All	See Blowers/Fans			n/a
Air Handling Units With external (blower) isolation	All	3	0.75 inches	none	Note 14
Air Compressors & Vacuum Pumps (8)					
Tank Mounted					
Horizontal	Up to 10 hp	3	0.75 inches	none	FPH
Horizontal	15 hp & Up	3	0.75 inches	C	FPH
Vertical	All	3	0.75 inches	C	FPH
Base Mounted	All	3	0.75 inches	C	FPH
Large Reciprocating	All	3	0.75 inches	C	FPH
Blowers/Fans (2,3) (SWSI, DWDI, Centrifugal, Utility)					
Up to 22 inches	All	2	0.25 inches	B	n/a
24 inches and Up					
301 to 500 rpm	Up to 40 hp	3 & 5	1.50 inches	B	n/a
Above 500 rpm	Up to 40 hp	3 & 5	0.75 inches	B	n/a
301 to 500 rpm	50 hp & Up	3 & 5	1.50 inches	C	n/a
Above 500 rpm	50 hp & Up	3 & 5	1.00 inches	C	n/a
Boilers	All	1	0.25 inches	IP	none
Chillers					
Absorption	All	1	0.25 inches	IP	FPC
Centrifugal	All	1	0.25 inches	C	FPC
Reciprocating	All	2	0.25 inches	IP	FPC
Screw	All	1	0.25 inches	IP	FPC
Cooling Towers					
301 to 500 rpm	All	1	0.25 inches	none	none
Above 500 rpm	All	1	0.25 inches	none	none
Fluid Coolers					
Outdoors	All	1	0.25 inches	none	none
Indoors	All	1	0.25 inches	IP	FPC
Fans, Axial (2,3)					

Up to 22 inches	All	2 & 5	0.25 inches	none	n/a
24 inches and Up					
301 to 500 rpm	Up to 2 inches. S.P.	3 & 5	0.75 inches	B	n/a
Above 500 rpm	Up to 2 inches. S.P.	3 & 5	0.75 inches	B	n/a
301 to 500 rpm	2.1 inches. S.P. & Up	3 & 5	1.50 inches	C	n/a
Above 500 rpm	2.1 inches. S.P. & Up	3 & 5	0.75 inches	C	n/a
Flue Gas Economizers	All	none	---	IP	n/a
Fuel Oil Pumps	All	none	---	IP	n/a
Incinerators	All	1	0.25 inches	IP	n/a
Piping	All	4	1.50 inches	none	none
Pumps					
Close Coupled	Up to 7.5 hp	2	0.25 inches	B	FPC
	10 hp & Up	3	0.75 inches	B	FPC
Flex Coupled	Up to 40 hp	3	0.75 inches	B	FPC
	OVER 50 hp	3	0.75 inches	C	FPC
Large Inline	5 to 25 hp	3	0.75 inches	none	FPC
	30 hp & Up	3	0.75 inches	none	FPC
End Suction & Split Case	Up to 40 hp	3	0.75 inches	C	FPC
	50 to 125 hp	3	0.75 inches	C	FPC
	150 hp & Up	3	0.75 inches	C	FPC
Grouped On Base	All	1	0.30 inches	IP	FPC
Packaged Systems (8)	All	3	0.75 inches	C	FPC
Thermal Storage Systems	All	none	---	IP	none

MOUNTED ON STRUCTURAL FLOOR								
Equipment	Horsepower & Other	21 TO 30 feet FLOOR SPAN			31 TO 40 feet FLOOR SPAN			Pipe
		Isolator Type	Minimum Deflection	Base Type	Isolator Type	Minimum Deflection	Base Type	Connection Type (1,4)
Air Handling Units With internal (blower) isolation	All	See Blower/Fans			See Blower/Fans			n/a
Air Handling Units With external (blower) isolation	All	3	1.50 inches	C	3	2.50 inches	C	Note 14
Air Compressors & Vacuum Pumps (8)								
Tank Mounted								
Horizontal	Up to 10 hp	3	1.50 inches	none	3	1.50 inches	none	FPH
Horizontal	15 hp & Up	3	1.50 inches	C	3	1.50 inches	C	FPH
Vertical	All	3	1.50 inches	C	3	1.50 inches	C	FPH
Base Mounted	All	3	1.50 inches	C	3	1.50 inches	C	FPH
Large Reciprocating	All	3	1.50 inches	C	3	1.50 inches	C	FPH
Blowers/Fans (2,3) (SWSI, DWDI, Centrifugal, Utility)								
Up to 22 inches	All	3 & 5	0.75 inches	B	3 & 5	1.50 inches	C	n/a
24 inches and Up								
301 to 500 rpm	Up to 40 hp	3 & 5	2.50 inches	B	3 & 5	2.50 inches	B	n/a
Above 500 rpm	Up to 40 hp	3 & 5	0.75 inches	B	3 & 5	1.50 inches	B	n/a
301 to 500 rpm	50 hp & Up	3 & 5	2.50 inches	C	3 & 5	2.50 inches	C	n/a

Above 500 rpm	50 hp & Up	3 & 5	1.50 inches	C	3 & 5	2.50 inches	C	n/a
Boilers	All	4	1.50 inches	B	4	2.50 inches	B	none
Chillers								
Absorption	All	4	1.50 inches	none	4	1.50 inches	none	FPC
Centrifugal	All	4	1.50 inches	C	4	1.50 inches	C	FPC
Reciprocating	All	4	1.50 inches	none	4	2.50 inches	none	FPC
Screw	All	4	1.50 inches	none	4	1.50 inches	none	FPC
Cooling Towers								
301 to 500 rpm	All	4	2.50 inches	none	4	2.50 inches	none	FPC
Above 500 rpm	All	4	0.75 inches	none	4	1.50 inches	none	FPC
Fluid Coolers								
301 to 500 rpm	All	4	2.50 inches	none	4	2.50 inches	none	FPC
Above 500 rpm	All	4	0.75 inches	none	4	1.50 inches	none	FPC
Fans, Axial (2,3)								
Up to 22 inches	All	3 & 5	0.75 inches	none	3 & 5	0.75 inches	C	n/a
24 inches and Up								
301 to 500 rpm	Up to 2 inches. S.P.	3 & 5	2.50 inches	C	3 & 5	2.50 inches	C	n/a
Above 500 rpm	Up to 2 inches. S.P.	3 & 5	1.50 inches	B	3 & 5	1.50 inches	B	n/a
301 to 500 rpm	2.1 inches. S.P. & Up	3 & 5	2.50 inches	C	3 & 5	2.50 inches	C	n/a
Above 500 rpm	2.1 inches. S.P. & Up	3 & 5	1.50 inches	C	3 & 5	2.50 inches	C	n/a
Incinerators	All	4	1.50 inches	B	4	2.50 inches	B	none
Piping (9)								
First 3 supports from equipment connection	All	3	Note 11	none	3	Note 11	none	n/a
Remaining supports within 50 feet of equipment connection	All	3	0.75 inches	none	3	0.75 inches	none	n/a
Pumps								
Close Coupled	Up to 7.5 hp	3	0.75 inches	B	3	0.75 inches	C	FPC
	10 hp & Up	3	1.50 inches	B	3	1.50 inches	C	FPC
Flex Coupled	Up to 40 hp	3	1.50 inches	B	3	1.50 inches	C	FPC
	50 to 125 hp	3	1.50 inches	C	3	2.50 inches	C	FPC
	Over 125 hp	3	3.5 inches	C	-	-	-	-
Large Inline	5 to 25 hp	3	1.50 inches	none	3	1.50 inches	none	FPC
	30 hp & Up	3	1.50 inches	none	3	2.50 inches	none	FPC
End Suction & Split Case	Up to 40 hp	3	1.50 inches	C	3	1.50 inches	C	FPC
	50 to 125 hp	3	1.50 inches	C	3	2.50 inches	C	FPC
	150 hp & Up	3	2.50 inches	C	3	3.50 inches	C	FPC
Packaged Systems (8)	All	3	1.50 inches	C	3	2.50 inches	C	FPC

SUSPENDED FROM STRUCTURE								
Equipment	Horsepower & Other	21 TO 30 feet FLOOR SPAN			31 TO 40 feet FLOOR SPAN			Pipe
		Isolator Type	Minimum Deflection	Base Type	Isolator Type	Minimum Deflection	Base Type	Connection Type (1,4)
Air Handling Units With internal (blower) isolation	All	See Blower/Fans			See Blowers/Fans			n/a
Air Handling Units With external (blower) isolation	All	3	1.50 inches	C	3	2.50 inches	C	Note 14
Blowers/Fans (2,3) (SWSI, DWDI, Centrifugal, Utility)								
Up to 22 inches	All	3 & 5	0.75 inches	B	3 & 5	1.50 inches	C	n/a
24 inches and Up								
301 to 500 rpm	Up to 40 hp	3 & 5	2.50 inches	B	3 & 5	2.50 inches	B	n/a
Above 500 rpm	Up to 40 hp	3 & 5	0.75 inches	B	3 & 5	1.50 inches	B	n/a
301 to 500 rpm	50 hp & Up	3 & 5	2.50 inches	C	3 & 5	2.50 inches	C	n/a
Above 500 rpm	50 hp & Up	3 & 5	1.50 inches	C	3 & 5	2.50 inches	C	n/a
Fans, Axial (2,3)								
Up to 22 inches	All	3 & 5	0.75 inches	none	3	0.75 inches	C	n/a
24 inches and Up								
301 to 500 rpm	Up to 2 inches. S.P.	3 & 5	2.50 inches	C	3	2.50 inches	C	n/a
Above 500 rpm	Up to 2 inches. S.P.	3 & 5	1.50 inches	B	3	1.50 inches	B	n/a
301 to 500 rpm	2.1 inches. S.P. & Up	3 & 5	2.50 inches	C	3	2.50 inches	C	n/a
Above 500 rpm	2.1 inches. S.P. & Up	3 & 5	1.50 inches	C	3	2.50 inches	C	n/a
Fans, Inline (2,3)								
Up to 0.5 hp		3 or 3N	0.50 inches	none	3 or 3N	0.50 inches	none	n/a
0.75 to 3 hp		3 or 3N	0.75 inches	none	3 or 3N	0.75 inches	none	n/a
5 to 7.5 hp		3 or 3P & 5	1.50 inches	none	3 or 3P & 5	1.50 inches	none	n/a
10 hp & Up		3 or 3P & 5	1.50 inches	none	3 or 3P & 5	2.50 inches	none	n/a
10 hp & Up		3 or 3N & 5	1.50 inches	none	3 or 3N & 5	2.50 inches	none	n/a
Fans Coil Units								
Up to 0.5 hp		2	0.50 inches	none	2	0.50 inches	none	FPC
0.75 to 1.0 hp		3 or 3N	0.75 inches	none	3 or 3N	0.75 inches	none	FPC
1.5 hp & Up		3 or 3P	0.75 inches	none	3 or 3P	1.50 inches	none	FPC
Piping (9)								
First 3 supports from equipment connection Remaining supports within 50 feet of equipment connection	All	3P	Note 11	none	3P	Note 11	none	n/a
Suspended Individually	Up to 3 inches	3N	0.75 inches	none	3N	0.75 inches	none	n/a
	4 inches & Up	3P	0.75 inches	none	3P	0.75 inches	none	n/a
Suspended on Trapeze	All	3P	1.50 inches	none	3P	1.50 inches	none	n/a
	All	3N	2.50 inches	none	3N	2.50 inches	none	n/a

Piping in Mechanical Rooms and Sensitive Areas (10,12,15)								
	Up to 3 inches	3N	0.75 inches	none	3N	0.75 inches	none	n/a
	4 to 6 inches	3P	1.50 inches	none	3P	1.50 inches	none	n/a
	8 inches & Up	3P	1.50 inches	none	3P	1.50 inches	none	n/a
	8 inches & Up	3N	2.50 inches	none	3N	2.50 inches	none	n/a
Piping at Building Expansion and Seismic Joints								
Nonflammable Gases (non-medical)	All	n/a	n/a	none	n/a	n/a	none	FPH or Loop
Potable Water	All	n/a	n/a	none	n/a	n/a	none	FPC or Loop
Other Systems	All	n/a	n/a	none	n/a	n/a	none	loop
Piping at Plenum Penetrations	All	n/a	n/a	none	n/a	n/a	none	Note 14
Pumps								
Inline	Up to 2 hp	3 or 3N	0.75 inches	none	3 or 3N	0.75 inches	none	FPC
	3 to 5 hp	3 or 3P	1.50 inches	none	3 or 3P	1.50 inches	none	FPC
	7.5 hp & Up	3 or 3P	1.50 inches	none	3 or 3P	1.50 inches	none	FPC
	7.5 hp & Up	3 or 3N	2.50 inches	none	3 or 3N	2.50 inches	none	FPC

MOUNTED ON ROOF								
Equipment	Horsepower & Other	21 TO 30 feet FLOOR SPAN			31 TO 40 feet FLOOR SPAN			Pipe
		Isolator Type	Minimum Deflection	Base Type	Isolator Type	Minimum Deflection	Base Type	Connection Type (1,4)
Air Conditioning Units								
External	Less than 50 Tons	3 locked out	1.50 inches (13)	D & E	3 locked out	1.50 inches (13)	D & E	Note 14
Internal			---	B		---	B	n/a
External	50 Tons & Up	3 locked out	2.50 inches (13)	D & E	3 locked out	2.50 inches (13)	D & E	Note 14
Internal			---	B		---	B	n/a
Blowers/Fans								
Externally Isolated	Up to 5 hp	3	0.75 inches	E	3	0.75 inches	E	n/a
	7.5 hp & Up	3	1.50 inches	E	3	1.50 inches	E	n/a
Internally Isolated	Up to 10 hp	3	0.75 inches	E	3	1.50 inches	E	n/a
Condensers and Condensing Units								
Less than 25 Tons		4	1.50 inches	E	4	1.50 inches	E	Note 14
25 Tons & Up		4	2.00 inches	E	4	2.00 inches	E	Note 14
Cooling Towers and Fluid Coolers								
301 to 500 rpm	All	4	2.50 inches	none	4	2.50 inches	none	FPC
Above 500 rpm	All	4	0.75 inches	none	4	1.50 inches	none	FPC

B. Notes to Tables:

1. Install flexible piping connectors on equipment side of equipment isolation valves.
2. Size indicates diameter of wheel.
3. Provide Type 5 isolators on units operating at 2 inches or more static pressure.

- a. Mount one pair of isolators (on opposite sides) on each of fan's flexible connections.
 - b. Adjust isolators to prevent flexible connections from extending to a tension condition.
 - c. Attach isolators to duct at flanged joint through angle iron on back side of joint.
 - d. See Section 23 31 13.
- 4. A swing joint with three flexible mechanical groove couplings may be substituted for an FPC.
 - 5. Spring diameter: 2.50 inches.
 - 6. Spring diameter: 4 inches.
 - 7. Spring diameter: 6 inches.
 - 8. On packaged systems, provide only external isolation.
 - 9. Provide isolators on piping connected to vibrating equipment (i.e., equipment for which piping connections are specified).
 - 10. Provide isolators for drainage and vent piping only if connected to vibrating equipment.
 - 11. Same type as specified for equipment, except minimum deflection is 0.75 inches, and maximum deflection is 2.00 inches.
 - 12. Mechanical rooms and sensitive areas:
 - a. Mechanical rooms:
 - 1) Provide isolators for piping within mechanical rooms.
 - 2) Where isolators are indicated for piping connected to vibrating equipment, provide isolators which have the largest indicated minimum deflections.
 - b. Sensitive areas:
 - 1) Operating rooms.
 - 13. Integral with base D.
 - 14. Piping connection types:
 - a. Water: FPC.
 - b. Steam and refrigerant: FPH.

END OF SECTION

SECTION 23 05 53
MECHANICAL IDENTIFICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Mechanical Identification Systems, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Piping system identification:
 - 1. ASME/ANSI-A13.1 Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Pipe markers.
 - 2. Valve tags.
 - 3. HVAC duct markers.
 - 4. Equipment name plates.
 - 5. Access panel markers.
 - 6. Underground marking tape.
- B. Contract Closeout Information:
 - 1. Valve Chart.
 - a. Submit completed Spare Parts and Maintenance Material Transmittal form.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Mechanical Identification Systems:
 - 1. Pipe, valve and equipment markers:
 - a. Base:
 - 1) Seton Name Plate.
 - b. Optional:
 - 1) Brady, WH.
 - 2) EMED.
 - 3) Kolbi Industries.
 - 4) 3M.
 - 5) Craftmark Identification Systems.
 - 6) Marking Services, Inc.
 - 7) Carlton Industries.
 - 8) Brimar.
 - 2. Underground marking tape:
 - a. Base:
 - 1) Reef Industries.
 - b. Optional:
 - 1) Seton Name Plate.

2) EMED.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 PIPE MARKERS

A. Conform to ASME/ANSI-A13.1.

B. Pressure sensitive vinyl self-adhesive material.

C. Mechanically fastened type: Snap on or strap on.

1. For dirty greasy, oily pipe where pressure sensitive markers may not perform satisfactorily.

D. Provide with arrows indicating direction of flow.

E. Letter sizes: In accordance with table in Part 3.

2.3 VALVE TAGS

A. Brass or anodized aluminum type.

B. Brass:

1. Minimum 19 gauge, polished, 1-1/2 inches 40 mm diameter with following lettering:

a. Service: 1/4 inches 6 mm stamped black filled letters.

b. Valve numbers: 12 mm 1/2 inches stamped black filled letters.

C. Valve tag fasteners:

1. 4 ply 0.018 inches 0.457 mm copper or monel wire meter seals, brass "S" hooks or No.16 brass jack chain.

2.4 HVAC DUCT MARKERS

A. HVAC Duct Markers:

1. 4 inches 102 mm black painted stenciled letters denoting system number (e.g., AHU-1, RF-3, EF-5), type (supply, return, exhaust) and flow direction.

2.5 EQUIPMENT NAME PLATES

A. Equipment name plates:

1. 1/16 inches 1.6 mm rigid plastic, Setonply, Emedolite or bakelite with four edges beveled; or engraved aluminum with black enamel background and natural aluminum border and letters.

a. Two 3/8 inches 10 mm mounting holes.

b. Lettering size: Minimum 1/2 inches 12 mm high.

2. In addition to nameplates, label equipment with 4 inches 102 mm black painted stencil. Single stencil location to be in clear view.

2.6 ACCESS PANEL MARKERS

A. Metal Tack Style:

1. Use on acoustical tile ceilings.

2. Seton style BCM or ECM.

B. Engraved Plastic Style.

1. 3/4 inches 20 mm square with center hole for small screw.

2. Seton style CM75.

2.7 UNDERGROUND MARKING TAPE

A. Underground Marking Tape:

1. 0.10 mm 4 mil inert plastic film for underground use.

2. Resistant to alkalis, acids and other destructive agents found in soil.
 3. Minimum tensile strength: 20 pounds per 3 inches 12 kg per 100 mm width.
 4. Minimum elongation: 500%.
 5. Provide continuous printed message repeated every 16 to 36 inches 400 to 1000 mm warning of pipe buried below (e.g.: "CAUTION GAS LINE BURIED BELOW").
 6. Color code:
 - a. Yellow: Natural gas and fuel oil systems.
 - b. Blue: Water systems, domestic and fire.
 - c. Green: Sanitary sewer system.
 7. Reef Industries, Standard Terra Tape.
- B. Underground Detectable Marking Tape:
1. Lamination bond of 1 layer of aluminum foil between 2 layers of inert plastic film.
 - a. Aluminum foil: Minimum 0.35 mils 0.009 mm thick.
 - b. Inert plastic film: Minimum 4.3 mils 0.11 mm thick.
 2. Resistant to alkalis, acids and other destructive agents found in soil.
 3. Minimum tensile strength: 63 pounds per 3 inches 38 kg per 100 mm width.
 4. Minimum elongation: 500%.
 5. Provide continuous printed message repeated every 400 to 1000 mm 16 to 36 inches warning of pipe buried below (e.g.: "CAUTION GAS LINE BURIED BELOW").
 6. Tape to be inductively locatable and conductively traceable using a standard pipe and cable device for minimum of 8 years after burial.
 7. Color code:
 - a. Yellow: Natural gas and fuel oil systems.
 - b. Blue: Water systems, domestic and fire.
 - c. Green: Sanitary sewer system.
 8. Reef Industries, Detectable Terra Tape.

PART 3 - EXECUTION

3.1 VALVE IDENTIFICATION

- A. Identify valves, with service designation and valve number designation on valve tags.
 1. Tagging of valves at unit heaters, fan coil units, air terminal unit reheat coils and plumbing fixture stops are not required.
 2. Install tags on valves using valve tag fasteners in manner for easy reading.
- B. Label medical gas valves in accordance with NFPA-99.
- C. Furnish 4 charts including valve identification number, location (room number, department) and purpose.
 1. Mount 1 chart in frame and secure on wall in location directed by Owner.
 2. Include remaining 3 sets in Operation and Maintenance Manuals.

3.2 PIPE IDENTIFICATION

- A. Fire-protection and Sprinkler Piping.
 1. Painting not required in non-finished areas.
- B. Identify piping systems with indicated lettering:

Drawing Symbol	Pipe Identification Lettering
A	Medical Air (380 kPa55 psi)
BB	Boiler Blowdown
BFW	Boiler Feed Water
C	Medical Carbon Dioxide (380 kPa55 psi)
CA	Compressed Air
CD	Condensate Drain
CLPR	Clean Low Pressure Return (under 210 kPa 30 psi)
CLPS	Clean Low Pressure Steam (under 210 kPa 30 psi)
CPD	Condensate Pump Discharge
CR	Condenser Water Return
CS	Condenser Water Supply
CW	Domestic Cold Water
CWR	Chilled Water Return
CWS	Chilled Water Supply
DA	Dental Compressed Air (380 kPa55 psi)
DI	Deionized Water
DV	Dental Vacuum
DW	Distilled Water
EV	Medical Anesthesia Evacuation
F	Fire Protection
FOR	Fuel Oil Return
FOS	Fuel Oil Supply
G	Natural Gas
GWR	Glycol Water Return
GWS	Glycol Water Supply
HPR	High Pressure Return (over 480 kPa 70 psi)
HPS	High Pressure Steam (over 480 kPa 70 psi)
HW(120)	Domestic Hot Water Supply (temperature)
HWC(120)	Domestic Hot Water Circulating (temperature)
HWR	Heating Hot Water Return
HWS	Heating Hot Water Supply
IA	Medical Instrument Air (1100 kPa160 psi)
LA	Laboratory Air (380 kPa55 psi)
LO	Laboratory Oxygen (380 kPa55 psi)
LPR	Low Pressure Steam Return (under 210 kPa 30 psi)
LPS	Low Pressure Steam (under 210 kPa 30 psi)
LV	Laboratory Vacuum
MPR	Medium Pressure Return (210 to 480 kPa 30-70 psi)
MPS	Medium Pressure Steam (210 to 480 kPa 30-70 psi)
N	Medical Nitrogen (1100 kPa160 psi)
NO	Medical Nitrous Oxide (380 kPa55 psi)
NPW	Nonpotable Water
O	Medical Oxygen (380 kPa55 psi)

P	Discharge Plumbing-Sump Pump/Sewage Ejector
PCWR	Process Cooling Water Return
PCWS	Process Cooling Water Supply
PR	Condensate Pump Return
S	Sprinklers
SCW	Soft Cold Water
V	Medical-Surgical Vacuum
WAGD	Medical Waste Anesthetic Gas Disposal

C. Locate identification lettering as follows:

1. Next to each valve and fitting, except on plumbing fixtures and equipment.
2. At each branch or riser take off.
3. At each passage through walls, floors and ceilings, both sides.
4. At each pipe passage to underground.
5. On horizontal pipe runs every 20 feet 6100 mm, at least once in each room and each story traversed by piping system.
6. Identify piping contents, flow direction, supply and return.
7. So it is readable from access panels and not obscured by other work.
8. At least once in or above every room.

D. Size lettering, marker color fields, and arrows as follows:

Outside Diameter of Pipe or Pipe Covering	Length of Color Field (Markers)	Size of Letters and Arrows
mm	mm	mm
20 to 32	200	12
40 to 50	200	20
65 to 150	300	32
200 to 250	600	65
Over 250	800	90

Outside Diameter of Pipe or Pipe Covering	Length of Color Field (Markers)	Size of Letters and Arrows
IN	IN	IN
3/4 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

E. Pipe Markers:

1. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

F. Where supplementary color identification of medical gas piping is used, paint or label in accordance with gases and colors indicated in CGA Pamphlet C-9.

G. Where piping is heat traced, provide warning labels on insulation adjacent to each piping system identifier.

1. Temperature maintenance cable: See Section 22 10 16.

3.3 DUCTWORK IDENTIFICATION

- A. Locate duct markers as follows:
 - 1. At each branch or riser take-off.
 - 2. Next to equipment.
- B. Stencil ductwork or exterior surface of insulation.

3.4 EQUIPMENT IDENTIFICATION

- A. Attach equipment nameplates in conspicuous location, directly on item of equipment or apparatus such as starters, pumps, fans, HVAC units and control panels.
 - 1. Secure nameplates with self-tapping screws, or nuts and bolts.
- B. For unsuitable surfaces, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.
- C. Identify devices located above ceilings and below raised floors with additional identification.
 - 1. Use access panel markers (metal tack style) for acoustical tile ceilings, or engraved plastic style, 3/4 inches 20 mm square, for mounting on panel door; or equipment nameplates.
 - 2. Coordinate with Owner on identification method and color codes.
 - 3. Provide markers on all removable ceilings and ceiling access panels to indicate locations of valves, dampers, smoke detectors, etc., and other mechanical items that may need servicing or adjustment. Glue marking tacks in place to prevent their falling out.
 - 4. Where fire protection devices are located inside ductwork, provide an additional tag on the duct access door identifying device inside.
 - a. Identification letter size: 1-1/2 inches 40 mm high minimum.
 - 5. Color code access panel markers as follows:
 - a. Red: Fire dampers, smoke detectors, sprinkler shutoff valves and duct type smoke detectors.
 - 1) Notation:
 - D - Damper
 - V - Valve
 - S - Smoke Detector
 - H - Heat Detector
 - b. Yellow: Steam, radiation, reheat and chilled water valves:
 - 1) Notation:
 - V - Valve
 - c. Gold: Automatic and balancing dampers:
 - 1) Notation:
 - V - Valve
 - D - Damper
 - d. Blue: Gases (valves):
 - 1) Notation
 - O - Oxygen
 - V - Vacuum
 - A - Medical Air
 - N - Nitrogen
 - NO - Nitrous oxide
 - EV - Anesthesia Evacuation
 - T - Temperature Control Air

3.5 INSTALLATION OF UNDERGROUND MARKING TAPE

- A. Add marking tape on all below ground geothermal piping, every 10' along piping system..

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Testing and Balancing, as indicated, in accordance with provisions of Contract Documents.
- B. Test, balance and adjust following mechanical systems:
 - 1. Air distribution systems.
 - 2. Air handling units and air moving equipment.
 - 3. Heat Pump systems including pumps.
 - 4. Heating and cooling coils.
 - 5. Existing air distribution systems affected by new installation.
 - 6. Temperature Controls:
 - a. Assist Temperature Controls installer with calibration of air and waterside control components such as airflow stations, flow meters, etc as outlined in Section 25 10 00.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Agency qualifications: Independent test and balance agency, member of Associated Air Balance Council (AABC), or National Environmental Balancing Bureau (NEBB).
 - 1. Work supervised by a certified Testing and Balancing Engineer.
 - 2. Indicate at least 5 successfully completed projects of similar size and scope.
- B. Testing and balancing standards: AABC or NEBB standards and procedures.

1.3 RESPONSIBILITIES OF TESTING AND BALANCING (TAB) AGENCY

- A. Review contract document ductwork drawings before bid and advise 23 31 13 contractor as to the number and size of additional branch main volume dampers required to facilitate balancing.
- B. In accordance with 23 31 13, review contractor ductwork installation drawings before fabrication and advise where additional volume dampers are required to facilitate balancing.
- C. Schedule work with trades involved.
- D. Check, adjust, and balance system components to obtain optimum conditions for function and operation of system.
- E. Evaluate operation of systems and advise installer of necessary adjustments and corrective measures.
- F. Prepare and submit test reports.
 - 1. Submit to Owner and to Contractor for Submittal to Architect.

1.4 RESPONSIBILITIES OF MECHANICAL INSTALLER

- A. Coordinate and schedule with testing agency.
- B. Start-up system and keep in correct operation during balancing operations.
- C. Provide necessary adjustments and corrections to systems as directed by Testing and Balancing Agency.
- D. Maintain accessibility to test locations and devices requiring adjustment.
- E. Provide additional sets of pulleys and belts as required by Testing and Balancing Agency.

- F. Provide a complete set of approved mechanical-equipment shop drawings to Testing and Balancing Agency.
- G. Provide a complete set of "As-built" drawings to Testing and Balancing Agency.

1.5 JOB CONDITIONS

- A. Balance at time directed by Architect.
 - 1. If balancing is not done during peak cooling season demonstrate satisfactory balancing during next peak cooling season.
- B. Keep dust, dirt and debris to an absolute minimum and reinstall removed ceiling tiles to original positions at end of each work day.

1.6 CORRECTIVE WORK

- A. Provide extended warranty of ninety (90) days, after completion of test and balance work, during which time Architect may, at Architect's discretion, request recheck or resetting of equipment or system which is not performing satisfactorily. Provide technicians to assist as required in making such tests.

1.7 SUBMITTALS

- A. Project Information:
 - 1. Within sixty (60) days of award of contract submit a complete Submission Report including:
 - a. A company resume listing its personnel and project experience in air and hydronic balancing.
 - b. An inventory and calibration data of instruments and devices in possession of balancing agency whether or not they will be used on this project.
 - c. A working agenda that includes procedures for testing and balancing each air and water flow system.
 - d. Test and Balance Report Forms and Field Data Sheets that will appear in final report, with design data already filled in.
 - e. A written, system-by-system description of measurements, test locations and procedures that will be employed during test and balance.
- B. Contract Closeout Information:
 - 1. Final test and balance report:
 - a. Use forms similar to AABC or NEBB latest editions.
 - b. Report(s) signed by TAB Engineer.

PART 2 - PRODUCTS

2.1 JOB SITE INSPECTIONS

- A. During construction inspect installation of piping, sheet metal work, temperature controls, flow meters, pressure taps, strainers and other components of HVAC system as specified in contract documents.
- B. Note any deficiencies and submit them, in writing, to Architect.
 - 1. Include these inspection reports in final TAB report.

2.2 FINAL TEST AND BALANCE REPORT

- A. Using field data, test forms and procedures outlined in Submission Report, perform and record measurements, and complete final TAB report including:
 - 1. Preface:
 - a. General discussion of system including any abnormalities and problems encountered.
 - 2. Instrumentation list:

- a. List of instruments including type, model, manufacturer, serial number and calibration date.
3. System identification:
 - a. On each Test and Balance Report Form, number and/ or letter air terminal units, zones, supply, return and exhaust openings and traverse points to correspond to numbers and letters on Field Data Sheets.
4. Air handling equipment:
 - a. Manufacturer, model number, and serial number.
 - b. Design and manufacturer related data.
 - c. Total actual air flow rate by traverse if practical; if not practical, sum of outlets may be used, or a combination of each of these procedures.
 - 1) For specific systems, such as ones with diversity, see AABC National Standards.
 - d. Suction and discharge static pressure of each fan, as applicable.
 - e. Outside air and return air total air flow rate.
 - f. Actual operating current, voltage, and brake power of each fan motor.
 - g. Final RPM of each fan.
 - h. Fan and motor sheave manufacturer, model, size, number of grooves and center distance.
 - i. Belt size and quantity.
 - j. Static pressure controls final operation set points.
5. Pumps:
 - a. Manufacturer, size, and serial number.
 - b. Design and manufacturer's related data.
 - c. Pump operating suction and discharge pressures, and final total dynamic head.
 - d. No-flow (pump discharge valve closed) suction and discharge pressures, and corresponding total dynamic head. (This procedure is to determine actual impeller size.)
 - e. Rated and actual operating current, voltage and brake power of each pump motor.
 - f. Submit pump curve indicating design, operating, and no-flow points of operation.
6. Heat Recovery Unit:
 - a. Manufacturer and model number.
 - b. Design and manufacturer's related data.
 - c. Service and location.
 - d. Actual pressure drop and related water flow rate or steam pressure, primary side.
 - e. Actual pressure drop and related water flow rate or steam pressure, secondary side.
 - f. Primary side entering and leaving temperatures. (Not applicable for steam-to-water heat exchangers.)
 - g. Secondary side entering and leaving temperatures.
 - h. Temperature control setting.
7. Heating and cooling coils:
 - a. Manufacturer.
 - b. Design and manufacturer's related data.
 - c. Rated and actual water pressure drops through each coil and related water flow rate.
 - d. Rated and actual static air pressure drops across each coil.
 - e. Entering and leaving water temperatures.
 - f. Wet bulb and dry bulb temperatures entering and leaving each cooling coil.
 - g. Dry bulb temperatures entering and leaving each heating coil.
 - h. Water flow rate from flow stations or steam pressure.
8. Air terminal units, diffusers, registers and grilles:

- a. Adjust air terminal units to deliver design maximum and minimum air-flow conditions.
- b. Flow rate at each air outlet (diffuser).
- c. Flow rate at each return and exhaust air inlet (register or grille).

PART 3 - EXECUTION

3.1 GENERAL

- A. Final reports are required to be completed and submitted far enough in advance of local agencies final inspections for occupancy to provide adequate time for Engineer to review, Contractor to correct any deficiencies and reports to be revised for agencies final inspections.
- B. Coordinate and schedule testing and balancing with Contractor and Mechanical Contractor.
 - 1. Report deficiencies in systems to Mechanical Contractor for resolution.
- C. Accurately calibrate and maintain test instruments in good working order.
 - 1. If requested, conduct tests of instruments in presence of Engineer.
- D. If requested, conduct balancing tests in presence of Engineer.
- E. Do not begin balancing until system(s) have been substantially completed and are in good working order to permit preliminary measurements of total air or water volumes and system pressures.
- F. Proceed with final balancing and adjustments when systems are 95 to 100% complete.
- G. Record inspections, tests and adjustments.

3.2 AIR BALANCING METHODS

- A. Balance each air system that is served by air filters, using artificial static loading of system, to demonstrate, test and obtain system design pressure drop data.
 - 1. Provide dirty filter pressure drop conditions on system.
 - 2. Do not use high efficiency filters (75% and above) in testing and balancing.
 - 3. Static pressure losses may be simulated by using wood or sheet steel blanking plates in high efficiency filter racks and housings.
 - 4. Do not install blanking plates within 600 mm 2 feet of low efficiency filter unit or rack.

3.3 AIR BALANCE TESTING PROCEDURE

- A. Perform tests and balance system in accordance with approved Submission Report.
- B. Take readings of airflow stations if installed or make pitot tube traverse of main supply, return and exhaust air ducts.
 - 1. Obtain flow rates at fans at both maximum and minimum outside air operation.
- C. Test and adjust each diffuser, grille, and register served by an air terminal unit to within 10% of design requirements.
- D. In cooperation with HVAC Controls installer, set automatically operated dampers to operate as indicated.
 - 1. Check controls for proper calibration and list controls requiring adjustment.

3.4 WATER BALANCE TESTING PROCEDURE

- A. Complete air balancing before commencing water balancing.
- B. Perform test and balance systems in accordance with approved Submission Report.

3.5 OPERATING TEST

- A. After systems are balanced, conduct operating test of not less than 8 hours duration to demonstrate to satisfaction of Architect that system(s) comply with requirements of plans and specifications, and that equipment and controls are functioning properly.

END OF SECTION

SECTION 23 07 00
PIPE, DUCT AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Pipe, Duct and Equipment Insulation, as indicated, in accordance with provisions of Contract Documents.
- B. Insulation Applications:
 - 1. Pipe insulation.
 - 2. Duct insulation.
 - 3. Equipment insulation.
 - 4. Insulation jacketing and prefabricated fitting covers.
 - 5. Insulation fasteners: Adhesives, mastics, and caulking.
 - 6. Special Considerations at hangers and bracing: See Section 23 05 29 Penetrations and Supports.
- C. Definitions:
 - 1. Concealed: Outside surfaces are isolated from room ambient air conditions by physical barrier.
 - a. Concealed items are typically accessed through suspended ceilings, through access doors, or by cutting and patching.
 - b. Listed below are examples of spaces that typically contain concealed items:
 - 1) Walls.
 - 2) Partitions.
 - 3) Chases.
 - 4) Shafts.
 - 5) Ceiling spaces.
 - 2. Exposed to weather: Outside surfaces are not isolated by physical barrier(s) from weather or outside ambient air conditions.
 - 3. Runouts: Piping not more than 12 feet in length.
 - 4. Thermal conductivity (k): Btu/(h-ft-deg F).
 - 5. Serviceable: strainers, steam traps, cleanouts.
 - 6. Non-Serviceable: fittings, valves.
- D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Comply with the following fire and smoke hazard ratings:
 - 1. Test products by procedure ASTM E84, NFPA-255 and ANSI/UL-723.
 - 2. Rating requirements:
 - a. Maximum Flame Spread: 25.
 - b. Maximum Smoke Developed: 50.
 - 3. Properly identify products for flame and smoke ratings.
 - a. Shipping cartons may be labeled instead of product.
- B. Comply with requirements of the following:
 - 1. ASTM C547 Standard Specification for Mineral Fiber Preformed Pipe Insulation.
 - 2. ASTM C533 Standard Specification for Calcium Silicate Pipe and Block Insulation.

3. ASTM C534 Standard Specification for Preformed Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - a. Products are allowed to deviate from this standard with regard to insulation density.
4. ASTM C552-00 Standard Specification for Cellular Glass Thermal Insulation.
5. ASTM C553 Standard Specification for Mineral Fiber Blanket and Felt Insulation.
6. ASTM C585 Recommended Practice for Inner and Outer Diameters of Rigid Pipe 'Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
7. ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
8. ASTM C1136 Standard Specification for Flexible Low Permeance Vapor Retarders for Thermal Insulation.
9. ASTM C795 Thermal Insulation for Use Over Austenitic Stainless Steel.
10. Federal Specification HH-I-558B Mineral Fiber Boards, Blankets, Pipe Covering.
11. ASTM E 84, Surface Burning Characteristics: Underwriters Laboratories Applied Fireproofing Listing Nos. 11660-2, 11660-4.
12. ASTM E 2336: Standard Test Methods Fire Resistive Grease Duct Enclosure Systems.
13. ASTM E 814, Through-Penetration, 2-Hour Firestop Test.
14. ASTM E 119 Standard Method of Fire Tests of Building Construction, 2 Hour Wall Panel Test, 2 Hour External Total Engulfment Test, hose stream evaluation.
15. ASTM C 518 Aging Test, Steady State Heat Flux Measurements and Thermal Transmission Properties.
16. ASTM E 162, Surface Flammability of Materials.
17. ASTM E 136, Combustion Characteristics of Building Materials in a Vertical Tube Furnace.
18. ISO 6944-1985, Method of Determining Fire Resistance of Ventilation Ducts.
19. National Commercial and Industrial Insulation Standards (2013 seventh edition).
 - a. Published by Midwest Insulation Contractors Association (MICA).
 - b. Endorsed by National Insulation Association (NIA).
 - c. MICA plate numbers listed in this specification reference this document.

1.3 SUBMITTALS

- A. Product Data:
 1. Pipe insulation.
 2. Precut insulation inserts.
 3. Ductwork insulation.
 4. Insulation for hot equipment.
 5. Insulation for high-temperature equipment.
 6. Insulation for cold equipment.
 7. Jacketing and prefabricated fitting covers.
 8. Insulation fasteners.
 9. Schedule of services and insulation thicknesses.

PART 2 - GENERAL

2.1 MANUFACTURERS

- A. Pipe, Duct and Equipment Insulation:
 1. Insulation materials:
 - a. Base: As indicated.
 - b. Optional:
 - 1) Owens-Corning Fiberglass.
 - 2) Armacell.

- 3) Nomaco K-Flex.
- 4) CertainTeed Insulations.
- 5) Knauf Insulation.
- 6) Johns Manville.
- 7) Pittsburgh Corning.
- 2. Jacketing:
 - a. Base: As indicated.
 - b. Optional:
 - 1) Ceel-Co.
 - 2) Childers Products.
 - 3) Johns Manville.
 - 4) Proto PVC Corporation.
 - 5) RPR Metals.
 - 6) Pabco Metals Corporation.
- 3. Prefabricated fitting covers:
 - a. Base: As indicated.
 - b. Optional:
 - 1) Ceel-Co.
 - 2) CertainTeed Insulations.
 - 3) Childers Products.
 - 4) Proto PVC Corporation.
 - 5) Johns Manville.
 - 6) RPR Metals.
 - 7) Pabco Metals Corporation.
- 4. Adhesives, mastics, and sealants:
 - a. Base: As indicated.
 - b. Optional:
 - 1) Foster Products, Division of HB Fuller.
 - 2) Armacell.
 - 3) Childers Products.
 - 4) Dow.
 - 5) Johns Manville.
 - 6) Knauf Insulation.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. General:

- 1. Do not use material that exceeds specified flame and smoke ratings.
- 2. Use permanent treatments to jacketings and facings to impart specified fire ratings.
- 3. Use of water soluble treatments is prohibited.

2.3 PIPE INSULATION - NON-FLEXIBLE FIBERGLASS

- A. Preformed commercial-grade fiberglass.
- B. Temperature range: 0 deg F to 850 deg F.
- C. Thermal conductivity at mean temperature:

1. $k \leq 0.23$, 75 deg F.
 2. $k \leq 0.29$, 200 deg F.
 3. $k \leq 0.54$, 500 deg F.
- D. Facing: All service jacket.
- E. Integral vapor retarder: Provide where indicated in Part 3.
- F. Seams, longitudinal: 2 inches self-sealing facing tabs.
1. Provide adhesive on both contacting surfaces.
 2. Designed to perform without stapling.
- G. Pipe insulation, non-flexible; cellular glass:

2.4 PIPE INSULATION - FLEXIBLE

- A. Commercial-grade closed-cell elastomeric or unicellular polyolefin thermal insulation.
- B. Temperature range: 40 to 200 deg F.
- C. Thermal conductivity at mean temperature:
1. $k \leq 0.27$, 75 deg F.
 2. $k \leq 0.276$, 90 deg F.
- D. Seams, longitudinal: Factory-cut and self-sealing.
1. Base product: AP Armaflex SS.

2.5 DUCTWORK INSULATION, NON-FLEXIBLE

- A. Commercial-grade fiberglass thermal insulation formed with a thermosetting resin into semi-rigid or rigid boards.
- B. Temperature range: 0 to 450 deg F.
- C. Minimum density:
1. Semi-rigid: 3.0 pcf.
 2. Rigid: 6.0 pcf.
- D. Thermal conductivity at mean temperature:
1. Semi-rigid:
 - a. $k \leq 0.22$, 75 deg F.
 - b. $k \leq 0.27$, 150 deg F.
 - c. $k \leq 0.38$, 300 deg F.
 2. Rigid:
 - a. $k \leq 0.23$, 75 deg F.
 - b. $k \leq 0.27$, 150 deg F.
 - c. $k \leq 0.37$, 300 deg F.
- E. Facing: All-Service-Jacket (ASJ).
- F. Temperature range: -20 to 150 deg F.
- G. Base Products:
1. Semi-Rigid: Owens-Corning Fiberglas Type 703.
 2. Rigid: Owens-Corning Fiberglas Type 705.

2.6 DUCTWORK INSULATION - FLEXIBLE

- A. Interior Use:

1. Commercial-grade fiberglass thermal insulation, formaldehyde free.
 2. Temperature range: 40 to 250 deg F.
 3. Thermal conductivity at mean temperature: $k \leq 0.30$, 75 deg F.
 4. Installed R-value: 6.0 hour-ft²-degF/BTU based on 2.2 inches nominal thickness.
 5. Density: 0.75 pcf.
 6. Facing: Foil-Reinforced-Kraft (FRK) vapor-retarding.
 7. Seams: 2 inches facing tab.
 8. Base product: Owens-Corning Fiberglass commercial-grade all-service duct wrap.
- B. Exterior Use:
1. Commercial-grade closed-cell elastomeric or unicellular polyolefin thermal insulation.
 2. Temperature range: -40 to 180 deg F.
 3. Thermal conductivity at mean temperature: $k \leq 0.27$, 90 deg F.
 4. Water vapor permeability: 08 perm-in.
 5. Base Product: AP Armaflex Sheet and Roll.

2.7 INSULATION FOR COLD EQUIPMENT

- A. Material: Commercial-grade elastomeric thermal insulation.
- B. Designed for application with complete adhesive coverage on systems operating at temperatures between -40 and 180 deg F.
- C. Thermal conductivity at mean temperature:
1. $k \leq 0.27$, 75 deg F.
- D. Base product: AP Armaflex sheet insulation.

2.8 JACKETING AND PREFABRICATED FITTING COVERS

- A. General:
1. Fitting Covers:
 - a. Designed to fit over precut insulation inserts.
 - b. Designed specifically for fitting being covered.
 - c. 2-gore covers are not acceptable.
 - d. Where PVC covers are used, insulation inserts shall be the same density as the adjacent pipe insulation, low density inserts are not allowed.
- B. Jacketing and Fitting Covers:
1. High impact PVC.
 2. Minimum 0.028 inches thick.
- C. Metal Jacketing and Fitting Covers:
1. Material: As indicated in Part 3.
 2. On cold systems and equipment, provide factory moisture barrier.
 3. Attaching method:
 - a. 0.020 x 3/8 inches bands on 9 inches centers unless indicated otherwise in Part 3.
 - b. Band material: Same as jacketing and covers.
 4. Minimum 2 inches overlap at joints.
 5. Tubular jacketing: Locking longitudinal seams.
 6. Base manufacturer: Childers.

2.9 INSULATION FASTENERS

- A. Insulation Adhesive:

1. Flexible pipe insulation: Manufacturers standard adhesive as approved for application.
 2. Foster 30-36.
 3. Foster Spark-Fas 85-70.
- B. Insulation Mastic:
1. Childers CP-30.
 2. Foster 35-00-GPM.
- C. Insulation Caulking:
1. As recommended by insulation manufacturer.

PART 3 - EXECUTION

3.1 APPLICATION

- A. General:
1. Apply products per manufacturer's recommendations and as specified.
 - a. Include allowance for thermal expansion and contraction.
 2. MICA plate numbers are listed under some insulation applications to clarify scope and acceptable methods of insulation application for particular listing.
 3. Do not insulate piping until satisfactory completion of required pressure tests.
 4. Do not insulate piping until heat tracing cable has been installed.
 5. Do not insulate piping below grade.
 - a. Specific exceptions may exist under Pipe Insulation - Flexible.
 6. Apply insulation to clean, dry surfaces and within manufacturers recommended temperature range.
 7. Butt edges of insulation firmly together, and seal joints with compatible jackets, facings and adhesives as specified.
 8. Apply insulation with a continuous, unbroken vapor retarder including, but not limited to, insulation of following.
 - a. Vapor seals on hangers, supports, and anchors secured directly to cold surfaces.
 9. Continue insulation through sleeves and wall and ceiling openings.
 10. Insulate fittings, unions, valve bodies, flanges and other pipeline accessories.
 11. Insulation at piping supports: Coordinate with Section 23 05 29.
 12. Rectangular and flat-oval ductwork exposed to weather:
 - a. Apply insulation and jacketing so top of ductwork crowns to prevent pooling of water.
 - 1) Minimum crown slope: 1/4 inches/FT.
 13. Insulation installed in multiple layers: Stagger joints between layers.

3.2 PIPE INSULATION - NON-FLEXIBLE FIBERGLASS

- A. General:
1. Provide either type of lap seal at joints:
 - a. Self-sealing facing tabs.
 - b. 3 inches wide pressure-sensitive joint-sealing tape matching facing.
 - 1) Manufacturer: Same as insulation.
 - c. Insulation application standard: MICA plate number 1-100.
 - d. Insulation application for heat traced piping standard: MICA plate number 1-900.
 2. Fittings:
 - a. On non-serviceable items, use either of the following methods:
 - 1) Built-up systems:

- a) Elbows: MICA plate numbers 2-100 through 2-800 as applicable.
 - b) Valves and fittings: MICA plate number 2-530 or 2-536 as applicable.
 - c) Flanges: MICA plate number 2-535.
 - d) Tees: MICA plate number 2-120.
 - 2) Prefabricated fitting cover encapsulated:
 - a) Elbows: MICA plate number 2-500.
 - b) Valves and fittings: MICA plate number 2-130.
 - c) Flange or grooved coupling: MICA plate number 2-535.
 - b. Serviceable items: Provide prefabricated fitting covers attached with bands.
 - 1) Exception: On systems exposed to weather, attach with method described as best by manufacturer.
 - c. Exposed fittings, flanges, valves, and pipe terminations: Provide prefabricated fitting covers.
 - d. Built-up system:
 - 1) DN50 2 inches and smaller: Finish with mineral fiber cement to thickness of adjoining pipe insulation.
 - 2) DN65 2-1/2 inches and larger: Insulate with insulation insert, mitered pipe insulation segments or preformed fiberglass fittings.
 - a) Secure with vinyl faced insulation strapping tape or 20 AWG galvanized annealed wire finished with one coat of mineral fiber cement.
 - 3) Finish with Glass Fab embedded in 2 coats of Foster 30-36 adhesive.
- B. Provide non-flexible insulation on following piping systems in wall thickness indicated:
- 1. Hydronic systems:
 - a. Heating water piping, with or without glycol to 200 deg F:
 - 1) DN32 1-1/4 inches and smaller: 1-1/2 inches.
 - 2) DN40 1-1/2 inches and greater: 2 inches.
 - 2. Plumbing systems:
 - a. Domestic cold water piping:
 - 1) DN40 1-1/2 inches and smaller: 1 inch.
 - 2) DN50 2 inches and greater: 1-1/2 inches.
 - b. Domestic hot/recirculating water, 100 to 140 deg F:
 - 1) DN32 1-1/4 inches and smaller: 1 inch.
 - 2) DN40 1-1/2 inches and greater: 1-1/2 inches.
 - c. Domestic hot/recirculating water 141 to 180 deg F:
 - 1) DN32 1-1/4 inches and smaller: 1-1/2 inches.
 - 2) DN40 1-1/2 inches and greater: 2 inches.
 - 3. Low pressure steam and steam condensate piping, 15 psi or less, pumped condensate return, condensate vent, blowdown, boiler feed, and exhaust steam piping:
 - a. DN75 3 inches and smaller: 2-1/2 inches.
 - b. DN100 4 inches and larger: 3 inches.
 - 4. Steam and steam condensate piping, 16 psi to 100 psi:
 - a. DN20 3/4 inches and smaller: 3 inches.
 - b. DN25 1 inch and larger: 4-1/2 inches.
 - 5. Steam and steam condensate piping greater than 100 psi:
 - a. DN20 3/4 inches and smaller: 4-1/2 inches.
 - b. DN25 1 inch and larger: 5 inches.
 - 6. Refrigerant systems:

- a. Refrigerant/brine piping:
 - 1) DN32 1-1/4 inches and smaller: 1 inch.
 - 2) DN40 1-1/2 inches and larger: 1-1/2 inches.
- 7. Medical gas systems:
 - a. Medical air and lab air intake piping:
 - 1) All sizes: 1 inch.
 - 2) Medical air and lab air intakes are cold systems.
 - b. Medical vacuum exhaust piping:
 - 1) DN40 1-1/2IN and smaller: 1-1/2 inches.
 - 2) DN25 1IN and larger: 3 inches.
- C. Piping Within Air Handling Units:
 - 1. Flame-resistant, aluminum-faced, vapor retarder jacket over non-flexible insulation on steam, condensate-return, heating-water, and chilled-water piping inside air handling units.
 - 2. Extend vapor retarder jacket outside of unit enclosure.
 - 3. Cover joints with 3 inches wide pressure sensitive tape matching jacket.

3.3 PIPE INSULATION - FLEXIBLE

- A. General:
 - 1. Install insulation sleeve over piping.
 - 2. Do not make longitudinal field cuts.
 - 3. Seal joints with manufacturer approved adhesive.
 - 4. Do not use flexible pipe insulation on systems with heat tracing cable or temperature maintenance cable.
- B. Fittings:
 - 1. Insulate fittings and valve bodies with segments cut from pipe insulation.
- C. Provide flexible insulation on following piping systems in wall thickness indicated:
 - 1. Hydronic systems:
 - a. Cooling coil condensate:
 - 1) All sizes: 1 inch.
 - b. Chilled water piping, with or without glycol, 40 to 55 deg F:
 - 1) DN40 1 1/2 inches and smaller: 1 inch.
 - 2) DN50 2 inches and above: 1 1/2 inches.
 - 2. Refrigerant systems:
 - a. Refrigerant/brine piping:
 - 1) DN32 1-1/4 inches and smaller: 1 inch.
 - 2) DN40 1-1/2 inches and larger: 1-1/2 inches.
 - 3. Plumbing systems:
 - a. Domestic cold water piping:
 - 1) DN40 1-1/2 inches and smaller: 1/2 inches.
 - 2) DN50 2 inches and larger: 1 inch.
 - b. Waste piping from lab sinks to main stacks:
 - 1) All sizes: 1/2 inches.
 - c. Waste piping from water coolers and drinking fountains to first point of mixing with waste from a different type of fixture:
 - 1) All sizes: 1/2 inches.
 - d. Domestic water piping below grade within 5 feet of outside walls:

- 1) All sizes: 1/2 inches.
- e. Horizontal rain leaders, including overflow systems and 24 inches up and down from horizontal and up to underside of roof deck:
 - 1) All sizes: 1 inch.
 - 2) Rain leaders are cold systems.
- f. Horizontal condensate drain leaders (serving condensate drain discharge from cooling coil condensate drains, walk in refrigerator and freezer cooling units) and floor drain:
 - 1) All sizes: 1 inch.
 - 2) Condensate drain leaders are cold systems.

3.4 DUCTWORK INSULATION - NONFLEXIBLE

A. General:

1. Secure insulation to ductwork by impaling over welded-pin or adhesive-pin mechanical fasteners.
 - a. Secure insulation on mechanical fasteners with speed clips.
 - b. Space mechanical fasteners to hold insulation securely in place.
 - 1) Maximum spacing: 12 inches centers.
2. Where access is not possible for pin attachment, use adhesive or caulk.
 - a. Cover entire surface with brush applied adhesive.
 - b. Apply caulk in continuous bead on 6 inches centers.
3. Seal joints and speed clips with 3 inches wide pressure-sensitive joint-sealing tape matching facing.
 - a. Staple corners of tape with outward clinching staples.
4. Cold systems only: Coat staples with mastic.
5. Reinforce edges with metal corner angles.
6. Apply insulation to ductwork from unit housing to ends of duct runs including diffuser necks and register ducts.
7. Do not apply insulation over coil and damper access panels.
8. Use FRK facing on concealed ductwork.
9. Use ASJ facing on exposed ductwork.

B. Provide non-flexible insulation on following ductwork in thickness indicated:

1. Outside-air rectangular ductwork:
 - a. All sizes: 2 inches.
2. Supply-air ductwork exposed in occupied spaces, except equipment rooms:
3. Factory packaged air handling units, mixed-air plenum and ductwork, component housings to fan unit inlet including transition sections and prefilter:
 - a. All sizes: 2 inches.
4. Fan discharge transition to and including final filter housing:
 - a. All sizes: 2 inches.
5. Relief-air/exhaust-air plenums behind louvers or below gravity and powered roof ventilators:
 - a. All sizes: 2 inches.

3.5 DUCTWORK INSULATION - FLEXIBLE

A. General:

1. On ductwork 24 inches wide and less, secure insulation to bottom of ductwork with 4 inches wide bands of brush-applied adhesive on 12 inches centers.
2. On ductwork over 24 inches wide, secure insulation to bottom of ductwork by impaling over welded-pin or adhesive-pin mechanical fasteners.

- a. Secure insulation on mechanical fasteners with speed clips.
- b. Space mechanical fasteners to hold insulation securely in place.
 - 1) Maximum spacing: 12 inches centers.
- c. Seal speed clips with 3 inches wide pressure-sensitive joint-sealing tape matching jacket.
 - 1) Staple corners of tape with outward clinching staples.
 - 2) Cold systems only: Seal staples with mastic.
3. Provide either type of lap seal at joints:
 - a. Seal facing tab over adjoining facing with lap adhesive.
 - 1) Secure lap with outward clinching staples on 6 inches centers.
 - b. Use 3 inches wide pressure-sensitive joint-sealing tape that matches facing.
 - 1) Secure both sides of tape with outward clinching staples on 6 inches centers.
 - c. Cold systems only: Seal staples with mastic.
4. Apply insulation to ductwork from unit housing to ends of duct runs, including diffuser necks and register ducts.
5. Do not apply insulation over coil and damper access panels.
- B. Provide flexible insulation on following ductwork in thickness indicated:
 1. Outside-air round ductwork:
 - a. All sizes: 3 inches; minimum installed R-value of 8.0.
 2. Supply-air ductwork, including downstream of terminal units, sound attenuators, reheat coil casings and tube ends or specified to be covered by nonflexible insulation:
 - a. All sizes: 2-1/8 inches; minimum installed R-value of 6.0.
 3. Return-air ductwork in non-air conditioned areas (including utility shafts):
 - a. All sizes: 2-1/8 inches; minimum installed R-value of 6.0.
 - b. Ceiling spaces directly above conditioned spaces are considered conditioned.
- C. Flexible Elastomeric:
 1. For exterior ductwork exposed to weather.
 2. Install in accordance with MICA National Commercial and Industrial Standards Plate No.: 20A.
 3. Adhesive: Applied as required to assist installation.
 4. Mechanical fasteners: As required to assist installation.
 5. Provide one of following as a weather barrier:
 - a. Jacket: metal.
 - b. Aluminum composite facing with UV/weather resistant coating.
 - 1) Example: K-Flex LS sheet.
 - 2) Product must be provided with a twenty-five (25) year limited warranty against breakdown of the membrane due to ultraviolet radiation.
 - c. Factory applied multi-ply laminate UV/weather resistant facing.
 - 1) Example: Armaflex ArmaTuff Plus II.
 - 2) Thickness: 16 mil laminated covering membrane.
 - a) UV protective, blended polymeric top surface.
 - b) Puncture-resistant blended polymeric base around a scrim reinforced core.
 - 3) Product must be provided with a ten (10) year limited warranty against breakdown of membrane due to ultraviolet radiation.
 6. Insulation of standing seams: insulation manufactures field-cut pipe insulation with weather barrier.

7. Apply insulation and jacketing so that top of ductwork has crown that effectively prevents pooling of water.
 - a. Minimum crown slope: 1/4 inches/FT.
8. Provide flexible elastomeric insulation on the following exterior ductwork in thickness indicated:

3.6 INSULATION - COLD EQUIPMENT

- A. Apply insulation with adhesive and coatings approved by manufacturer.
 1. Completely cover joining surfaces (equipment surfaces, and back and butting edges of insulation).
 2. Apply with 1/8 inches overlay pressure on butt joints.
 3. Apply 2 coats of white latex enamel to outside layer.
- B. Provide cold-equipment insulation on following equipment in number of layers and total thickness indicated:
 1. Heat Pump water pump casing: 1 layer, 3/4 inches.
 - a. Insulation assembly standard: MICA plate number 50.
 2. Domestic water meter: 1 layer, 3/4 inches.
 - a. Insulation assembly standard: MICA plate number 8-400.
 3. Roof drain bodies: 1 layer, 20 mm 3/4 inches.
 4. Heat Pump water expansion tanks: 1 layer, 3/4 inches.
 - a. Insulation assembly standard: MICA plate number 4-200.
 5. Heat Pump water air separators: 1 layer, 3/4 inches.
 - a. Insulation assembly standard: MICA plate number 4-200.

3.7 JACKETING AND PREFABRICATED FITTING COVERS

- A. General:
 1. Stagger jacketing and insulation joints.
- B. Systems exposed to weather:
 1. Material:
 - a. 0.016 inches smooth aluminum.
 2. Attach as recommended by manufacturer.
 3. Joints:
 - a. Orient joint laps to prevent entry of water.
 - b. Seal joints weather tight.

END OF SECTION

SECTION 23 08 16
HVAC SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The purpose of this section is to specify Division 23 responsibilities and participation in the commissioning process. Responsibilities and participation in the commissioning process shall comply with the requirements of specification Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.
- B. The Owner has contracted with a Commissioning Authority (CxA) to oversee certain commissioning activities on this project. While the CxA has the overall responsibility for planning and coordinating the commissioning process, all parties participate. This includes the owner, construction manager, facility operator, architect, engineer, general contractor, subcontractors, specialty subcontractors, equipment suppliers, vendors, building authorities, and others entities as required.
- C. The General Contractor and all Subcontractors shall each designate one person to represent their own company as Commissioning Coordinator (CC). Each Commissioning Coordinator shall participate as a member of the Commissioning Authority's 'Commissioning Team'.
- D. Commissioning and coordination with the Commissioning Authority are the responsibility of the Contractor (including subcontractors and vendors). The Contractor is responsible for providing all scheduling, coordination and support required for start-up, testing, and commissioning.

1.2 RELATED WORK

- A. Division 01 Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 23 11 00
MECHANICAL PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Pipe and Fittings, as indicated, in accordance with provisions of Contract Documents.
- B. Systems Included:
 - 1. Pressurized piping.
 - 2. Non-pressurized piping.
 - 3. Acid resistant piping.
 - 4. High purity water piping.
 - 5. Perforated drainage piping.
 - 6. Accessories:
 - a. Dielectric fittings.
 - b. Unions.
- C. This specification lists a variety of piping that may be applicable to the project. Not all piping and fittings listed are applicable to the project, refer to appropriate spec sections for project applicability.
- D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Pipe and fittings to be ASTM labeled for rating specified.
- B. Pipe and fittings to be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed NSF International.
- C. Welder qualifications: Certified under requirements of ANSI/ASME-B31.1 Power Piping.
- D. Comply with NSF 61 for potable domestic water piping and components that come in contact with potable water.

1.3 SUBMITTALS

- A. Contract Closeout Information:
 - 1. Manufacturer of listed products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Dielectric Waterway Fittings:
 - 1. Base:
 - a. Perfection Corp. Victaulic Company of America.
 - b. Grinnell.
 - c. Victaulic.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 PIPE

- A. Black Steel Pipe:
 - 1. Seamless or welded steel pipe, ASTM-A53, standard weight unless otherwise indicated.

2. For fire sprinkler service:
 - a. The following Testing Standards and listed grades are acceptable:
 - 1) ASTM-A135, Grade B
 - 2) ASTM-A53, Grade B.
 - 3) ASTM- A795, Grade B.
 - b. Weight: Schedule-40 unless otherwise indicated.
- B. Copper Pipe:
 1. Seamless copper tubing, ASTM B88, Type-K, Type-L, or Type-M as indicated.
 2. Joints:
 - a. Soldered: Use ASTM B32, 95% tin, 5% antimony solder, or Silvacbrite 100.
 - b. High temperature soldered: Use 540 degrees C 1,000 degrees F solder.
 - c. Roll grooved.
 - d. Ring seal crimped, where specified and permitted by authority having jurisdiction.
 3. 2760 kPa 400 psi fittings: Heavy wall type, Mueller "Steamline".
 4. 2760 kPa 400 psi fittings: Heavy wall type, Mueller "Steamline".

2.3 FITTINGS AND COUPLINGS

- A. Steel Pipe Fittings:
 1. Socket welding fittings: ANSI/ASME-B16.11 and ASTM A234.
 2. Butt welding fittings: ANSI/ASME-B16.9, ANSI/ ASME-B16.25 and ASTM A105.
 3. Grooved fittings: Square cut, ASTM-A53 steel, or roll grooved, ASTM A135.
 4. Flanged fittings: ANSI/ASME-B16.5 and ASTM A105.
 5. Flange bolts: ASTM A193 Grade B7.
 6. Gaskets: Spiral wound metallic.
- B. Malleable Iron Pipe Fittings:
 1. Threaded fittings: ANSI/ASME-B1.20.1 and ANSI/ASME-B16.3, Class 150.
 2. Threaded couplings: Same as threaded fittings except Class 300.
 3. Grooved couplings: ASTM A47, coupling segments with EPDM Grade-E gasket.
 4. Galvanized malleable iron couplings: Victaulic; or ITT Grinnell.
- C. Copper Pipe Fittings:
 1. Wrought copper fittings: ANSI/ASME-B16.22.
 2. Cast brass fittings: ANSI-B16.18.
 3. Mechanical groove-end fittings: Factory roll grooved.
 4. Flared tubing fittings: Use only on annealed pipe.
 5. Cast flanged fittings: ANSI/ASME-B16.24, Class 150.
 6. 2760 kPa 400 psi fittings: Heavy wall type, Mueller "Steamline".
- D. Dielectric Fittings:
 1. General:
 - a. Standard product for prevention of galvanic corrosion.
 2. Dielectric union:
 - a. Ground-joint union with end connections of different material.
 - 1) End connection materials: Compatible with respective piping materials.
 - 2) Gasket and inert, non-corrosive thermoplastic sleeve shall electrically isolate end connections from each other.
 3. Dielectric waterway fitting:

- a. ASTM A53 Schedule-40, hot dip galvanized, steel pipe casing with inert, non-corrosive thermoplastic lining (NSF/FDA listed).
 - b. Threaded or threaded X rolled grooved connections.
 - c. Victaulic, "Clearflow".
- E. Unions.
 - 1. Same type, pressure rating and material as piping.
 - 2. Flanges: Raised face type of same type, pressure rating and material as piping.
 - 3. Unions in copper pipe:
 - a. DN50 2 inches and smaller: Use wrought copper solder joint copper to copper unions.
 - b. DN65 2-1/2 inches and larger: Use brass flange unions.
 - 4. Dielectric unions: See Dielectric fittings.

PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with ANSI/ASME B31.9 for pressure piping installations.
 - 1. Install piping without "bull-head" fittings.
- B. Flush out water piping systems with clean water prior to adding treatment.
- C. Flush out fuel oil piping with compressed air.
- D. In general, make connections to components in piping systems with 3-elbow swing joints to allow for movement.
 - 1. Movement includes but not limited to expansion, contraction, seismic, and equipment vibration isolation.

3.2 PIPING

- A. Install piping parallel to building walls at such heights as not to obstruct portion of window, doorway, stairway, or passageway.
 - 1. Where interference develops in field, offset or reroute piping as required to clear such interferences.
 - 2. Consult Drawings for exact location of pipe spaces, ceiling heights, door and window openings or other architectural details and report discrepancies to Architect, before installing piping.
- B. Pitch Piping to Drain:
 - 1. Minimum pitch of 1 mm/m 1 inch in 100 feet(except drainage piping).
 - 2. Make piping and equipment drainable.
 - 3. Accomplish pipe drainage using drain valves located on equipment and fixtures or separate drains.
 - 4. Drains: See Section 23 05 19.
- C. Factory cut and thread nipples from seamless stock.
 - 1. Use nipples of same material as pipe with which they are used.
 - 2. Do not use close nipples except where such use is unavoidable.
 - 3. Use Schedule-80 seamless pipe for close nipples and nipples of pipes DN10 3/8 inches or smaller.
- D. Provide backing and sleeves required in walls or floors for setting of fixtures or equipment.
- E. Where transition occurs from sweated fittings (as at connection to fixture supplies, etc.), provide rigid anchorage so that no strain will be placed upon tubing.

3.3 JOINTS

A. Threaded Joints:

1. Cut piping carefully, ream, thread, and work into place without springing.
2. Use a small amount of prepared pipe thread lubricant on outside threads only.
3. Provide in accordance with ANSI/ASME-B1.20.1.

B. Flanged Joints:

1. Take care to ensure that there is no restraint on opposite end of pipe or fittings which would prevent uniform gasket compression or cause unnecessary stress in flanges.
2. Keep one flange free to move in any direction while flange bolts are being tightened.
3. Do not pack or assemble bell and spigot joints affected by flanged joints until such flanged joints have been tightened.
4. Tighten bolts gradually and at a uniform rate, so that gasket compression is uniform over entire area of gasket.

C. Mechanical Joints:

1. Assemble in accordance with instructions and recommendations of pipe manufacturer.
2. Clean joint surfaces and lubricate with soap solution or water soluble lubricant immediately before joint is assembled.
3. Groove-end and plain-end joints:
 - a. Use mechanical joint system only with pipe meeting joint manufacturer's requirements.
 - 1) When joint manufacturer's pipe requirements exceed specified requirements, provide pipe that meets joint manufacturer's requirements.
 - b. Prepare pipe and install system in accordance with joint manufacturer's instructions and recommendations.

D. Use dielectric waterway fittings for connections between dissimilar metals.

3.4 UNIONS

A. Provide a union between valves, at connection to each fixture, device, or item of equipment, and elsewhere as required to facilitate installing, servicing, making up and disconnecting piping.

1. Install each union to facilitate removal of parts, equipment or fixtures for inspection or cleaning.
2. Install in a position which will permit device, fixture, or part to be removed without disconnecting piping except unions.

B. Install unions in accordance with Fluid Controls Institute (FCI).

1. Grooved piping systems:
 - a. Grooved type couplings may serve as unions.
2. Make connections between couplings and flanged equipment with slip-on flanges and a grooved nipple, or groove-to-flange adapter.
3. Welded piping systems:
 - a. Where flanged end-service valves are used at equipment connections, flange unions will not be required.
 - b. Make connections to flanged valves and equipment using ANSI welding neck or slip on type welding flanges.
 - c. Flanged cast iron ells may be used for connections between pumps, strainers, check valves and other flanged equipment.

C. Install dielectric fitting at each piping joint and equipment connection between ferrous and non-ferrous materials.

3.5 WELDED STEEL PIPING

- A. Where welded piping is specified, make welds by oxy-acetylene or electric process in accordance with ANSI/AWS D10.12 and ANSI/AWWA C206.
 - 1. Welding rods: Grade recommended for purpose by manufacturer; each rod stamped with manufacturer's name and identification.
- B. Line Welds:
 - 1. Single V-butt type.
 - 2. Mill or machine bevel pipe at 37.5 degrees to within 1.6 mm 1/16 inches of inside wall, except that in field, limited amount of pipe may be flame beveled.
 - 3. Pipe with a wall thickness of 4.8 mm 3/16 inches or less need not be beveled but may be welded by melting down into, and building up over abutting ends.
 - 4. Separate abutting ends of joints before welding to permit complete fusion to bottom without overlapping.
 - 5. Tack in 2 or more points to maintain alignment, and fusion weld.
 - 6. Weld continuously around pipe.
- C. Make welds of sound weld metal, thoroughly fused into ends of pipe, and to bottom of vee.
 - 1. Build in excess of pipe wall to give reinforcement of 0.25 pipe wall thickness.
 - 2. Weld metal shall present a gradual increase in thickness from surface of pipe to center of weld.
 - 3. Minimum weld width: 2.5 times thickness of pipe wall.
- D. Use welding ells at turns in welded lines except where pipe bends are indicated or are required for flexibility.
- E. Mitered ells will not be permitted.
- F. Do not weld pipe couplings in place of welding fittings for branch connections.
- G. Weld-O-Lets and Thread-O-Lets:
 - 1. Scribe and cut openings in main pipes for welded branches accurately taking care to remove plug and cuttings from main pipe.
 - 2. Full weld fillet welds for full depth of fillet, with additional beads to form well rounded connection as recommended by Weld-O-Let manufacturer.
 - a. Partially filled fillets not acceptable.
- H. Cut openings into pipe for welded connections accurately to give carefully matched intersections.
- I. Make welded fittings of same material with same pressure and temperature rating as pipe with which they are used.
- J. Make flanged connections to control valves, pump suction, and specialties with ANSI standard welding neck flanges.
 - 1. Other flange connections may be made with slip-on flanges provided they are seal welded on inside.
- K. Fuse fillet welds for flanges or fittings into pipe and plate for minimum distance of 1.5 times pipe wall thickness and depth of weld of 1.25 times pipe wall thickness.

3.6 THREADED STEEL PIPING

- A. Branch connections to screwed piping may be made with Weld-O-Lets or Thread-O-Lets.
- B. Do not weld pipe couplings in place of welding fittings for branch connections.

3.7 COPPER PIPING

- A. Brazed High Temperature Soldered Joints:

1. Take care to avoid annealing of pipe material.
 2. For pipe sizes DN50 2 inches and larger: Use a circular torch such as Circa Torch by Cedarberg Industries, for soldering joints.
- B. Solder: Lead-free.
- C. T-drilling:
1. Tapped pipe shall be least DN25 1 inch diameter and branch shall be at least 2 pipe sizes smaller.
 2. Braze high temperature solder joints.
 3. Branch pipe shall not protrude into main.

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Hydronic Piping Systems, as indicated, in accordance with provisions of Contract Documents.
- B. Systems and Products Included:
 - 1. Systems:
 - a. Condensate and cooling coil drain piping.
 - b. Condenser (Heat Pump) water piping.
 - c. Heating water piping.
 - d. Make-up water piping.
 - e. Water treatment system piping.
 - 2. Products:
 - a. Air vents.
 - b. Expansion tanks.
 - c. Flow switch wells.
 - d. Pressure and temperature test stations, combination.
 - e. Air Eliminators and Dirt Separators.
 - f. Strainers.
 - g. Valves.
 - h. Water flow measurement devices.
 - i. Water treatment system.
- C. Work installed but not furnished:
 - 1. Automatic valves: Furnished in Section 25 10 00.
 - a. Provide fittings and reducers required for installation of automatic valves.
 - 2. Electronic flow measurement devices: Furnished in Section 25 10 00.
- D. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Piping standards: Section 23 11 00.
- B. Manual valve standards: Section 23 05 23 (for valves with "V" prefix).

1.3 SUBMITTALS

- A. Product Data:
 - 1. Air vents.
 - 2. Expansion tanks.
 - 3. Pressure and temperature test stations, combination.
 - 4. Air Eliminator and Dirt Separators.
 - 5. Strainers.
 - 6. Valves, automatic balancing.
 - 7. Valves, manual.
 - 8. Valves, pressure reducing.
 - 9. Valves, pressure relief.

10. Water flow measurement devices.
 11. Water treatment system.
- B. Contract Closeout Information:
1. Operation and Maintenance Data for items requiring operational instructions or periodic maintenance such as: air vents, constant flow control valves, pressure relief valves, triple duty valves, water flow measurement devices, water treatment system, glycol feed systems, etc.
 2. Field test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Automatic High Capacity Air Vents:
1. Base:
 2. Optional:
 - a. Armstrong International.
 - b. Hoffman Specialty.
 - c. Metraflex.
 - d. Thrush.
- B. Manual Air Vents:
1. Base:
 2. Optional:
 - a. Crane Valves.
 - b. Jenkins.
 - c. Johnston.
 - d. OIC.
 - e. Powell.
 - f. Stockham Valves & Fittings.
 - g. Walworth.
- C. Expansion Tanks:
1. Base:
 2. Optional:
 - a. Armstrong Pumps.
 - b. Bell & Gossett, ITT.
 - c. Taco.
 - d. Thrush.
- D. Air Eliminator and Dirt Separators:
1. Base:
 2. Optional:
 - a. Armstrong International.
 - b. Bell & Gossett, ITT.
 - c. Spirotherm.
 - d. Taco.
- E. Strainers, Air Separator/Strainers:
1. Base:

- 2. Optional:
 - a. Armstrong Machine Works.
 - b. Bell & Gossett, ITT.
 - c. Taco.
 - d. Thrush.
- F. In-line Wye Strainer and Valve Combination Strainers:
 - 1. Base:
 - 2. Optional:
 - a. Flow Design Inc.
 - b. Griswold Controls.
 - c. Nexus Valve.
- G. Automatic Balancing Valves:
 - 1. Base:
 - 2. Optional:
 - a. Flow Design Inc..
 - b. Griswold Controls.
 - c. Nexus Valve.
- H. Water and Glycol Pressure Reducing Valves:
 - 1. Base:
 - 2. Optional:
 - a. Armstrong Pumps.
 - b. Bell & Gossett, ITT.
 - c. Conbraco.
 - d. Taco.
 - e. Watts Control Valves.
 - f. Thrush.
- I. Water and Glycol Pressure Relief Valves:
 - 1. Base:
 - 2. Optional:
 - a. Armstrong Pumps.
 - b. Bell & Gossett, ITT.
 - c. Farris.
 - d. Taco.
 - e. Teledyne Farris Engineering.
 - f. Thrush.
- J. Water Flow Measurement Devices:
 - 1. Base:
 - 2. Optional:
 - a. Barco USA.
 - b. Data Industrial.
 - c. Dynasonics.
 - d. Gerand Engineering.
 - e. Victaulic of America.
- K. Water-treatment-system cleaning chemicals:

1. Base:
 - a. Oakite Products.
 2. Optional:
 - a. Mitco.
 - b. Diversey Water Technologies.
- L. Water Treatment System Chemical Feeders:
1. Base:
 - a. Calgon-Vestal.
 2. Optional:
 - a. Diversey Water Technologies.
 - b. Mitco.
 - c. Nalco.
- M. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Pipe And Fittings

1. Pipe and fittings - General:
 - a. The following are not permitted:
 - 1) Plain end, pressure fit type fittings.
 - 2) Hole cut mechanical tee or saddle fittings.
 - 3) Short radius elbows and fittings.
2. Fittings: galvanized where galvanized piping is used.
3. Condensate and cooling-coil-drain piping:
 - a. Copper, type M or L, and soldered joints.
 - b. Galvanized steel with cast iron drainage type fittings.
4. Condenser water piping: Same as chilled water piping.
5. Heating water piping, above grade:
 - a. Copper, type L, with soldered joints, and wrought copper or cast brass fittings.
 - 1) Optional fittings:
 - a) Ring seal crimped fitting system: DN50 2 inches and smaller where approved by authority having jurisdiction.
 - b. Black steel, with welded joints.
 - 1) For DN65 2-1/2 inches and larger: Use butt welding fittings.
 - 2) For DN50 2 inches and less: Use socket welding fittings, 13.8 MPa 2000 psi class, malleable or cast iron threaded fittings.
 - 3) Weld-o-let or thread-o-let type fittings may be used in lieu of tees for branch connections, provided main is one size larger than takeoff. Couplings or half couplings are not acceptable except for non-flow connections such as thermometers or gauges.
6. Make-up water piping:
 - a. Same as system served.
7. Water treatment system piping:
 - a. Same as system served.

B. Air Vents:

1. High Capacity, automatic:

- a. 2080 kPa 300 psi rated test pressure, minimum.
 - b. Maximum working pressure: 1340 kPa 150 psiG.
 - c. Maximum temperature: 100 deg C 212 deg F.
 - d. Body and cover material: Cast iron, ASTM-A126, Class B.
 - e. Seat material: Stainless steel-T303, ASTM-A276 or Viton.
 - f. Float and float arm material: Stainless steel-T304, ASTM-A240.
2. Low Capacity, automatic:
- a. 1040 kPa 150 psi rated, minimum.
 - b. Maximum working pressure: 680 kPa 100 psiG.
 - c. Maximum temperature: 100 deg C 212 deg F.
 - d. Cast bronze, chrome plated, body with renewable valve and seat.
 - e. Synthetic rubber disc.

C. EXPANSION TANKS

1. Tanks, expansion (air-elimination system):
- a. Pre-pressurized diaphragm type.
 - b. Size: As scheduled.
 - c. Rated pressure: 860 kPa 125 psiG.
 - d. Rated operating temperature: 115 deg C 240 deg F, minimum.
 - e. Precharge pressure: Same as scheduled minimum operating pressure.
 - f. Bladder: Heavy duty butyl, removable for inspection.
 - g. ASME constructed and stamped.

D. Flow Switch Wells

1. Flow switch wells:
- a. Install DN25 1 inch thread-o-let for flow switch installation.
 - b. Provide DN25 1 inch nipple and cap.

E. Pressure And Temperature Test Stations, Combination

1. Pressure/temperature test station, combination:
- a. Station to receive either a DN6 1/8 inches OD temperature or pressure probe.
 - b. Fitting: Solid brass, DN8 1/4 inches NPT, with 2 valve cores of neoprene (maximum 95 deg C at 3450 kPa 200 deg F at 500 psi) or Nordel (maximum 135 deg C at 3450 kPa 275 deg F at 500 psi).
 - c. Provide extension at locations with pipe insulation. Extension length shall match or exceed insulation thickness.
 - d. Provide with color coded and marked cap with gasket, rated at 6900 kPa at 60 deg C 1000 psi at 140 deg F.
2. Pressure and temperature test kit:
- a. Range: 0-700 kPa 0-100 psi, 0-230 feet WG.
 - b. 3 mm 1/8 inches OD probe and 125 mm 5 inches stem pocket testing thermometers.
 - 1) Provide 2 for geothermal water: -4 to 52 deg C 25-125 deg F.
 - c. No. 500 gauge adapter with 3 mm 1/8 inches OD probe.
 - d. Protective carrying case.

F. Air Eliminators and Dirt Separators

1. Air eliminators and dirt separators:
- a. Coalescing type air eliminator and dirt separator.
 - b. Shell: Fabricated Steel.

- c. Seals: Viton.
- d. Removable stainless steel or copper wound air/dirt collection medium.
- e. An integral full port float actuated brass venting mechanism shall be installed at the top of the venting chamber.
- f. Design pressure: 150 psiG.
- g. NPT tappings for vent and blowdown connections.
- h. Air Removal Efficiency: 100 percent free and entrained air and 99.6 percent dissolved air.
- i. Dirt Removal Efficiency: 80 percent of all particles 30 microns and larger within 100 passes.
- j. Removable lower head to facilitate removal of internal assembly for inspection

G. Strainers

1. Strainers, air separator/strainers:
 - a. ASME code construction.
 - b. Removable stainless steel air collector tube.
 - c. NPT tappings for vent and blowdown connections.
 - d. Stainless steel strainer with 5 mm 3/16 inches diameter perforations.
 - 1) Free area: Not less than 5 times cross sectional area of connecting pipe.
 - e. Working pressure: 860 kPa at 180 deg C 125 psiG at 350 deg F.
2. Strainers, in-line wye strainer and valve combination:
 - a. One piece configuration consisting of O-ring union, P/T plug, blow down and ball valve with handle.
 - b. Strainer valves DN32 1-1/4 inches and smaller: Limit passage of particles larger than 500 microns.
 - c. Strainer valves DN40 1-1/2 inches and larger: Limit passage of particles 1000 microns and larger.
 - d. Bronze body construction with threaded or sweat connections.
 - 1) Internal parts: Brass and stainless steel.
 - 2) Ball valve:
 - a) Ball and stem: 316 stainless steel.
 - b) Port size: standard.
 - c) Blowout proof stems.
 - d) Reinforced Teflon (PTFE) seats.
 - e) Teflon (PTFE) seals.
 - f) Adjustable packing.
 - g) Extended necks and stems that isolate moving valve parts from insulation.
 - e. Provide valves with unions to allow field exchange of internal components without removing valve body from pipeline.
 - f. Provide metal ID taps permanently marked to show direction of flow, strainer mesh and model number.
3. Strainers - single-basket type:
 - a. Screwed or flanged.
 - b. Body: Cast iron, flanged ends, bolted access cover.
 - c. Coating: Rust inhibiting.
 - d. Working pressure, non-shock: 1040 kPa 150 psiG.
 - e. Screens: Bronze, monel or stainless steel.
 - 1) DN50 2 inches and less: 1.20 mm 3/64 inches perforations.

- 2) DN65 2-1/2 inches and larger: 3.20 mm 1/8 inches perforations.
4. Strainers - Suction Diffusers:
 - a. Angle cast iron body type with inlet vanes and combination diffuser-strainer-orifice cylinder.
 - b. Provide with disposable 16 mesh strainer for system start-up.
 - c. Orifice cylinder with 5 mm 3/16 inches diameter openings.
 - 1) Designed to withstand pressure differential equal to pump shutoff head (maximum 175 PSI).
 - 2) Free area equal to 5 times cross-section area of pump suction opening.
 - d. Vane length: Not less than 2-1/2 times pump suction opening.
 - 1) Provide with adjustable support foot to carry weight of suction piping.
5. Strainer, tee-pattern type.
 - a. Grooved ends.
 - b. Body: One-piece ductile iron casting conforming to ASTM-A536 or malleable iron conforming to ASTM-A47.
 - c. Coating: Rust inhibiting.
 - d. Working pressure rating: 2070 kPa 300 psi.
 - e. Basket screen: 304 stainless steel 1.12 mm 0.041 inches wire in a woven No.6 mesh wire screen with 3.20 mm 0.126 inches opening.
 - f. Vertical down flow or horizontal flow.
 - g. Cleaning access through blank end cap.
6. Strainers, wye:
 - a. See Section 23 05 19, Piping Specialties.

H. Valves

1. Automatic Balancing Valves:
 - a. Factory calibrated, direct acting, automatic pressure compensating.
 - b. Control flow rates within 4 percent of flow rating over operating pressure differential range.
 - 1) Set flow rating to match the maximum flow required by device served.
 - c. Pressure differential range:
 - 1) 20-200 kPa 2-32 psiD.
 - d. Threaded-brass or copper-sweat body with stainless-steel internal parts.
 - e. Provide a metal identification tag with chain for each installed valve.
 - 1) Identify valve model number, rated L/s GPM, direction of flow, and differential pressure range.
 - f. Provide with integral unions to allow field exchange of internal components without removing valve body from pipeline.
 - g. Provide as indicated.
2. Manual valves:
 - a. Angle valves:
 - 1) DN50 2 inches and smaller: V-17.
 - 2) DN65 2-1/2 inches and larger: V-18.
 - b. Balancing valves:
 - 1) DN50 2 inches and smaller: V-64.
 - 2) DN65 2-1/2 inches to DN300 12 inches: V-65.
 - 3) DN200 8 inches and larger:
 - a) Plug valve: V-37 with memory stop.

- b) Provide venturi waterflow measuring device.
- 4) Ball type balancing valves/circuit setters shall not be used.
- c. Isolation valves (Ball valves):
 - 1) DN50 2 inches and smaller: V-13 or V-14.
- d. Isolation valves (Butterfly valves):
 - 1) DN50 2 inches and smaller: not used.
 - 2) DN65 2-1/2 inches and larger: V-34 or V-35.
- e. Boiler blowdown valves: Plug, globe, angle and check.
 - 1) Rated for 1730 kPa and 205 deg C 250 psiG and 400 deg F.
- f. Boiler feedwater valves: Plug, globe, angle and check.
 - 1) Rated for 1730 kPa and 205 deg C 250 psiG and 400 deg F.
- g. Check valves, pump discharge:
 - 1) DN50 2 inches and smaller: V-25 or V-26.
 - 2) DN65 2-1/2 inches and larger: V-28, V-29, or V-30.
- h. Check valves, other:
 - 1) DN50 2 inches and smaller: V-25.
 - 2) DN65 2-1/2 inches and larger: V-28 or V-29.
- i. Isolation valves (Gate Valves):
 - 1) DN50 2 inches and smaller: not used.
 - 2) DN65 2-1/2 inches and larger: V-3.
- j. Globe valves:
 - 1) DN50 2 inches and smaller: V-6 or V-7.
 - 2) DN65 2-1/2 inches and larger: V-8.
- k. Plug valves:
 - 1) DN50 2 inches and smaller: V-36.
 - 2) DN65 2-1/2 inches and larger: V-37.
- 3. Pressure reducing valves:
 - a. Water type, diaphragm operated with low inlet pressure check valve and built-in strainer.
 - b. Construction:
 - 1) Body: Brass.
 - 2) Diaphragm: EPT.
 - 3) Check valve: Rubber.
 - 4) Seat: Brass.
 - 5) Stem: Brass with Buna N insert.
 - 6) Strainer: Brass.
 - c. Maximum working pressure: 690 kPa 100 psiG.
 - d. Adjustable pressure range: 175-415 kPa 25-60 psiG.
- 4. Pressure relief valves, water:
 - a. ASME-approved, tight-shutoff, self-closing.
 - b. DN65 2-1/2 inches and less: Screwed.
 - c. DN80 3 inches and larger: Flanged.
 - d. Ten percent over pressure.
 - e. Test lever.
 - f. Capacity: Same kW BTUH as equipment served. See schedules.
 - g. Relief setting: 860 kPa 125 psiG unless indicated otherwise.

I. Water Flow Measurement Devices

1. Differential water pressure meter:
 - a. Portable type with 150 mm 6 inches round dial, 270 degree indication.
 - b. Range: 0-25 kPa 0-100 inches WG as specified.
 - c. Provide purge valves and hoses, minimum of 6 M 20 feet.
 - d. Meter assembly rated at 1700 kPa and 120 deg C 250 psi and 250 deg F.
 - e. Arrange tubing for multi-station measurement.
2. Venturi waterflow measuring device:
 - a. Accuracy: Plus/minus 1 percent at design flow.
 - b. Maximum pressure drop: 2.4 kPa 0.8 feet.
 - c. Provide safety shut-off valves, sensing taps, nipples and quick connection couplings.
 - d. Identify with metal tag on chain indicating:
 - 1) Size.
 - 2) Location.
 - 3) L/s GPM.
 - 4) Meter reading for GPM specified.
 - e. Sizes DN15 1/2 inches through DN50 2 inches brass, screwed.
 - f. Sizes DN65 2-1/2 inches and over steel, flanged or butt welded.

2.3 WATER TREATMENT SYSTEM

A. Water Treatment System Cleaning Chemicals:

1. Alkaline:
 - a. Oakite 62, 162, 24, 77.
2. Acid:
 - a. Oakite 32.

B. Water Treatment-system chemical feeders:

1. Pot type feeders constructed for operating pressure of 1040 kPa 150 psi.
2. Capacity of feeders: 12 L 3 GAL minimum.

2.4 VIBRATION ISOLATION

A. Vibration Isolation: Section 23 05 50.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install in accordance with Section 23 11 00 and Section 23 05 00.
- B. Excavation and backfilling: Section 23 05 00.
- C. Reaction anchorage: Section 23 05 00.
- D. Piping more than 5 feet outside building: See Civil Drawings.
- E. Connect equipment.

3.2 PIPE AND FITTINGS

- A. Do not insulate or conceal piping until testing is completed.

3.3 AIR VENTS

- A. Automatic Air Vents:
 1. Provide shut off valve ahead of vent.

2. Provide copper relief line from valve to drain or drip pan.
 3. Provide at locations indicated on equipment and piping schematic drawings.
- B. Air vents, manual:
1. Vents shall prevent air binding in systems.
 2. Vent valves:
 - a. Provide at trapped high points of closed cooling and heating piping systems.
 - b. Provide at coil headers in air handling units unless an automatic air vent is indicated at that location on equipment or piping schematic drawings.
 3. Coin operated vents:
 - a. May be used in lieu of vent valves at coil headers for terminal units with piping connections DN32 1-1/4 inches and smaller.

3.4 FLOW SWITCH WELLS

- A. Provide flow switch wells at following locations:
1. Condenser water supply line to each chiller.
 2. Chilled water return line to each chiller.

3.5 PRESSURE AND TEMPERATURE TEST STATIONS, COMBINATION

- A. Provide at locations indicated on equipment and piping schematic drawings.

3.6 AIR ELIMINATORS AND DIRT SEPARATORS

- A. Provide at locations indicated on equipment and piping schematic drawings.

3.7 STRAINERS

- A. Provide full line size strainers ahead of control valves (motor operated), regulating valves, pumps, and as indicated.
- B. Provide strainer types as indicated:
1. Condenser water: Single-basket or tee type.
 2. Chilled water: Single-basket, tee, or wye type.
 3. Heating water: Single-basket, tee, or wye type.
- C. Connections to suit piping.
- D. Provide blow-down valves:
1. Strainers DN150 6 inches and larger: DN40 1-1/2 inches blow-down valve.
 - a. Pipe blow down to drain.
 2. Strainers DN50 to DN125 2 to 5 inches: DN25 1 inch blow-down valve with DN20 3/4 inches hose end connection.
 3. Strainers DN40 1-1/2 inches and smaller: DN15 1/2 inches blow-down valve with DN20 3/4 inches hose end connection.

3.8 VALVES

- A. Heating and cooling pipe risers:
1. Provide isolation valves at main feed points to risers.
 2. Provide isolation valves at branch take-offs from risers.
- B. Install pressure relief valves on heat exchangers' piping between exchanger and isolation valves.
- C. Provide drain piping at pressure relief valves and valves with test levers.
1. Extend piping to within 150 mm 6 inches of floor.
- D. System Drains: See Section 23 05 19.

3.9 WATER FLOW MEASUREMENT DEVICES

- A. Provide as indicated.

3.10 WATER TREATMENT SYSTEM

- A. Mount chemical feeder across balance valve on pump discharge of systems.
 - 1. Geothermal water system.

3.11 CONDENSATE DRAINS

- A. Pipe condensate drains for all equipment (i.e. air handling units, fan coil units, kitchen condensing units, etc.) and route to nearest floor drain, mop sink, etc. Coordinate final location with architect.

3.12 VIBRATION ISOLATION

- A. Vibration Isolation: Section 23 05 50.

3.13 TESTING

- A. Test heating and cooling piping upon completion of a section or of entire system.
 - 1. Test hydrostatically to pressure not less than 50 percent in excess of maximum pressure to which pipe will ordinarily be subjected, but in no case greater than the pressure rating of the worst case device/pipe or fitting in the system.
 - 2. Repair or replace leaks or defective pipe disclosed by tests.
 - 3. Repeat tests until piping indicates tight.

3.14 CLEANING OF HEAT PUMP CONDENSEER AND HEATING WATER SYSTEMS

- A. Do not valve in or operate system pumps until after system has been cleaned.
- B. At system completion, make temporary connection to domestic water system, and flush system until clear water is visible from drain connection.
 - 1. Drain system after flushing.
- C. At project completion, clean systems:
 - 1. Thoroughly flush system with a recommended hot solution (70-82 deg C 160-180 deg F) of alkaline cleaning chemical to remove oil and grease that may be present.
 - a. Thorough flushing includes eliminating air from system.
 - b. Drain systems, and rinse completely with clean water.
 - c. Measure and record volume of each system for purpose of chemical treatment.
 - 2. Add water and acid solution, and circulate through systems as recommended by manufacturer to remove rust and scale.
 - a. Circulate solution through systems at a minimum velocity of 3 m/s 10 FPS.
 - b. Drain systems, and rinse completely with clean water.
 - 1) Rinse system at a minimum velocity of 3 m/s 10 FPS.
 - 3. Check drain water for pH level.
 - 4. If drain water is acidic, neutralize system by thoroughly reflushing with alkaline-type material as indicated above.
- D. After cleaning is complete, and just before start-up, clean strainers.

3.15 START-UP

- A. After cleaning is complete, and water pH is acceptable to manufacturer of water treatment chemicals, add manufacturer-recommended amount of chemicals to systems.
- B. Provide bi-monthly testing for the first 12 months after start-up to verify that the correct chemical concentrations are present in each system.

- C. Add chemicals as needed for throughout the entire first year for proper operation at the completion of the warranty period.

END OF SECTION

SECTION 23 21 14

GEOHERMAL LOOP HEAT EXCHANGER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Description of Work:

1. This specification designates the requirements for a complete geothermal loop heat exchanger (GLHE), made to controlled dimensions, specifications and requirements as per ASTM D3035 for polyethylene pipe, ASTM D2683 for socket fusion fittings and ASTM D3261 for butt/saddle fusion fittings.
2. Extent of GLHE piping work is indicated on Drawings and schedules, and by requirements of this Section.
 - a. This section includes pipe and pipe fittings for GLHE including all drilling, backfilling, flushing, pressure testing, and other incidental work as required for a complete and operational GLHE.
 - b. Work shall include all outside pipe up through the floor to the transitions off the header in the Mechanical Room.
3. Refer to other Division 20 and 23 Sections for hydronic specialties; HVAC pumps; ground coupled heat pump loop glycol systems; and testing, adjusting and balancing.
4. The successful Contractor will be required to coordinate their work with the successful building General and Mechanical Contractor to provide a fully operating and functioning GLHE system.
5. The location of the GLHE connection to the building heat pump piping system and the point of responsibility change is shown on the plans.

- B. This section specifies a system or part of a system being commissioned as defined in Section 01 91 13 - General Commissioning Requirements. Testing of these systems is required in cooperation with the Owner's Representative, Construction Management Team, and the Commissioning Professional. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Section 01 91 13 - General Commissioning Requirements for detailed commissioning requirements, including an outline of Systems Manual contents and submission requirements.

1.2 RELATED WORK

A. Related Work:

1. All applicable Division 1 Sections for general conditions.
2. All applicable Division 2 Sections for excavation, backfilling, and disposal of waste materials.
3. Section 23 05 19 - Piping Specialties.
4. Section 23 05 23 - Manual Valves.
5. Section 23 05 29 - Penetrations and Supports.
6. Section 23 21 23 - HVAC Pumps.

1.3 QUALITY ASSURANCE

A. Codes and Standards:

1. Mechanical Code Compliance: Fabricate and install GLHE water piping in accordance with applicable mechanical code.
2. Comply with all local and state laws and ordinances.

B. Qualification of GLHE Contractors:

1. The entire exterior GLHE system shall be fabricated, installed and tested by a qualified specialist in this type of work.
2. Driller's Qualifications: Drillers shall be Water Well Contractors licensed by the State of Nebraska.
3. Pipe Installer's Qualifications: Installers must have completed a certified training program offered by the International Ground Source Heat Pump Association (IGSHPA) or IGSHPA approved manufacturer's certification program and shall have at least two (2) years of successful installation experience on projects with GLHE work similar to that required for this project.
4. Pipe Fabricators Qualifications: The only acceptable method for joining buried pipe systems is by a heat fusion process.
 - a. GLHE fabricators must have completed a heat fusion school in which each participant has performed a heat fusion procedure under direct supervision of an IGSHPA Certified Heat Fusion Technician; an IGSHPA approved manufacturing certification program, or a DOT certified heat fusion technician.
 - b. Certified technicians must attend a retraining school annually.
5. Contractor shall maintain and furnish to Architect/Engineer complete drilling logs.
6. Should the Contractor hit rock formations or other material that make the use of the specified loop lengths impractical, Contractor shall contact the Architect/Engineer to discuss alternate layouts of the wellfield.
7. In the event that loops cannot be installed to the depth shown on the Drawings, the Contractor shall notify the Architect/Engineer prior to proceeding and obtain his concurrence on the Contractor's proposal as to the number, depth and spacing of loops.

1.4 DELIVERY, STORAGE AND HANDLING

A. Delivery, Storage and Handling:

1. See Division 01.
2. Pipe shall be stored in a manner, which will prevent the detrimental effects of weather, temperature, and other exposure to adverse conditions.
 - a. Storage areas shall not interfere with the operations of the owner or the operation of any of the other contractors at the project site.
3. All pipes and fittings are to be sealed to prevent debris, rodents and other foreign material from entering the piping system.
4. Store pipes and pipe fittings in accordance with manufacturer's recommendations.
5. All pipes and fittings are so sealed to prevent debris, rodents and other foreign material from entering the piping systems.
6. Pipes and fittings shall not be stored in sub-freezing weather for more than 24 HRS.
 - a. Pipes and fittings exposed to prolonged freezing materials shall be removed from the job site or stored in a heated area.

1.5 SUBMITTALS

A. Product Data:

1. Submit manufacturer's technical product data and installation instructions for GLHE piping materials, valves, hangers, pressure and temperature test ports, thermometers, pressure gauges, backfill material (grout), joining methods and products.

B. Record Drawings:

1. At project closeout, submit record drawings of installed ground coupled heat pump loop water piping and piping products, in accordance with requirements of Division 01.
2. Formation logs indicating strata encountered for first bore hole drilled, the bore hole nearest the center of the loop field, and the bore hole at each corner of the loop field.

3. Detailed pressure test procedure from polyethylene pipe manufacturer with acceptance test criteria.
 4. Loop field installation, flushing and pressure test logs for each zone.
 5. Maintenance Data: Submit maintenance data and parts lists for ground coupled heat pump loop water piping materials and products.
 - a. Include this data, product data, and Record Drawings in maintenance manual in accordance with requirements of Division 01.
- C. Documentation:
1. Well drilling procedure describing, in detail, the procedure for drilling holes, placing and pressure testing piping, backfilling/grouting, purging and charging the GLHE.
 2. Evidence of completion of a certified training program offered by the International Ground Source Heat Pump Association as well as evidence that all technicians on the job site have attended a heat fusion training/retraining school within the past 12 months.
 - a. Proof of certification shall also be maintained at the job site.
 3. Letter of certification from pipe and fittings manufacturer, along with a certification document from the resin supplier, verifying compliance with IGSHPA standards.
- D. Refer to Section 01 91 13 - General Commissioning Requirements for commissioning-related submittals and submittal review processes.

1.6 PERMITS

- A. Permits:
1. All permits, fees, licenses, etc., required for this project shall be obtained and paid for by the Contractor.
 2. Contractor shall obtain all permits, pre-notification forms, and other approvals from the State of Nebraska at least fourteen working days prior to the commencement of work.
 - a. No well field work shall commence without written notification from the State and City have been reviewed and approved by the Architect/Engineer.
 3. Well field shall be registered with the City and State as required upon completion.

1.7 WARRANTY

- A. Special Product Warranty:
1. GLHE installation Contractor shall submit a written warranty with operation and maintenance data.
 - a. Warranty shall provide for repair and/or replacement of pipe and fittings due to failure in workmanship within the specified warranty period.
 - b. Warranty period shall be five (5) years from date of Substantial Completion and shall cover both materials and labor as required for pipe, fittings, backfilling material, trenching, etc.
 - c. Note that this warranty shall be provided in addition to the 25 year pipe and fitting material warranty provided by the manufacturer.
 - d. Both the installation warranty and the 25 year pipe manufacturer warranty shall be transferable.

1.8 APPLICABLE PUBLICATIONS

- A. Publications:
1. International Ground Source Heat Pump Association (IGSHPA) manuals.
 2. ASHRAE Commercial/Institutional Ground Source Heat Pump Engineering Manual.
 3. ASHRAE Ground Source Heat Pumps - Design of Geothermal Systems for Commercial and Institutional Buildings.
 4. ASTM D3035.

5. ASTM D2683.
6. ASTM D3261.

1.9 TEST WELL INFORMATION

A. Test Well Information:

1. A bore was found at a near location and will be used as drill information for the contractor..
2. The soil formation is shown on the Drawings.
3. This bore is provided for information only.
 - a. Bidding contractors are given the opportunity, prior to bid date, to conduct their own drilling tests and borings.
 - b. All costs associated with these tests shall be borne by the Contractor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Geothermal High Density Polyethylene Pipe and Fittings:

1. Centennial Plastics LLC.
2. Chevron Phillips Chemical Company, LP – Driscoplex 5300 Climate Guard.
3. ISCO Industries – 5300 series Climate guard system.
4. Requirement: Pipe and fittings manufacturer shall provide a letter of certification, which includes a certification document from the resin supplier that verifies compliance with IGSHPA standards.

B. Thermally Enhanced Bentonite Grout: Black Hills Bentonite Company.

C. Watertight Wall Sleeves:

1. Calpico Pipe Linx.
2. Thunderline Link Seal.

D. Valve Tags and Pipe Labels:

1. Seton.
2. Brady.
3. Craftmark.

2.2 GEOTHERMAL LOOP HEAT EXCHANGER PIPING

A. General:

1. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated.
 - a. Provide sizes and types matching piping and equipment connections; provide fittings of materials, which match pipe materials used in GLHE water piping.
 - b. Where more than one type of materials or products are indicated, selection is installer's option.

B. Geothermal Loop Heat Exchanger Piping (Above Grade):

1. See Section 23 21 13 for above ground piping.
2. The manifold shall be made of metal piping.

C. Geothermal Loop Heat Exchanger Piping (Below Grade):

1. Material: Piping shall be extruded high density polyethylene (HDPE) conforming to the specifications and requirements of ASTM D3035.
 - a. The pipe shall be virgin resin with an allowance for on-site manufacturer re-processed resin.

- b. No recycled resin shall be used.
 - c. The approved pipe products are Driscoplex 5300 Climate Guard Pipe or equal.
 - d. Pipe shall be inert to most chemical compounds.
 - e. Heat transfer fluids such as propylene glycol, methanol, sodium chloride and calcium chloride shall have no effect on the pressure capability or long-term performance of the pipe.
 - f. The pipe shall not rust, rot, pit, corrode or otherwise react to highly corrosive soils into which it may be placed.
2. Resins exhibiting the balance of properties offered by pipe-grade resin possessing the ASTM D3350 PE3408 cell classification No. 345434C.
 3. Pipe schedules and dimension ratios (DR) shall be approved for the operating pressures (both static and dynamic) and temperatures expected.
 - a. As a minimum, the following industry standard pressure ratios and schedules shall be used:

Nominal Pipe Size	Vertical Pipe	Horizontal Pipe
3/4 IN	DR-11	DR-11
1 IN	DR-11	DR-11
1-1/4 IN	DR-11	DR-13.5 or Schedule 40
1-1/2 IN	DR-11	DR-13.5 or Schedule 40
2 IN	N/A	DR-15.5 or Schedule 40
3 IN	N/A	DR-15.5 or Schedule 40

4. The GLHE system pipe fittings which are molded shall be manufactured to the dimensional specifications and requirements of ASTM D2683 (for socket fusion fittings) or ASTM D3261 (for butt/saddle fusion fittings).
 - a. The material used in the manufacturing of the fitting shall be the same approved extrusion material as the connecting pipe.
 - b. Pipe and fittings shall be approved by pipe manufacturer as meeting requirement of this specification.
 - c. For fabricated fittings, a minimum "quick-burst" strength of the fittings shall not be less than that of the pipe, nor less than four times the long-term water-rated working pressure.
 - d. The approved fittings are Chevron Phillips Driscoplex 5300 Climate Guard or equal pressure-component fittings.
5. All "U" bend fittings and piping loops for vertical bore holes shall be factory or shop fabricated and field pressure tested to 100 psig before inserting into the bore hole.
 - a. See Part 3 for further pressure testing requirements.
 - b. Installer shall record each bore hole piping pressure test in a log book to be submitted as part of the Project Record Documents.
 - c. Log book shall use same bore hole labeling scheme as indicated in the Construction Documents.
6. Each GLHE pipe loop shall be marked with the manufacturer's name and product name, nominal size, ASTM dimensional standard, PPI material classification, cell classification, manufacturer's date code, and incremental loop length (using the U-bend as the datum point).
 - a. Print lines shall repeat a minimum of every 5 FT.
7. Joining Method:
 - a. The approved joints are socket or butt heat fusion, flanging, transition fittings and proof-tested, approved mechanical "couplers".
 - 1) NO OTHER JOINING METHODS ARE ACCEPTABLE, INCLUDING SADDLE HEAT FUSION.
8. Thermal Efficiency:

- a. Pipe shall provide exceptional heat transfer capabilities when compared to the average k-value of other thermoplastic materials.
- 1) The thermal conductivities (k-values) in Btu/HR/FT/DegF shall be approximately 0.225.

2.3 BENTONITE GROUT

A. Grout Requirements:

1. Bentonite slurry material shall consist of powdered sodium bentonite clay (API Specification: API 13A, 11th Edition, April 1984) and clean water in the proportion specified by the bentonite grout manufacturer.
 - a. The minimum acceptable proportion shall be at least 9.5 LBS of powdered bentonite to 1 GAL of water (15 percent solids content).
 - b. A thermal enhancement compound (high-grade silica sand) shall be added to the slurry and shall be specified and supplied by the manufacturer bentonite base material.
2. Bentonite and thermal enhancement compound shall be mixed as required by manufacturer to provide listed conductivity and shall be pre-manufactured and prepackaged prior to delivery.
3. Bentonite pellets or granular bentonite shall consist of powdered sodium bentonite clay (API Specification: API 13A, 11th Edition, April 1984).
4. All bentonite grout materials shall have a permeability less than 1×10^{-7} cm/sec.
5. All bentonite slurry grout materials shall have a thermal conductivity of 0.90 Btu/HR/FT/DegF or greater.
6. All bentonite grout materials shall be approved for surface seals and aquifer seals per Title 178 NAC 12 and local code requirements.
7. Thermally enhanced grout shall be Black Hills Bentonite Thermal Grout Select by GeoPro, Inc.

2.4 SLEEVES

A. Sleeve Requirements:

1. Sheet Metal: 10 gage, galvanized steel, round tube closed with welded joints.
2. Steel: Galvanized, welded steel pipe.
3. Modular Sleeve Seals: Modular mechanical type, interlocking synthetic rubber links, bolted connections and pressure plates, watertight seal to 20 psig.

2.5 DIELECTRIC UNION COUPLINGS OR FLANGED CONNECTIONS

A. Requirements:

1. Specifically designed to isolate piping systems and equipment of dissimilar materials.
 - a. Must effectively prevent galvanic action and stop corrosion.
2. Same end connections as systems or equipment installed, full line size.
3. Provide at all locations where dissimilar materials join.

2.6 HANGERS AND SUPPORTS

- A. General: Provide supports and anchors, complying with Section 23 05 29.

2.7 UNDERGROUND-TYPE PLASTIC LINE MARKERS

A. General:

1. Manufacturer's standard permanent, bright-colored; continuous-printed plastic tape, intended for direct-burial service; not less than 6 IN wide and 4 mils thick.
 - a. Provide tape with printing which most accurately indicates type of service of buried pipe.

2. Provide multi-ply tape consisting of solid aluminum foil core between two layers of plastic tape.

2.8 FLANGES, UNIONS AND COUPLINGS

A. General:

1. Pipe Size 2 IN and Under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.
2. Pipe Size Over 2 IN: 150 psig forged steel flanges for ferrous piping; bronze flanges for copper piping; preformed neoprene gaskets.

2.9 MANUAL AIR VENTS

A. General:

1. Short vertical sections of 2 IN DIA pipe to form air chamber, with 1/2 IN brass needle or coin-operated valve at top of chamber.

PART 3 - EXECUTION

3.1 INSPECTION

A. Requirements:

1. Examine areas and conditions under which ground loop exchanger water piping materials and products are to be installed.
 - a. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.
2. Carefully inspect the pipe to detect any damage that may have occurred during shipping or as a result of excessive abuse at the job site.

3.2 COORDINATION

A. Requirements:

1. Sequence, coordinate and integrate installation of geothermal loop heat exchanger materials for efficient flow of the work.
 - a. Give particular attention to large equipment or piping requiring positioning prior to closing in the building
2. Coordinate the GLHE work with work of the building general contractor such that:
 - a. Interference between GLHE, mechanical, electrical, architectural, and structural work, including existing services, will be avoided.

3.3 IDENTIFICATION OF EXPOSED PIPE AND VALVES

A. General: Install mechanical identification in accordance with Section 23 05 53.

3.4 IDENTIFICATION OF BELOW-GRADE PIPING

A. General:

1. Each pipe shall be permanently indent marked with the manufacturer's name, nominal size, pressure rating, relevant ASTM standards, cell classification number and date of manufacture.
 - a. Each fitting shall be identified with the manufacturer's name, nominal size, pressure rating, relevant ASTM standards and date of manufacture.
2. Provide underground plastic tape pipe markers.
 - a. Install tape 6-18 IN below finished grade, immediately above all horizontal pipe runs.
3. Attach coated 14 GA copper trace wire along entire length of all underground polyethylene pipes and terminate in the buildings mechanical room.

3.5 INSTALLATION OF GEOTHERMAL LOOP HEAT EXCHANGE PIPING (BELOW GRADE)

A. General:

1. Install underground piping as indicated and in accordance with applicable local codes and in accordance with manufacturer's written instructions.
 - a. Lay underground piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert.
 - b. Make welded fittings in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.
 - c. Clean interior piping of dirt and other superfluous material as work progresses.
 - d. Maintain swab or drag in line and pull past each joint as it is completed.
 - e. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
2. Construction and installation shall be in accordance Division 2 for trench construction, embedment material, bedding, haunching, initial backfill and final cover.
3. Bore depth shall be 280: Use drilling technique (such as "sonic") that will enable full depth bores to be drilled and excavated.
4. Excavation, Laying Pipe and Backfilling (Also refer to Division 2):
 - a. Ground loop heat exchanger contractor shall perform all excavation and backfilling necessary to install the required mechanical work.
 - 1) Coordinate the work with other excavating and backfilling work in the same area.
 - b. Grade the bottom of the trenches accurately to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length.
 - c. All horizontal outdoor piping shall be buried a minimum of 78 IN deep.
 - 1) If the soil contains sharp rocks, dig the trench 12 IN deeper than required and install a base of 12 IN of suitable backfill before placing the pipe.
 - 2) Provide rounded corners at changes of direction and at trench "tees".
 - d. The full length of each pipe section shall rest solidly upon the pipe bed.
 - 1) Keep pipe interior clean and dry during laying operations.
 - 2) When work is not in progress, plug the ends or close them by another acceptable method.
 - 3) Do not lay pipe in water and keep water out of trench until joining is complete. Provide valves, plugs, or caps, as required, where pipe ends are left for future connections.
 - e. Deposit suitable granular sand backfill material under the pipe in 6 IN layers and thoroughly compact.
 - 1) Provide a minimum of 4 IN sand bed, or 1/8 of pipe outside diameter, whichever is greater.
 - 2) Provide tamped granular sand backfill in 6 IN layers to a minimum 12 IN above top of pipe.
 - 3) Be careful not to disturb the pipe.
 - 4) Carry backfilling simultaneously on both sides of pipe to eliminate the possibility of lateral displacement.
 - f. After the piping is installed, tested, flushed, purged, inspected and approved while still under pressure, deposit suitable backfill material in layers and thoroughly compact in accordance with appropriate Division 2 Sections.
 - 1) Insure that no sharp rocks come into contact with any pipe walls.
 - 2) Coordinate the laying of the header piping with all existing new site utilities as well as landscape plans.
 - g. Pre-grading and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition and elevation by the Geothermal Loop Heat Exchanger Contractor at his/her own expense.

5. Join the pipe and fittings using the butt or socket fusion process, NO OTHER PIPE JOINING METHOD IS ACCEPTABLE.
 - a. Make vertical loop takeoff tee fittings using tees on header piping 1-1/4 IN and above.
 - b. Use bell reduction fittings at all pipe reductions to eliminate trapped air.
 - c. Use reducing socket tees when fabricating socket type reducing headers.
 - d. Allow joints to cool for 3 HRS before exposure to cold joint testing or pressure testing.
6. Any kinks or sharp bends in the piping are not acceptable.
 - a. Also, only continuous length pipe is acceptable for change of directions (no butt or socket fusion joints).
 - b. Consult pipe manufacturer for minimum bend radius.
 - c. Install elbow fittings for bends, which require tighter radii than manufacturer recommends.
7. Care should be taken to make sure the total system pressure, operating plus surge, does not exceed the pressure rating of a specific DR or Schedule of Pipe.
8. To ensure long-term performance, pipe should be installed strictly in accordance with accepted engineering design methodology for water source heat pump applications, and in accordance with the manufacturer's installation instructions.
9. When installed down-hole, as in a vertical loop, ample precautions should be taken to make sure the ballast used to facilitate the insertion process does not impinge, gouge or cut into the pipe.
10. To facilitate drilling of vertical bore holes, portable slush pits or small trenches shall be used.
 - a. All drilling fluid and bentonite residue shall be removed from the site.
 - b. If trenches are used for slush pits, they shall be backfilled and compacted in accordance with Division 2 requirements.
11. Prior to installation, each vertical pipe loop shall be filled with water and hydrostatically tested in the field prior to insertion in the vertical bore hole.
 - a. The duration of the test and acceptance criteria shall be specified in the pipe manufacturer's written pressure testing instructions.
 - b. Exercise suitable safety precautions during testing, to guard against injury to personnel near lines being tested, in case of pipe system component, or joint failure under pressure.
 - c. Results of all tests shall be recorded and supplied to the Architect/Engineer upon completion of the project, or as required by the Architect/Engineer.
12. Lateral pipes shall be purchased in such lengths and installed in such manner as to minimize the number of fusion joints required.
13. Lateral piping supply and return lines or bundles shall be separated to minimize thermal interference between the two.
 - a. The number of points where supply and return lines cross one another shall be minimized.
14. Slope lateral piping to provide venting.
 - a. Slope pipe upward in direction of flow.
15. Open ends of all lateral pipe shall be sealed to prevent the entry of contaminants until final connections are made.
16. Connect polyethylene piping to steel piping in Mechanical Room using adapter fittings.
17. After each vertical loop in a zone is connected to the lateral piping, and prior to backfilling, the piping system shall be pressure tested.
 - a. Testing shall be by air or water pressure, at 1.5 times the normal operating pressure.
 - b. The duration of the test and acceptance criteria shall be the more stringent of the pipe manufacturer's written pressure testing instructions and as specified herein.

- c. Exercise suitable safety precautions during testing, to guard against injury to personnel near lines being tested, in case of pipe system component, or joint failure under pressure.
 - d. Results of all tests shall be recorded and supplied to the Architect/Engineer upon completion of the project, or as required by the Architect/Engineer.
18. Connect loop field piping to the supply/return header system as shown.

3.6 PRESSURE TESTING

A. General:

1. Prior to insertion of U-Tube into bore hole: Test at 100 psi for five (5) minutes minimum.
2. Following purging of system, system shall be tested at 60 psi for one (1) hour minimum.
3. Discard any coils with leakage before U-Tube insertion and replace any U-tubes found to be defective after insertion.
 - a. Follow manufacturer's guidelines for verifying pressure changes during test.

3.7 GROUTING

A. General:

1. Bentonite Grout Slurry: Each bore hole shall be continuously pressure grouted from the bottom of the bore hole to the top of the bore using a grout pump per manufacturer's recommendations and in accordance with IGSHPA's standards specified in their publication "Proper Grouting Procedures for Ground-Source Heat Pump Systems", and all state and local code requirements.
2. Each bore hole shall be grouted within 3 HRS of being drilled.
3. Tremie pipes used to pressure grout the bore holes shall be inserted with the pipe loop and removed as the bore hole is filled.
 - a. No permanent tremie pipes are allowed.
4. Since settling of the grouting material will occur after the initial grouting, the contractor shall monitor each bore hole and add grout as required.
5. Conductivity Testing: Contractor shall be responsible for sending (3) samples of grout as described below to GeoPro for thermal conductivity testing at no additional cost to the owner.
 - a. Sample #1: Shall be taken during the grouting of the 1st bore hole.
 - b. Sample #2: Shall be taken during the grouting of the 20th bore hole.
 - c. Sample #3: Shall be taken during the grouting of the 50th bore hole.

3.8 INSTALLATION OF VALVES

A. General:

1. Install valves in accordance with manufacturer's written instructions and in accordance with applicable Division 15 specifications.

3.9 INSTALLATION OF PIPE SUPPORTS

A. General:

1. Install supports and anchors in accordance with requirements of Section 23 05 29.

3.10 INSTALLATION OF SEALS AND SLEEVES

A. General:

1. Pipe 3-1/2 IN and smaller: Seal pipe penetrations through walls below grade using steel pipe sleeves and flexible polyurethane foam.
2. Seal around penetrations utilizing techniques, which allow optimum sealant movement.

3.11 FIELD QUALITY CONTROL

A. Requirements:

1. Cold Joint Testing.
 - a. All fusion joints 2 IN and smaller shall be tested for cold joints prior to pressure testing and backfilling.
 - 1) Cold joint test shall consist of compressing pipe approximately 1 IN from fusion joint.
 - 2) Separation of joint or subsequent leak during pressure test shall indicate cold joint.
 - 3) All cold joints shall be repaired and retested prior to backfilling.
 - 4) All joints, which fail the cold joint test shall be recorded and supplied to the Architect/Engineer upon completion of the project, or as required by the Architect/Engineer.
2. Upon completion of GLHE installation, perform complete GLHE hydrostatic pressure test per polyethylene pipe manufacturer's written instructions, and as follows:
 - a. Notify Architect/Engineer 48 HRS prior to test.
 - b. Leave joints, including welds, uninsulated and exposed for examination during the test.
 - c. Provide temporary restraints where required.
 - 1) If temporary restraints are not practical, isolate expansion joints from testing.
 - d. Flush system with clear water.
 - e. Isolate equipment that is not to be subjected to the test pressure from the piping.
 - 1) If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve.
 - 2) Flanged joints at which blinds are inserted to isolate equipment need not be tested.
 - f. Set relief valve set at pressure no more than 1/3 higher than test pressure to protect against damage by expansion of liquid or other source of over-pressure during the test.
 - g. Use ambient water temperature as a testing medium except where there is risk of damage due to freezing.
 - 1) Another liquid may be used if it is safe for work persons and compatible with the piping system components.
 - h. Use vents to release trapped air while filling the system.
 - i. Examine system to see that equipment and parts that cannot withstand test pressure are properly isolated.
 - j. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the normal operating pressure.
 - 1) The test pressure shall not exceed the maximum pressure for any vessel, pump, valve or component on the system under the test.
 - k. After the hydrostatic test pressure has been applied for at least ten minutes, examine the piping joints and connections for leakage.
 - 1) Eliminate leaks by tightening, repairing or replacing components as appropriate and repeat hydrostatic test until there are no leaks.
 - l. Architect/Engineer shall verify acceptance of the pressure test.
 - m. Clean and flush piping system.
- B. Major equipment & system start-up, operational tests, and energization shall be scheduled and documented in accordance with the commissioning requirements detailed in Section 01 91 13 General Commissioning Requirements.

3.12 ADJUSTING, CLEANING AND AIR PURGING

A. General:

1. The GLHE contractor shall be responsible for flushing, purging, cleaning and filling all of the outside piping.
 - a. Outside piping is defined as all ground coupled heat pump loop external to the building and installed as part of this Contract.
2. Flushing, Testing and Cleaning:
 - a. Cleanliness: During installation, trash, soil and small animals shall be kept out of the pipe.
 - 1) Ends of the pipe shall be capped until the pipe is joined to the circuit.
 - b. Flushing the Vertical Ground Heat Exchanger: Before connection of the vertical heat exchanger loops to the header lines, each loop shall be flushed thoroughly and left filled with clean water.
 - 1) If the loop is not immediately joined to the header, it shall be capped.
 - c. Pressurizing: The horizontal piping system shall be water filled and pressure tested by zone as specified in this Section prior to back fill of the trenches.
 - 1) Every joint and fitting shall be visually and physically examined.
 - 2) Notify Architect/Engineer 48 HRS before test.
 - 3) Make note of test in log book mentioned previously in this specification.
 - 4) Record test duration, pressures, etc.
3. Air Purging:
 - a. The hydronic system shall be purged of all air by bleeding air from all high spots and circulating water through the system for minimum of 48 HRS.
 - b. Prior to backfilling, the complete loop field piping system shall be purged of air and flow tested to ensure proper water flow in all portions of the heat exchanger.
 - 1) A portable temporary purging unit shall be utilized and consist of the following:
Purge Pump-high volume and high head; open reservoir, filter assembly with bypass; connecting piping, and connection hoses.
 - c. Using the purging unit described above, flush and purge each Geothermal Loop Heat Exchanger zone until free of air, dirt and debris.
 - 1) A minimum velocity of 2 FT/sec is required in all pipe sections to remove the air.
 - a) The flush and purge water velocity shall not exceed 7 FT/sec.
 - b) This flushing and purging operation should be conducted with the water source heat pump piping isolated with shut off valves.
 - c) Do not flush and purge through the heat pump units.
 - (1) Temporary hoses shall be connected during the flush-out procedure in such a way as to bypass the heat pump, auto-flow control valve, and the strainer.
 - d) Coordinate with the building mechanical contractor (Do not allow the acid solution used to purge and flush the indoor metal pipe system to the heat pump units to become mixed with the solution in the GLHE).
 - d. Utilizing the purging unit, conduct a pressure and flow test on the completed Geothermal Loop Heat Exchanger to ensure the system is free of blockage.
 - 1) If the flow test indicates blockage, locate the blockage systematically clamping off loops with a pinch-off tool or using the shut-off valves, remove the blockage, then repurge and conduct the pressure and flow test again until all portions of the system are flowing.
 - 2) The flow test must be observed and approved by the Architect/Engineer.
 - e. The Geothermal Loop Heat Exchanger inspection report is to be filled out by the Contractor and is to be witnessed by the Architect/Engineer.

4. System Startup: Prior to heating and cooling system startup by the building mechanical contractor, ensure all valves are in correct position and GLHE is unblocked and leak free prior to system startup.
 - a. The GLHE Contractor shall be present at and coordinate with the building mechanical contractor during building mechanical system startup.
 - b. The General Contractor shall coordinate filling of the entire heat pump loop system (inside the facility and outside the facility) with propylene glycol, as scheduled.

3.13 FUNCTIONAL PERFORMANCE TESTING

- A. System Functional Performance Testing is part of the Commissioning Process as detailed in Section 01 91 13 - General Commissioning Requirements. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Professional.

END OF SECTION

SECTION 23 21 23

HVAC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for HVAC Pumps, as indicated, in accordance with provisions of Contract Documents.
- B. Types Included:
 - 1. In-line pumps.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Standards:
 - 1. Hydraulic Institute Standards: HI1983, 14TH Edition.
 - 2. Hydraulic Institute Engineering Data Handbook: HI979, First Edition.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Pumps:
 - a. Include curves.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - 2. Letter stating extra material has been delivered.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Flexible pump couplings:
 - 1. Base:
 - a. Dodge Regupol; "Para-flex".
 - b. Wood's "Sure-flex".
- B. In-line pumps:
 - 1. Base:
 - 2. Optional:
 - a. Allis-Chalmers, ITT.
 - b. Aurora.
 - c. Buffalo Forge.
 - d. Goulds Pumps.
 - e. Bell & Gossett, ITT.
 - f. Peerless Pump.
 - g. Taco.
 - h. Weil Pump.
 - i. Ingersoll Dresser Pumps.
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. In-Line Pumps

1. In-line pumps, heating and cooling water: Centrifugal, close-coupled, single stage, bronze fitted, vertical mount.
 - a. Capacity: As scheduled.
 - b. Capable of being serviced without disturbing piping connections.
 - c. Pump body: Cast iron with 870 kPa 125 psi ANSI drilled flanges.
 - 1) Rated working pressure: 1210 kPa 175 psi.
 - 2) Provide with gauge ports.
 - d. Impeller: Non-ferrous material, enclosed type.
 - 1) Hydraulically and dynamically balanced.
 - 2) Keyed to shaft and secured by locking capscrew.
 - e. Provide internally-flushed mechanical seal with ceramic seal seat.
 - f. Non-ferrous shaft sleeve to cover wetted area under seal.
 - g. Motor: Open drip-proof enclosure with regreaseable ball bearings.

2.3 EXTRA MATERIALS

- A. Provide one extra mechanical pump seal with gaskets for each double suction pump.

2.4 VIBRATION ISOLATION

- A. Vibration Isolation: Section 23 05 50.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install pumps according to manufacturer's recommendations and as specified.

3.2 VIBRATION ISOLATION

- A. Vibration Isolation: Section 23 05 50.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, tools, equipment, and services for Refrigerant Piping System, as indicated, in accordance with provisions of Contract Documents.
- B. Systems Include:
 - 1. Refrigeration piping.
 - 2. Refrigeration valves.
 - 3. Refrigeration specialties.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Piping standards: See Section 23 11 00.
- B. Valve standards: See Section 23 05 23.

1.3 SUBMITTALS

- A. Contract Closeout Information:
 - 1. Test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Refrigerant piping specialties:
 - 1. Base:
 - a. Sporlan Valve.
- B. Expansion valves:
 - 1. Base:
 - a. Sporlan Valve.
 - b. Alcoa Building Products.
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Pipe And Fittings
 - 1. Refrigerant piping: Copper, dehydrated, with high-temperature soldered joints and wrought copper (2760 kPa 400 psiG) fittings.
 - a. For underground use: Type K.
 - b. For above ground use: Type L.
 - 2. For field assembled units, size refrigeration lines in accordance with manufacturer's published tables using pressure or temperature drops as follows:
 - a. Suction lines: 1.11 degrees C 2 degrees F.
 - b. Liquid lines: 0.56 or 1.11 degrees C 1 degree F or 2 psi.
 - c. Hot gas lines: 0.56 degrees C or 24.8 kPa 1 degree F or 3.6 psi.
 - d. Size discharge and hot gas risers for positive oil return to compressors.

3. Hangers: See Section 23 05 29.
- B. Refrigerant Piping SPECIALTIES
 1. Moisture indicator: indicate presence of moisture in system by change of color.
 - a. Install adjacent to filter.
 - b. In bypass line use Sporlan SA-12S.
 2. Strainers: Design to permit removing screen without removing strainer from piping system.
 - a. Provide with screens of not larger than 80 mesh.
 - b. Provide strainers on liquid line serving each thermostatic expansion valve and in suction line serving each refrigerant compressor not equipped with integral strainer.
 3. Oil traps:
 - a. Provide in lines as indicated.
- C. Valves
 1. Valves: Bronze.
 - a. In lines DN50 2 inches and smaller: Solder ends.
 - b. In lines DN80 3 inches and over: Four bolt union ends.
 2. Shut off valves: Packed type with gas tight cap seal and hard metal seats and shoulders which permit packing stuffing boxes wide open under pressure; or sealed diaphragm type.
 - a. Wheel, globe, angle or "T" handle.
 3. Check valves:
 - a. In liquid lines DN18 5/8 inches and smaller: Lift check type.
 - b. In lines DN20 - DN50 3/4 - 2 inches: Swing check type.
 - c. In lines DN80 3 inches and over: Wafer type swing check with bronze disc.
 4. Expansion valves: Sized by manufacturer for refrigerant used.
 - a. Provide one in each circuit with liquid distributor connection immediately after.
 5. Vent and test valves: Angle cap type with seal and outlet caps.

PART 3 - EXECUTION

3.1 REFRIGERANT PIPING ASSEMBLY

- A. Install in accordance with Section 23 11 00.
- B. Thoroughly clean piping of dirt and grease on inside with a suitable cleaning solution just before soldering.
- C. Polish end of tube and inside of fitting.
- D. Purge refrigerant piping of air while connections of refrigerant piping are being made.
 1. Shut off valves.
 2. Connect tank of dry nitrogen to line on back side of valve.
 3. Introduce dry nitrogen into line as refrigerant piping joints are successively made up from valve to each condenser.

3.2 TESTING

- A. Test refrigerant piping to hold pressure of twice normal working pressure for period of 72 hours before refrigerant is added.
- B. Testing pressure shall not exceed maximum rating of weakest component of system.
 1. Place an initial charge of refrigerant in system for detection purposes.
 2. Use dry nitrogen gas for pressure testing.
 3. Low side to be valved off and tested to 1380 kPa 200 psi.

- C. Check joints with an electronic leak detector.
- D. Cut out joints found to be leaky and replace with new material.

3.3 CLEANING

- A. After complete system is tested, disconnect suction and discharge lines from compressor for cleanup.
- B. Valve or blank off system into three separate systems for purpose of cleanup.
 - 1. Suction side including cooling coils.
 - 2. Discharge side including air cooled condenser.
 - 3. Hot gas reheat side including heating DX coils.
- C. Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant or any foreign matter shall be considered contaminated systems.
- D. Restore contaminated system(s) to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging using current refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Owner.
- E. Notify Engineer for a visual inspection of both cleaning process and completely cleaned system.

3.4 EVACUATION AND DRYING

- A. After tests and cleaning have been completed and system proved tight, charge each circuit with dry clean refrigerant to approximately 350 kPa 50 psi of gas pressure.
- B. Evacuate to 0.4 Pa absolute 100 micron Hg and hold for 48 hours.
 - 1. Use laboratory type vacuum pump capable of holding absolute pressure of 0.2 Pa absolute 50 micron Hg.
- C. Admit another drying charge of refrigerant and allow 4 to 6 hours to absorb moisture and install dryer cores.
- D. Use second evacuation to remove refrigerant and moisture.
- E. After second evacuation, charge system with refrigerant.
- F. Add refrigerant to system as required after final evacuation.

END OF SECTION

SECTION 23 31 13
AIR DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Air Distribution System, as indicated, in accordance with provisions of Contract Documents.
- B. Systems Included:
 - 1. Acoustical duct liner.
 - 2. Dampers.
 - 3. Fire and smoke dampers.
 - 4. Diffusers, registers and grilles.
 - 5. Duct access doors.
 - 6. Control dampers less actuators.
 - a. Actuators for control dampers: See Section 25 30 00.
- C. Work Installed but Not Furnished:
 - 1. Automatic dampers: Section 25 30 00.
 - 2. Airflow measuring stations: Section 25 30 00.
- D. Definitions:
 - 1. Low- and high-pressure ductwork:
 - a. See Article 2.2 of this section.
 - 2. Gage:
 - a. Steel sheet and wire: U S Standard Gage.
 - b. Steel wire: Washburn and Moen Gage.
 - 3. Concealed insulated surfaces:
 - a. Piping, ductwork and equipment in walls, partitions, floors, pipe chases, pipe shafts, duct shafts and above suspended ceilings.
 - 4. Exposed insulated surfaces:
 - a. Piping, ductwork, and equipment located in mechanical rooms, tunnels, and rooms without suspended ceilings.
- E. Duct sizes indicated are based upon internal dimensions.
 - 1. Where acoustical liner is applied to interior of a duct, increase size to maintain interior dimensions.
- F. Location of diffusers, registers and grilles are indicated on Architectural Reflected Ceiling Plans.
- G. Field Mounted Actuators:
- H. Dampers:
 - 1. Built and assembled by listed manufacturer.
- I. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE):
 - 1. ASHRAE Handbook - HVAC Systems and Equipment: Current chapter on duct construction.

2. ASHRAE Standard 70-72, Method of Testing for Rating the air flow performance of outlets and inlets.
- B. Air Diffusion Council (ADC):
 1. ADC Standard 1062: GRD-84, Test Code for Grilles, Registers and Diffusers.
 2. ADC Test Code FD 72-R1, Flexible Air Duct Test Code.
- C. Air Movement and Control Association International (AMCA):
 1. AMCA Standard 210, Test Code for Air Moving Devices.
- D. National Fire Protection Association (NFPA):
 1. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems, current edition.
 2. NFPA 96 Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, current edition.
 3. NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials
- E. Sheet Metal & Air Conditioning Contractors National Association (SMACNA):
 1. SMACNA HVAC Duct Construction Standard - Metal and Flexible, Current Edition.
 2. SMACNA Duct Cleanliness for New Construction, Current Edition.
- F. ASTM International (ASTM):
 1. ASTM A109 Standard Specification for Steel, Strip Carbon (0.25 Maximum Percent), Cold-Rolled.
 2. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 3. ASTM B23 Standard Specification for White Metal Bearing Alloys (Known Commercially as Babbitt Metal).
 4. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 5. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
- G. Underwriters Laboratories (UL):
 1. UL 181A Closure Systems for Use with Rigid Air Ducts.
 2. UL 181B Closure Systems for Use with Flexible Air Ducts and Air Connectors.
 3. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials

1.3 SUBMITTALS

- A. Shop Drawings:
 1. Ductwork layout at 1/4 inches 6 mm to 1 foot 305 mm scale.
 - a. Layout drawings to include sign-off from balancing contractor indicating the contractor has reviewed the documents to ensure volume damper installation is in compliance with the requirements of this section.
 - b. Shop drawings may not be copied, traced, or any other reproduced version of the construction documents.
 - c. Shop drawings should show progress from coordination with other trades, ductwork elevations, fittings, joints, sheet metal gauges, and any other pertinent information related to the layout, installation, or construction of the ductwork.
- B. Product Data:
 1. Ductwork and fittings.
 2. Dampers.
 3. Diffusers, registers, and grilles.
- C. Contract Closeout Information:

1. Operation and Maintenance Data:
 - a. Including but not limited to fire and smoke dampers, control dampers and combination louvers.
 - b. See Section 01 78 23.
2. Test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Factory Fabricated Duct Connection Systems:

1. Base:
 - a. Ductmate Industries.
2. Optional:
 - a. Nexus.
 - b. Ward Industries, Inc.

B. Sealants, Mastics and Adhesives:

1. Base:
 - a. Hardcast.
2. Optional:
 - a. United McGill Airflow Corporation.
 - b. Foster (Division of HB Fuller).

C. Turning Vanes:

1. Base:
 - a. Ductmate.
2. Optional:
 - a. Airsan.
 - b. Tuttle & Bailey.
 - c. Titus.
 - d. VentProducts.

D. Flexible Fan Connections:

1. Base:
 - a. Ventfabrics.
2. Optional:
 - a. Duro-Dyne.
 - b. Elgin.

E. Pre-insulated Flexible Duct:

1. Base:
 - a. Atco.
2. Optional:
 - a. Flexible Technologies, Thermaflex.
 - b. Hart and Cooley.
 - c. Flexmaster.

F. Access Doors, Low- and High-Pressure:

1. Base:
 - a. Ductmate.

- 2. Optional:
 - a. Ward Industries.
 - b. United McGill Airflow Corporation.

G. Acoustical Duct Liners:

- 1. Base:
 - a. Knauf Fiber Glass.
- 2. Optional:
 - a. Knauf Fiber Glass.
 - b. CertainTeed Insulations.
 - c. Owens-Corning Fiberglass.
 - d. Johns Manville Corporation.

H. Manual/Backdraft/Control Dampers:

- 1. Base:
 - a. Ruskin.
- 2. Optional:
 - a. Greenheck.
 - b. Titus.
 - c. Portoff.
 - d. Nailor.
 - e. TAMCO.

I. Remote Operated Dampers:

- 1. Base:
 - a. Young Regulator Bowden
- 2. Optional:
 - a. Duro-Dyne.
 - b. Titus.

J. Fire Dampers:

- 1. Base:
 - a. Ruskin.
- 2. Optional:
 - a. Greenheck.
 - b. Portoff.
 - c. Nailor.

K. Smoke Dampers:

- 1. Base:
 - a. Ruskin.
- 2. Optional:
 - a. Greenheck.
 - b. Portoff.
 - c. Nailor.

L. Combination Fire/Smoke Dampers:

- 1. Base:
 - a. Ruskin.
- 2. Optional:

- a. Greenheck.
- b. Portoff.
- c. Nailor.

M. Diffusers, Registers, and Grilles:

- 1. Base:
 - a. Titus.
- 2. Optional:
 - a. Krueger.
 - b. Tuttle & Bailey.
 - c. Price.

N. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Sheet Metal:

- 1. Galvanized steel (G90): ASTM A653/A653M.

B. Ductwork:

- 1. Maintain full areas and suitable shapes at every point.
- 2. Shapes may be changed to fit unusual space conditions.
 - a. Cross sectional area to be maintained.
 - b. Modifications increasing system pressure drop require Architect approval.
 - c. Modifications increasing aspect ratio beyond 5:1 require Architect approval.
- 3. Provide necessary transitions and offsets to complete systems.
- 4. Construct systems of G90 galvanized steel, except as follows:
- 5. Ductwork, Low-Pressure, Sheet Metal:
 - a. Construct in accordance with SMACNA HVAC Duct Construction Standard per appropriate SMACNA table.
 - 1) Ductwork for systems operating between 2 inches WG 500 Pa and 3 inches WG 750 Pa static pressure, positive or negative:
 - a) Rectangular duct.
 - b) Round spiral seam duct.
 - 2) Ductwork systems operating under 2 inches WG 500 Pa positive or negative:
 - a) Rectangular duct.
 - b) Round duct: spiral or longitudinal seam.
 - b. Low-pressure ductwork includes but is not limited to:
 - 1) Supply ductwork on outlet side of single and dual duct air terminal units.
 - 2) Return, relief air, and outside air ductwork.
 - 3) Exhaust air ductwork from air inlets to air terminal units (e.g., isolation exhaust system).
 - 4) Exhaust air for other exhaust systems operating less than 3 inches WG .75 kPa static pressure, positive or negative.
 - 5) Supply ductwork for constant volume systems without air terminal units.
 - c. Transverse joints, rectangular:
 - 1) Ducts with longest side 36 inches 910 mm and longer:
 - a) Use factory fabricated flanged duct connection systems (e.g. Ductmate 35/25 slide on systems).

- b) Non-proprietary SMACNA defined T-22 or T-24 flanged connections.
 - c) Seal transverse flanged duct connections with pressure sensitive, high-density, closed cell, neoprene or polyurethane tape gasket.
 - 2) Ducts with longest side shorter than 35 inches 890mm:
 - a) Flanged duct connection systems as defined above are optional.
 - b) Refer to SMACNA HVAC Duct Construction Standard for proper duct construction.
 - d. Longitudinal seam: Use Pittsburgh lock seam only.
 - e. Seal low-pressure ducts to Seal Class A requirements.
 - f. Runouts to diffusers, register and grilles:
 - 1) Flexible duct.
 - 2) Provide rigid ductwork where ducts pass through smoke or fire rated walls, floors, or ceilings.
 - 3) Maximum flexible duct length: 3 feet 910 mm.
 - 4) Minimum turning radius:
 - a) As recommended by manufacturer.
 - b) Do not kink, bend, or restrict free area of duct.
- 6. Duct Hangers and Supports:
 - a. High- and low-pressure sheet metal ductwork:
 - b. SMACNA HVAC Duct Construction Standard.
- 7. Duct Fittings and Joints:
 - a. Low-Pressure Systems:
 - 1) Radius elbows without vanes:
 - a) Radius ratio (R/W) of 1.5 and greater.
 - 2) Connections to diffusers, grilles, and registers: Fitted securely to necks or collars provided behind diffuser, grille, or register face area.
 - 3) Branch connections:
 - a) Round: Factory built short cone or bellmouth type. Air scoops are not acceptable.
 - b) Rectangular: 45-degree entry type or radius elbow.
 - 4) Provide necessary transition pieces and duct collars to make connections to ductwork from neck sizes scheduled or indicated on drawings.
 - 5) Where building walls, floor and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted to building structure.
 - b. High-Pressure Systems:
 - 1) Elbows 3-8 inches 75-200 mm diameter: Die stamped, for minimum air friction loss, with continuous corrosion resistance welds.
 - 2) Elbows over 8 inches 200 mm diameter: Welded segment type, not less than 5 pieces for 90-degree elbows, and not less than 3 pieces for 45-degree elbows, using corrosion resistant welds.
 - 3) Tees: "Low loss, short cone type", unless specifically detailed otherwise for space limitations.
 - 4) "Y's" 45-degree type. 60-degree type may be used if space conditions dictate.
 - 5) Install "Y's" as indicated.
 - 6) Where tees are indicated, "Y's" may be substituted if space is available.
 - 7) "Y's": Straight sided type (no cone).
 - 8) Takeoffs from air handling unit plenums: Standard Bellmouth fittings.
 - a) Construct in accordance with SMACNA HVAC Duct Construction Standards.

- 9) "Y" takeoffs from horizontal ceiling mounted ducts to serve boxes: May be straight sided, shop fabricated type by accurately cutting and welding "Y's" into spiral ducts without use of fittings.
8. Turning Vanes, Square Elbows:
 - a. Velocities up to 2500 fpm 13 m/s: Single vane, runner Type 2, with 3/4 inches 20 mm trailing edge, 2 inches 50 mm vane radius and 1.5 inches 40 mm vane spacing, minimum 24 GA.
 - 1) For widths over 36 inches 910 mm install vanes in 2 or more sections or use tie rods to limit unbraced vane length.
 - b. Where inlet and outlet dimensions of elbows are not equal, set 2 or more sections at 45 degrees angle to give optimum turning.
 - c. Radius elbows without vanes: Radius ratio (R/W) of 1.5 and greater.
 - d. Radius elbows with vanes: Radius ratio (R/W) less than 1.5; use where space limitations occur.
 - 1) R/W = 0.75 to 1.0: Provide 3 vanes in elbow.
 - 2) R/W = 1.0 to 1.25: Provide 2 vanes in elbow.
 - 3) R/W = 1.25 to 1.5: Provide 1 vane in elbow.
 - 4) Provide vane spacing per SMACNA HVAC Duct Construction Standards.
 - e. Where square elbows are indicated or required, provide with turning vanes.
- C. Factory Fabricated Duct Connection Systems:
 1. Per SMACNA Joint construction standards, 18 gauge minimum.
- D. Sealant, Mastics and Adhesives:
 1. NFPA rating of "Non-Combustible".
 2. Flame spread rating: 25 or lower, in dry condition.
 3. Smoke developed rating: 50 or lower, in dry condition.
 4. Resistant to water and water vapors.
 5. Pressure rupture rating: 16 inches WG 4 kPa, minimum.
 6. Durkee-Atwood Permatite Class I Duct Sealer; [Hardcast Iron Grip 601](#) and [Duct Seal 321](#); or United McGill Sheet Metal Uni-Mastic 181 Duct Sealer and United Duct Sealer.
 7. Duct Sealing Tape:
 - a. NFPA rating of "Non-Combustible".
 - b. Flame spread rating: 25 or lower, in dry condition.
 - c. Smoke developed rating: 50 or lower, in dry condition.
 - d. Adhesive: Specifically compounded for maximum adhesion to galvanized and stainless steel.
 - e. Listings/Labels: UL 181A or UL 181B.
 8. RTV Foam:
 - a. UL listed room temperature vulcanized silicone rubber foam.
 9. NFPA rating of "Non-Combustible."
 10. Flame spread rating: 25 or lower, in dry condition.
 11. Smoke developed rating: 50 or lower, in dry condition.
 12. Compounded for maximum adhesion to galvanized and stainless steel ductwork.
 13. Listings/labels: UL 181A or UL 181B
- E. Flexible Fan Connections:
 1. Material: Neoprene double coated tightly woven glass fabric flexible connections.
 2. Fasten fabric to sheet metal duct work and to fan collar extension with 3/16 inches 5 mm rivets spaced not more than 5 inches 125 mm OC.

3. Locate in inlet and outlet of fans, as close to fan as possible.
4. Provide at ducts crossing building expansion joints and as indicated on drawings.
5. Connections shall not be under tension.
6. Provide minimum separation distance of 1 inch 25 mm across the connection.

F. Flexible Ducts, Pre-insulated:

1. Low-pressure construction:
 - a. Liner: Steel wire helix encapsulated with chlorinated polyethylene (CPE) film.
 - b. Insulation:
 - 1) 1 inches 25 mm x 3/4LB/CF 16 kg/m3 fiberglass insulation, minimum resistance of R-4.2.
 - c. Jacket:
 - 1) Bi-directional metalized polyester.
 - 2) Permeability: Not to exceed 0.05 perms when tested in accordance with ASTM E96 Procedure A.
2. High-pressure construction:
 - a. Liner: Heavy gauge corrugated aluminum with watertight continuous lock seams.
 - b. Insulation: 1 inch x 3/4LB/CF fiberglass insulation, minimum resistance of R-4.2.
 - c. Jacket:
 - 1) Bi-directional metalized polyester.
 - 2) Permeability: Not to exceed 0.05 perms when tested in accordance with ASTM E96 Procedure A.
 - 3) Flex duct must also meet any other local or state requirements for flexible duct construction and performance.
3. Rated working pressure:
 - a. Low-pressure duct: Positive 4 inches WG 750 Pa minimum; negative 1 inch WG 375 Pa minimum, for return or exhaust air connections.
 - b. High-pressure duct: Positive 8 inches WG 2500 Pa minimum; negative 8 inches WG minimum for return or exhaust air connections
4. Fire resistant, self-extinguishing, UL-181, Class 1, with flame spread of 25 or less and smoke development not to exceed 50.
5. Thermal conductance(C): 0.23 btu/ h-FT2-F 1.3 W/m2-K.
6. Low-pressure connections:
 - a. Secure duct to collar or sleeve with screws, or metal or nylon clamps or bands.
 - b. Seal connection with 2 wraps of duct tape.
7. High-pressure connections:
 - a. Secure duct to collar or sleeve with duct sealer and 1/2 inches 15 mm aluminum or galvanized steel bands or clamps.
 - b. Secure insulation jacket with 2 wraps of duct tape.
8. Turn radius: Not less than R/D equal to 1.0.
9. Provide flexible duct supports in accordance with SMACNA HVAC Duct Construction Standards.
10. As applicable, all products or assemblies to meet local or state code requirements.

G. Access Doors:

1. Provide at fire dampers, smoke dampers, fire and smoke dampers, duct mounted automatic dampers, duct mounted coils (except air terminal unit reheat coils), and where indicated on Drawings.
2. Position access doors to permit easy visual inspection and allow maintenance and resetting of device served.

3. Increase duct dimensions at devices when necessary to accommodate required access.
4. Install access doors above accessible lay-in ceilings.
5. Where access doors are installed above gypsum wall board ceilings or within shafts, provide access panels per Section 23 05 00.
6. Low- and high-pressure ductwork:
 - a. Access doors:
 - 1) Removable, double wall construction.
 - 2) 1 inches 25 mm thick fiberglass insulation.
 - 3) Closed cell neoprene gasket and attachment bolts.
 - 4) Airtight seal to static pressures of 20 inches WG 5 kPa.
 - b. Sizes:
 - 1) For ducts 460 mm 18 inches and under, the minimum door size shall be 255 mm x 150 mm 10 inches X 6 inches.
 - 2) For ducts 475 mm to 600 mm 19 inches to 24 inches, the minimum door size shall be 400mm x 300 mm 16 inches X 12 inches.
 - 3) For ducts over 600 mm 24 inches the minimum door size shall be 600 mm x 450 mm 24 inches X 18 inches.
 - c. Provide duct boot to install doors in round ducts or rounded side of flat oval duct.

H. Dampers:

1. Sizes and types: As indicated.
2. Locate as indicated.
3. Factory built and assembled dampers.
4. Dampers, control:
 - a. Provide damper schedule: Include damper leakage rating, service (e.g., 2-position vs. modulating), quantity, system served, indicate parallel or opposed blade, actuator type, spring ranges (where applicable), quantity of actuators per damper, damper actuator torque rating, damper section sizes (width by height), and shutoff leakage ratings.
5. Dampers Manual, Rectangular and Square:
 - a. Opposed blade type, fitted with shank bolts, marked for direction (open/closed) and factory fabricated. (No shop fabrications accepted.)
 - b. Provide locking hand quadrant, with 2 inches 50mm standoff bracket.
 - c. Construction:
 - 1) Greater than 36 x 12 inches 914 x 305 mm:
 - a) Frame: 16 GA galvanized steel formed into structural shape.
 - b) Blades: 16 GA galvanized steel, equipped with brass pin running on stainless steel pivot for vertical axis.
 - c) Axles: Continuous, steel 1/2 inches 13mm hex.
 - d) Basis of design: Ruskin MD35.
 - 2) 36 inches x 12 inches 914 mm x 305 mm and less:
 - a) Frame: 22 GA galvanized steel, flat or angle.
 - b) Blades: 22 GA galvanized steel, equipped with brass pin running on stainless steel pivot for vertical axis.
 - c) Axle: Continuous, steel 3/8 inches 10mm hex.
 - d) System pressure and velocity rating: 2.5 inches WG 622 Pa and 1500 fpm 7.6 m/s.
 - e) Basis of design: Ruskin MD25 or MD15.
6. Dampers Manual, Round:

- a. Butterfly type with circular blade mounted to shaft and factory fabricated. (No shop fabrications accepted.)
 - b. Frame: Minimum 20GA galvanized steel 7 inches 180 mm segment duct.
 - c. Blade: Minimum 20 GA galvanized steel.
 - d. Shaft: Continuous, Steel 3/8 inches 10mm hex.
 - e. System pressure and velocity rating: 2.5 inches water gauge and 1500 fpm.
 - f. Hand quadrant: Locking type with 2 inches 50 mm standoff bracket.
 - g. Bearings: Self-lubricating nylon or stainless steel sleeve.
 - h. Basis of design: Ruskin MDRS25.
7. Dampers, Backdraft, Low-Pressure:
- a. Counterbalanced, gravity operated.
 - b. Fabricate of aluminum.
 - c. Blades: Provided with common linkage rod and felt seals.
8. Dampers, Control:
- a. Frame:
 - 1) 16 GA galvanized steel, 16 gauge stainless steel or extruded aluminum. Damper material to match ductwork.
 - 2) Blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section shall not be located directly in the air stream. Blades mounted vertically shall be supported by thrust bearings.
 - 3) Pressure drop through dampers shall not exceed 0.04 inches water gauge at 1,000 feet/MIN in the wide-open position.
 - 4) Frames shall not be less than 2 inches in width.
 - b. Blades:
 - 1) Airfoil shaped; 6 inches 150 mm wide.
 - 2) Two layers of 22 GA galvanized steel mechanical joined sheets or extruded aluminum.
 - c. Seals:
 - 1) Extruded vinyl blade edge.
 - 2) Flexible metal compressible jamb seals.
 - d. Bearings:
 - 1) Aluminum frame construction: synthetic bearings.
 - 2) Galvanized or stainless steel construction: Stainless steel sleeve or ball bearing.
 - e. Temperature rating
 - 1) -40 to 200 deg F -40 to 93 deg C.
 - f. Pressure and velocity rating:
 - 1) Dampers shall be tested in accordance with AMCA 500-D.
 - 2) Dampers shall be rated for a minimum 4 inches WG 1000 Pa pressure differential at 2000 fpm 10 m/s.
 - 3) Dampers minimum pressure rating shall meet or exceed the pressure classification of the ductwork within which it is installed.
 - g. Blade arrangement:
 - 1) Opposed blade, except outside air and return air control dampers shall be parallel blade and arranged to promote mixing.
 - h. Actuators:
 - 1) See Section 25 30 00.
 - i. Examples:
 - 1) Aluminum frame construction: Ruskin CD50.

- 2) Galvanized frame construction: Ruskin CD60.
- 3) High-pressure duct: Ruskin CD80.

I. Remote Operated Dampers

1. Cable Controlled Rectangular Damper

- a. Damper(s) to be opposed blade type constructed of .050 minimum heavy duty extruded aluminum frames and blades. All necessary hardware to ensure compatibility with Bowden remote cable control system shall be included. Damper blades to include individual blade bushings for smooth and quiet operation. Damper blades shall rotate between a matched pair of formed and punched 306 stainless steel connecting slide rails which facilitate smooth blade movement and ensure alignment. Damper(s) shall be Young Regulator Model 830A-CC or prior approved equal.

2. Cable Controlled Round Damper

- a. Damper(s) to be constructed of heavy duty galvanized steel spiral shell design with rolled-in stiffening beads for superior rigidity. Spiral shell shall have one crimped end and one straight end for ease of installation. Damper to include "V" style 20 gauge galvanized steel blade secured with 1/2" diameter steel shafts and oil impregnated bronze bearings requiring no lubrication. Damper shall include all necessary hardware to ensure compatibility with Bowden remote cable control system. Damper(s) shall be Young Regulator Model 5020-CC or prior approved equal.

3. Route cables to control panel as indicated on plans or to accessible, discrete location.

J. Fire Dampers:

1. UL labeled; 1-1/2 hour rated unless otherwise indicated.
2. Fire dampers shall be dynamic type.
3. Provide as indicated and as required by NFPA and local regulations.
4. Provide with mounting angles and sleeves.
5. For curtain-type fire dampers, blades must be out of air stream (Type B fire damper), except as follows:
 - a. Fire dampers with blades in the airstream (Type A fire damper): where dampers are installed at a wall mounted grille and ductwork is not installed on both sides of the wall penetration.
 - b. For ducts where the smallest dimension is 8 inches 200 mm or less: Type C fire dampers shall be 1 inch 25 mm larger in each dimension and both frame and blades must be out of the air stream. This is not required at locations where fire dampers are installed at wall mounted grilles.
6. On round or flat oval ductwork, provide dampers in enclosure with round or oval connections on each side.
 - a. Fire Dampers in Low-Pressure Ducts:
 - 1) Provide curtain type damper, [Ruskin Model DIBD2](#).
 - a) Rated up to 2000 fpm 10.2 m/s at 4 inches WG 1000 Pa for vertical mounted applications.
 - b) Rated up to 2000 fpm 10.2 m/s at 4 inches WG 1000 Pa for horizontal mounted applications.
 - b. Fire Dampers in High-Pressure Ducts:
 - 1) For vertical mounted applications: curtain type damper, [Ruskin Model DIBDX2](#).
 - a) Rated up to 4000 fpm 19.9 m/s at 8 inches WG 2000 Pa.
 - 2) For horizontal mounted applications: curtain type damper, [Ruskin Model DIBD2](#).
 - a) Rated up to 2000 fpm 9.9 m/s at 4 inches WG 1000 Pa.
 - c. Fire Dampers for Stainless Steel Ductwork Systems:
 - 1) Provide as specified above except with Type 304L stainless steel construction.
 - 2) Provide as specified above except with Type 316 stainless steel construction.

- d. Ceiling Fire Dampers:
 - 1) UL listed specifically for floor/ceiling assemblies.
 - 2) Provide [Ruskin CFD Series](#) radiation damper suitable for type of diffuser, register, and grille.
 - 3) Provide mineral wool thermal insulating blanket for back side of diffuser, register, or grille as required by the manufacturer to comply with listing of damper.
- K. Smoke Dampers:
1. UL classified as a leakage rated damper for use in smoke control systems under UL555S, latest edition, and bear a UL label attesting to same.
 2. Suitable for velocity and pressure of system.
 3. Jamb seals: Stainless steel flexible metal compression type.
 4. Provide in ductwork adjacent to smoke partition (not in wall) with actuator in accessible location and visible for inspection.
 5. Provide dampers and actuators as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators as a rated assembly.
 6. Frame: 16 GA galvanized steel, minimum.
 - a. Loss through wide open damper based on AMCA Test Figure 5.3:
 - b. 12 inches x 12 inches duct size: Not more than 1.25 inches WG 310 Pa at 3000 fpm 15 m/s face velocity.
 - c. 24 inches x 24 inches duct size: Not more than 0.45 inches WG 110 Pa at 3000 fpm 15 m/s face velocity.
 - d. 36 inches x 36 inches duct size: Not more than 0.3 inches WG 75 Pa at 3000 fpm 15 m/s face velocity.
 7. Provide factory supplied caulked sleeve.
 8. Provide factory mounted resettable link and switch package with open and closed indicator and factory mounted momentary switch to allow damper to be tested at the damper.
 9. Smoke Dampers, Low-Pressure:
 - a. Parallel blade type with blades hinged together for operation in unison and bearings arranged for automatic operation.
 - b. UL555S Leakage Rating: Class I (20 L/sm² 4 cfm/SF at 250 Pa 1 inch WG).
 - 1) [Ruskin Model SD37.](#)
 - c. Blades: Single or double thickness type.
 - 1) Single thickness type: 16 GA steel, minimum.
 - 2) Double thickness type: 18 GA steel.
 - d. Blade width: Not more than 6 inches 150 mm.
 - e. Single blade dampers may be used for up to 8 inches 200 mm wide blade, or up to 12 inches 300 mm round.
 10. Smoke Dampers, Square or Rectangular, High-Pressure:
 - a. Parallel or opposed blade type with linkage for automatic operation.
 - b. UL555S Leakage Rating: Class I (8 cfm/SF 40 L/sm² at 4 inches WG 1000 Pa).
 - 1) [Ruskin Model SD60 or SD50.](#)
 - c. On round or flat oval ductwork:
 - 1) Provide dampers in an enclosure with round or oval connections on each side.
 11. Smoke Dampers, Round or Flat Oval, High-Pressure:
 - a. Single blade type with encompassed blade edge seal.
 - b. UL555S Leakage Rating: Class I (8 cfm/SF 40 L/sm² at 4 inches WG 1000 Pa).
 - 1) [Ruskin Model SDRS25.](#)
 12. Damper actuator:

- a. Pneumatic type, factory installed.
 - 1) Two-position type operating on 0 to 20 psiG 0 to 138 kPa air pressure.
 - 2) Spring return fail closed.
 - 3) UL listed at 250 deg F 120 deg C.
- L. Combination Fire-Smoke Dampers:
 - 1. Fire-Smoke Dampers, Combination:
 - a. UL classified as a Leakage Rated damper under UL555S, latest edition, bearing a UL label attesting to same.
 - b. UL555 fire rating: 1.5 Hour.
 - c. Suitable for velocity and pressure of system.
 - d. Compressible metal jamb seals.
 - e. Operator installed per UL requirements, in accessible location and visible for inspection.
 - f. Provide dampers and actuators as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators as a rated assembly.
 - g. Frame: 16 GA galvanized steel, minimum.
 - h. Loss through wide open damper:
 - i. Loss through wide open damper based on AMCA Test Figure 5.3:
 - 1) 12 inches x 12 inches duct size: Not more than 1.25 inches WG 310 Pa at 3000 fpm 15 m/s face velocity.
 - 2) 24 inches x 24 inches duct size: Not more than 0.45 inches WG 110 Pa at 3000 fpm 15 m/s face velocity.
 - 3) 36 inches x 36 inches duct size: Not more than 0.3 inches WG 75 Pa at 3000 fpm 15 m/s face velocity.
 - j. Provide factory supplied caulked sleeve.
 - k. Provide factory mounted resettable link and switch package with open and closed indicator and factory mounted momentary switch to allow damper to be tested at the damper.
 - 2. Fire-Smoke Dampers, Combination, Low-Pressure:
 - a. Parallel blade type with blades hinged together for operation in unison and bearings arranged for automatic operation.
 - b. May be used in lieu of separate fire and smoke dampers.
 - c. UL555S Leakage Rating: Class II (10 cfm/SF 50 L/sm² at 1 inch WG 250 Pa).
 - 1) Ruskin FSD36.
 - d. Fusible link: 165 deg F 74 deg C melting point.
 - 3. Fire-Smoke Damper, Combination, High-Pressure:
 - a. Parallel blade type.
 - b. May be used in lieu of separate fire and smoke dampers.
 - c. UL555S Leakage Rating: Class I (8 cfm/SF 40 L/sm² at 4 inches WG 1000 Pa).
 - 1) Ruskin Model FSD60.
 - d. Fusible link: 165 deg F 74 deg C melting point.
 - 4. Actuators, Fire-Smoke Damper:
 - a. Electric type, factory installed.
 - b. Two-position.
 - c. 120 VAC.
 - d. Spring return fail closed.
- M. Combination Control and Fire-Smoke Dampers:

1. UL classified as a leakage rated damper for use in smoke control systems under UL555S, latest edition, and bear a UL label attesting to same.
2. Velocity: Up to 2000 fpm.
3. Jamb seals: Stainless steel flexible metal compression type.
4. Use: As combination unit isolation and return control dampers at air handling units.
5. Provide dampers and actuators as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators as a rated assembly.
6. Frame: 5 inches x 16 GA galvanized steel, hat shaped channel.
7. Blades: On-piece airfoil, 6 inches wide and 14 gage galvanized steel equivalent thickness. Blades approximately 6 inches on-center.
8. Bearings: Stainless steel, flexible metal compression type.
9. Blade seals: Silicone edge type, mechanically fastened to the blade edge, for smoke seal to 450 deg F and galvanized steel for flame seal to 1900 deg F mechanically fastened to the blade edge.
10. Linkage: Concealed in frame.
11. UL555 fire rating: 1.5 Hour.
12. Temperature rating of 250 deg F.
13. Fusible link: 165 deg F melting point.
14. Provide factory mounted resettable link and switch package with open and closed indicator and factory mounted momentary switch to allow damper to be tested at the damper.
15. Loss through wide open damper based on AMCA Test Figure 5.3:
 - a. 36 inches x 36 inches duct size: Not more than 0.1 inches WG at 2000 fpm face velocity.
 - b. Example: Ruskin model FSD60M.
16. Damper actuator (operator):
 - a. Electric type, factory installed.
 - b. 2-position, except where indicated.
 - c. 120 VAC.
 - d. Spring return fail closed.
 - e. UL listed at 250 deg F.
 - f. Provide factory supplied caulked sleeve.
 - g. Provide smoke dampers as indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine structure, substrates, and conditions under which work is to be installed.
- B. Correct deficiencies.
- C. Installation constitutes acceptance of responsibility for performance.
- D. Install air flow measuring stations specified in Section 25 30 00 in accordance with manufacturer's installation instructions and as specified.

3.2 INSTALLATION OF DUCTWORK

- A. Ductwork Cleanliness:
 1. Reference Standard:
 - a. SMACNA – Duct Cleanliness for New Construction.
 2. Basic Level:
 - a. Under this level of ductwork cleanliness, it is acknowledged that ductwork leaving the premises of the manufacturer will include some or all of the following:

- 1) Internal and/or external self-adhesive labels or marking for parts identification.
 - 2) Exposed mastic sealant.
 - 3) Light zinc oxide coating on the metal surface.
 - 4) A light coating of oil on machine formed ductwork.
 - 5) Minor protrusions into the airway of rivets, screws, bolts, and other jointing devices.
 - 6) Internal insulation and associated fasteners.
 - 7) Discoloration marks from plasma cutting process.
- b. The internal surfaces of ductwork shall be wiped to remove excess dust immediately prior to installation.
3. Duct Cleanliness levels by space type:
 - a. Basic Level:
 - 1) Ductwork systems serving mechanical or electrical equipment rooms.
 - B. Install generally as indicated.
 - C. Conceal ductwork in finished spaces unless indicated otherwise.
 - D. Do not install ductwork in or allow to enter or pass through electrical rooms, elevator machine rooms, or spaces housing switchboards, panelboards, or distribution boards, except ductwork that serves electrical rooms, elevator machine rooms, or spaces.
 - E. Exercise special care to provide tight fitting well fabricated, well braced ductwork systems.
 - F. Field assemble rectangular, round, or flat oval ductwork as follows:
 1. Use duct joint sealer applied slip joints.
 2. Use Ductmate Spiralmate or Ovalmate systems.
 3. Isolate dissimilar metals with elastomeric sealant tape or fiber gaskets, and gaskets and washers for bolts.
 4. Install TDC flanged duct connection systems in accordance with SMACNA construction standards.
 - G. Fabricate duct connections for hoods, openings, fans, and other devices.
 - H. Where ducts pass thru fire rated and smoke rated construction, maintain rating indicated.
 1. Where fire dampers are not used, seal around duct with firestopping.
 2. See Section 07 84 00 for materials.
 - I. Do not kink, bend, or otherwise restrict the free area of flexible ductwork.
 - J. Ductwork Hangers:
 1. Install per SMACNA Duct Construction Standards but in no case shall ductwork hangers or ductwork be directly supported to or supported off of other ductwork.

3.3 INSTALLATION OF MANUAL DAMPERS

- A. Provide volume dampers, to facilitate air balancing, in the following locations whether shown on the plans or not:
 1. Run-outs to individual room terminal devices (i.e., supply grilles and diffusers, return and exhaust grilles). Locate damper as close to the run-out take off as possible.
 2. Lateral duct take-offs from a return or exhaust main riser for systems serving multiple floors.
- B. Provide additional branch main volume dampers required by the balancing contractor, refer to Section 23 05 93.

3.4 INSTALLATION OF FIRE AND SMOKE DAMPERS

- A. Install in accordance with manufacturer's instructions and UL requirements.
 1. See Section 07 84 00.

- B. Floor mounted dampers may be installed in a concrete floor curb.

3.5 PERFORMANCE TESTS

- A. Use a pressure blower with volume control and orifice flow meter to provide supply air for test.
- B. Submit reports to Architect.

3.6 CLEANING

- A. At substantial completion, clean work installed under this section.

3.7 EQUIPMENT DEMONSTRATION

- A. At substantial completion, inspect and test, and operate satisfactorily, in presence of Engineer and representative of Owner, operation of each piece of equipment and its accessories.
- B. If inspection or test indicates defects, replace defective work or material.
- C. Repeat inspections and tests until defects are eliminated.

END OF SECTION

SECTION 23 35 00
EXHAUST AND VENTILATING FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Air Terminal Units and Induction Units, as indicated, in accordance with provisions of Contract Documents.
- B. Systems Included:
 - 1. Ceiling exhaust fans.
 - 2. Gravity roof ventilators.
- C. Abbreviations:
 - 1. AMCA: Air Movement and Control Association.
 - 2. ADC: Air Diffusion Council.
 - 3. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.
- D. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Standards:
 - 1. ADC Standard 1062R2, Air Diffusing Equipment Test Code.
 - 2. AMCA Standard 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - 3. AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
 - 4. ASHRAE Standard 70, Method of Testing for Rating the Performance of Air Outlets and Inlets.
 - 5. NFPA-90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 6. ASTM B117-03: Standard Practice for Operating Salt Spray(Fog) Apparatus.
 - 7. ABMA : American Bearing Manufacturers Association.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Performance data.
 - 2. Physical dimensions.
 - 3. Fan curves.
 - 4. Sound data.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - 2. Owner instruction report.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General Fans:
 - 1. Base:
 - a. Members of AMCA.
- B. Ceiling Exhaust Fans:

1. Base:
2. Optional:
 - a. Carnes.
 - b. Acme Engineering and Manufacturing.
 - c. Greenheck.
 - d. Cook, Loren.
 - e. PennBarry.

C. Gravity Roof Ventilators:

1. Base:
2. Optional:
 - a. Carnes.
 - b. Aerovent, TCF.
 - c. Acme Engineering and Manufacturing.
 - d. Cesco Products.
 - e. Jenn Industries.
 - f. Cook, Loren.
 - g. PennBarry.
 - h. Greenheck.

D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Fans - General:

1. Performance ratings: Based on laboratory tests conducted in accordance with latest edition of ASHRAE/AMCA Standard Test Codes.
2. UL 705 listed.
3. Capacity and ratings: As indicated.
4. Arrangement and drive: As indicated.
5. Provide removable belt guard.
6. Fan drive sheaves for belt driven fans over 3.7 kW 5 hp:
 - a. Cast iron, split tapered bushings dynamically balanced at factory.
 - b. Provide initial fixed pitch sheave based upon design conditions.
 - c. Provide final fixed pitch drive sheaves for proper RPM determined during balancing process.
7. Fan wheels shall be statically and dynamically balanced per AMCA Standard 204.
8. Finish:
 - a. Steel fan components: Finished with paint system exceeding 1000 hour salt spray under ASTM B117 test method, minimum 2 mil thick.

B. Motors and Control:

1. See Section 23 05 00.
2. Provide TEFC motor for outdoor installations exposed to weather.

2.3 CEILING EXHAUST FANS

A. Ceiling exhaust fans:

1. Centrifugal, direct or belt driven type as indicated.
2. Housing: Galvanized steel lined with acoustical insulation.

- a. Specifically designed and manufactured for ceiling installation.
- b. Integral backdraft damper at fan discharge.
- c. Removable inlet grille mounted on housing.
- 3. Fan:
 - a. Forward curved centrifugal wheel mounted on motor with fan shrouds.
- 4. Motor:
 - a. Permanent split capacitor or capacitor start, induction run.
 - b. Permanently lubricated bearings.
 - c. Provide with overload protection.
 - d. Provide vibration isolation on motor fan assembly.
- 5. Electrical:
 - a. Provide junction box for electrical connection on housing and receptacle for motor plug-in.
- 6. Provide duct collar connections.

2.4 GRAVITY ROOF VENTILATORS

- A. Gravity Roof Ventilators:
 - 1. Size and type: As indicated.
 - 2. Housings:
 - a. Aluminum or galvanized steel.
 - b. Capable of withstanding 150 kg/m² 30 pound/SF snow load and 160 km/h 100 mph wind.
 - 3. Hoods:
 - a. Easily removable for access to throat area.
 - b. Provide with bird screens.
 - 4. Provide factory prefabricated, insulated roof curbs.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's recommendations and as specified.
- B. Caulk roof curbs for watertight installation.
- C. Coordinate placement of equipment on roof with other trades.

3.2 VIBRATION ISOLATION

- A. Vibration isolation: Section 23 05 50.

END OF SECTION

SECTION 23 52 33
BOILER - HYDRONIC

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Boiler - Hydronic, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Standards for boiler construction:
 - 1. ASME Boiler & Pressure Vessel Code, latest edition.
 - 2. National Board of Boiler & Pressure Vessel Inspectors (NBBPVI).

1.3 SUBMITTALS

- A. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - 2. Owner instruction report.
 - 3. Test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Boiler(s):
 - 1. Base:
 - a. Teledyne Laars.
 - b. Raypak.
 - c. Lochinvar.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Boiler: Electric
- B. Boiler controls:
 - 1. Firing sequence: On-Off fire.
- C. Boiler trim: Factory mounted; provide:
 - 1. High limit control.

2.3 VIBRATION ISOLATION

- A. Vibration Isolation: Section 23 05 50.

2.4 ELECTRICAL WORK

- A. Control wiring: Provide wiring between components for control functions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units in accord with NFPA, ASME, local codes, and manufacturer's instructions.

3.2 PERFORMANCE TEST

- A. Run performance test on equipment to insure proper operation of control functions.
- B. Operate boilers at 1/2 and full loads for minimum of 2 hours at each load.

3.3 START-UP

- A. Set and calibrate safety valves.
- B. Adjust firing equipment.

3.4 OPERATING DEMONSTRATION AND INSTRUCTION

- A. Demonstrate to Owner operation of system over entire range.

END OF SECTION

01 79 00SECTION 23 72 13
TOTAL ENERGY HEAT RECOVERY UNIT

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Total Energy Heat Recovery Unit, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Air Conditioning, Heating, & Refrigeration Institute (AHRI):
 - 1. AHRI Standard 1060 Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment (ANSI Approved).
- B. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE):
 - 1. ASHRAE Standard 84, Method of Testing Air-to-Air Heat/Energy Exchangers (ANSI Approved).
- C. ASTM International (ASTM):
 - 1. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - a. Flame spread: Less than 25.
 - b. Smoke developed: Less than 50.
- D. National Fire Protection Association (NFPA):
 - 1. NFPA-90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- E. Unit shall be UL or ETL listed.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Product information.
 - 2. Selection data.
 - 3. Energy performance data.
 - 4. Physical dimensions.
 - 5. Control sequences and wiring diagram.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - a. See Section 01 78 23.
 - 2. Warranty.
 - a. See Section 01 78 36.

1.4 WARRANTY

- A. Provide Manufacturer two (2) year warranty to include parts and labor from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Flat Plate Energy Recovery:
 - 1. Base:

- a. Oxygen
- 2. Optional:
 - a. Airotor
 - b. Greenheck
 - c. Semco

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. General:

- 1. Coordinate unit size and configuration with HVAC system configuration as indicated, in accordance with provisions of Contract Documents.

B. Housing:

- 1. Insulated double wall housing for stand-alone units:
 - a. 2 inches 50mm thick R-10 closed cell foam insulated panels with internal stiffeners and minimum 20 GA 0.81mm G90 galvanized metal double wall construction.
 - b. Constructed to withstand positive and negative internal static pressures of 6 inches 152mm W.G.
 - c. Include inlet and discharge duct connections and access openings.
- 2. Units installed in AHU housings do not require separate housing.

C. Controls:

- 1. Factory installed controller and sensors.
- 2. Provide four modes of operation identified by digital display or LED lights.
 - a. Heat Mode: Unit will operate to transfer heat from exhaust air to warm incoming outside air.
 - b. Defrost Mode: Unit will operate to limit amount of heat being removed from exhaust air and prevent frost from accumulating on plates.
 - 1) Incorporate on/off control, preheat coil operation.
 - c. Cool Mode: Unit will operate to cool incoming outside air by transferring heat to exhaust air.
- 3. Accommodate a supply air temperature reset signal from facility BMCS.

D. ERV Filters:

- 1. See filter schedule on drawings. Provide Merv 13 filters.
- 2. Provide (2) extra sets of filters for the replacement during the warranty period.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment as indicated and in accordance with manufacturer's instructions.
- B. Provide clearance for inspection, repair, replacement, and service.
- C. Electrical Specification Divisions provide overload protection in the operating disconnect switches and magnetic starters.
 - 1. Comply with NFPA 70.

3.2 TESTING

- A. Prior to initial operation, inspect equipment installation for conformance with Contract Documents.

- B. After systems are balanced, conduct operating test of not less than 8 hours duration to demonstrate equipment and controls are functioning properly.

3.3 FIELD TRAINING

- A. Conduct training courses for facility personnel designated by Owner's Representative.
- B. Provide field instruction to cover operation and maintenance of total energy heat recovery unit.

END OF SECTION

SECTION 23 81 26
UNITARY SPLIT AIR CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Unitary Split Air Conditioners, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Units shall be AHRI Certified™, the trusted mark of performance assurance for heating, ventilation, air conditioning and commercial refrigeration equipment, using AHRI Standard 1360.
- B. The specified system shall be factory-tested before shipment. Testing shall include but shall not be limited to: quality control checks.

1.3 SUBMITTALS

- A. Shop Drawings:
- B. Product Data:
 - 1. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details and field connection details.
 - 2. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics and gauges and finishes of materials.
 - 3. Include: single-line diagrams; electrical, and capacity data; piping and electrical connection drawings.
 - 4. Fan curves:
 - a. Provide fan curves reflecting the following conditions:
 - 1) Scheduled operating point clearly plotted.
 - 5. Submit product data of filter media, filter performance data, filter assembly and filter frames.
- C. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - 2. Owner instruction report.
 - 3. Test report.

1.4 SERVICEABILITY – ACCESS

- A. The cabinet shall be designed so that all components are easily accessible for service and maintenance through the unit's side and front.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Unitary split air conditioners:
 - 1. Base: Daiken
- B. Alternate:
 - 1. Carrier.
 - 2. Lennox Inds.
 - 3. Bryant Air Conditioning.
 - 4. Trane

C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Unitary Split Air Conditioner - General

1. Air conditioner: Unitary, split type, cooling (only) unit with outdoor condensing unit and indoor blower unit.
 - a. Sizes and capacities: As indicated.

B. Condensing Unit

1. Condensing unit: Air-cooled condensing unit, factory assembled, consisting of compressor, condenser coil and fan, and casing.
 - a. Units: CSA and UL approved; conforming to ARI Standard 210.
 - b. Operating range: -20-120 degrees F outdoor ambient.
 - c. Factory installed filter drier.
2. Compressor: Hermetic, welded shell-type.
 - a. Motor: Wide operating range, dual voltage.
 - b. Internal spring isolation and 2-stage sound isolation.
 - c. Winding thermostat and current overload device coupled with pressure limiting valve.
 - d. Internal protection devices for:
 - 1) Motor overload.
 - 2) Locked rotor.
 - 3) Extreme voltage supply.
 - 4) Excessive winding temperatures.
 - 5) Extreme pressures.
 - 6) Loss of refrigerant charge.
 - 7) Compressor cycling.
 - e. Off cycle crankcase heater.
3. Coil, condenser: Seamless aluminum tubes, DN10 3/8 inches OD, with aluminum fins mechanically bonded.
 - a. Two row.
 - b. Factory pressure and leak tested at 4140 kPa 600 psi.
 - c. Provide heavy duty protective grille on every side.
4. Fan, condenser: Aluminum, aerodynamically designed, statically balanced.
 - a. Motor: Two-speed, single phase, direct drive, heavy duty, permanently lubricated, with built in thermal overload protection.
 - b. Mount fan and motor support to cabinet top.
 - c. Provide grille to protect fan.
5. Casing, condensing unit: 1.2 mm 18 GA galvanized steel.
 - a. Finish: Phosphatized; epoxy resin primer; acrylic finish coat.
 - b. Removable end panel for access to components and connections.
 - c. Standard base size.
 - d. Mounting rails: Die formed; integral with base.
 - e. Drain holes in base pan.
 - f. Electrical and refrigeration connections in same location on units.

C. Blower Unit

1. Blower unit: Factory assembled; consisting of fan, filters, evaporator coil, controls and casing.
2. Fan, blower:
 - a. Centrifugal type, direct drive.
 - 1) Motor: Two-speed, permanent split capacitor, with built in thermal overload protection and run capacitor.
 - b. Electronically commutated motor.
 - 1) Motor: Brushless DC.
3. Filter, blower: Throwaway type, slide-in/slide-out.
4. Casing, blower unit: 0.9 mm 20 GA steel.
 - a. Finish: Baked enamel.
 - b. Lined with 13 mm. 1/2 inches thick, 8 kg/m³ 1/2 pcf density neoprene coated insulation.
 - c. Removable access panels with quarter-turn fasteners.
5. Coil, evaporator: Seamless copper tubes with aluminum fins mechanically bonded.
 - a. Quick-connect male couplers.
 - b. Expansion valve expansion device.
 - c. Operating charge of R-22.
6. Controls, blower unit:
 - a. Fan relay.
 - b. 50 VA transformer.
 - c. Thermostat: Cooling, for remote mounting.

2.3 REFRIGERANT PIPING AND ELECTRICAL WORK

- A. Piping, refrigerant for quick-connect installations: Pre-charged, factory assembled, in standard lengths.
 1. Female couplings.
 2. Suction line: Foam plastic insulated.
 3. Provide gauge ports at condenser.
- B. Piping, refrigerant, for field assembled piping: See Section 23 23 00.
- C. Control wiring: Provide wiring between components for control functions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. Connect piping, wiring and control wiring.

END OF SECTION

SECTION 23 81 46

GROUND SOURCE HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Unitary Heat Pump, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Units shall be AHRI Certified™, the trusted mark of performance assurance for heating, ventilation, air conditioning and commercial refrigeration equipment, using AHRI Standard 1360.
- B. The specified system shall be factory-tested before shipment. Testing shall include, but shall not be limited to: quality control checks.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details and field connection details.
 - 2. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics and gauges and finishes of materials.
 - 3. Include: single-line diagrams; electrical, and capacity data; piping and electrical connection drawings.
 - 4. Fan curves:
 - a. Provide fan curves reflecting the following conditions:
 - 1) Scheduled operating point clearly plotted.
 - 5. Submit product data of filter media, filter performance data, filter assembly and filter frames.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data.

1.4 SERVICEABILITY – ACCESS

- A. The cabinet shall be designed so that all components are easily accessible for service and maintenance through the unit's side and front.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Unitary heat pump:
 - 1. Base:
 - a. Climate Master
 - 2. Optional:
 - a. Bosch.
 - b. Florida.
 - c. Carrier.
 - d. Trane.
 - 3. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Heat pump: Packaged water source type, horizontal or vertical as indicated.
 - 1. Units: ARI listed and certified.
 - 2. Sizes and capacities: As scheduled.
 - 3. Provide heat pump unit including cabinet, filter, flexible hoses, and controls by one manufacturer.
- B. Cabinet: 1.2 mm 18 GA steel with 13 mm 1/2 inches fiberglass insulation discharge air duct cooler, removable front panel and control access door, and filter rack.
 - 1. Finish: Baked enamel.
 - 2. Conceal controls behind control access door.
 - 3. Removable panel: To allow compressor removable without removing entire unit.
 - 4. Sub-base: Welded, reinforced to carry entire unit weight.
- C. Refrigerant circuit: Chassis-mounted compressor, coaxial refrigerant to water heat exchanger, solenoid valve, completely factory installed.
 - 1. Easily removed from cabinet for service.
 - 2. Evaporator coil drain pan: Cleanable without removing chassis.
 - 3. Finish on sheet metal parts: Factory applied corrosion resistant enamel and epoxy coating.
 - 4. Filter: Throwaway type.
- D. Compressor: Hermetically-sealed, permanent split capacitor type.
 - 1. Thermal overload.
 - 2. Vibration isolated internally and externally.
- E. Coils, evaporator: Seamless copper tubes with aluminum fins.
- F. Evaporator fans:
 - 1. Forward-curved centrifugal type, direct connected.
 - a. Motor:
 - 1) Three speed; 1075 rpm maximum.
 - 2) Electronically commuted motor. Brushless DC.
 - 2. Electronically commuted motor.
- G. Coaxial (tube in tube) refrigerant to water heat exchanger:
 - 1. Copper inner water tube.
 - 2. Steel refrigerant outer tube.
- H. Refrigerant reversing valve: Four-way solenoid activated.
 - 1. Valve shall be designed to allow heating operation should solenoid fail.
- I. Controls:
 - 1. Control system: DDC, temperature control contractor provided, 24-volt, including unit mounted 24-volt terminal board and transformer.
 - 2. Room DDC Sensor: DDC control contractor:
 - a. Provide wiring between unit and DDC Sensor.
 - 3. For Rooms with CO2 sensors, the DDC Sensor and CO2 sensor can be in the same sensor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accord with manufacturer's instructions and recommendations.
- B. Provide clearances around the units as required by manufacture. Install heat pumps before other trades and coordinate with other trades and conduits to stay out of the clearance areas.

END OF SECTION

SECTION 23 82 43

ELECTRIC HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Electric Heaters, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Electric heaters.
 - a. Catalog cuts.
 - b. Wiring diagrams.
 - c. Performance data.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - 2. Owner instruction report.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Electric convection units:
 - 1. Base:
 - a. Q-Mark.
 - 2. Optional:
 - a. Markel.
 - b. Federal Pacific.
 - c. Indeeco.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Electric convection units:
 - 1. Furnish electric convection units of style and capacity scheduled.
 - 2. Housing:
 - a. Heavy gauge steel, designed for low temperature.
 - b. Finished in baked enamel.
 - c. Perforated metal cover.
 - 3. Elements: Metal sheathed, brazed fin.
 - 4. Furnish thermostat with wiring diagram.
 - a. Line voltage.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide wiring diagrams and supervise installation, wiring and control wiring of units.

END OF SECTION



DIVISION 25

INTEGRATED AUTOMATION



SECTION 25 08 16
BMS SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The purpose of this section is to specify Division 25 responsibilities and participation in the commissioning process. Responsibilities and participation in the commissioning process shall comply with the requirements of specification Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.
- B. The Owner has contracted with a Commissioning Authority (CxA) to oversee certain commissioning activities on this project. While the CxA has the overall responsibility for planning and coordinating the commissioning process, all parties participate. This includes the owner, construction manager, facility operator, architect, engineer, general contractor, subcontractors, specialty subcontractors, equipment suppliers, vendors, building authorities, and others entities as required.
- C. The General Contractor and all Subcontractors shall each designate one person to represent their own company as Commissioning Coordinator (CC). Each Commissioning Coordinator shall participate as a member of the Commissioning Authority's 'Commissioning Team'.
- D. Commissioning and coordination with the Commissioning Authority are the responsibility of the Contractor (including subcontractors and vendors). The Contractor is responsible for providing all scheduling, coordination and support required for start-up, testing, and commissioning.

1.2 RELATED WORK

- A. Division 01 Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 25 10 00
BUILDING MANAGEMENT SYSTEM (BMS)

PART 1 - GENERAL

1.1 APPLICATION OF THIS SECTION

- A. This Section applies to all heating, ventilating, and air conditioning work. Coordinate with applicable Sections as required.
- B. Refer to other Sections in Division 22, 23, 26, 27 and 28 for general requirements pertaining to plumbing, mechanical, electrical, telecom, and fire alarm work.
- C. Undivided Responsibility: Work of this section shall be included with the work specified in the following Sections:
 - 1. Section 25 30 00 – Building Management System (BMS) – Field Equipment.
 - 2. Section 25 90 00 – Building Management System (BMS) – Sequence of Operation.

1.2 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Building Management System (BMS), as indicated, in accordance with provisions of Contract Documents.
- B. Section Includes:
 - 1. Building Management System (BMS) hardware and software.
- C. Related Sections:
 - 1. Section 01 77 00 - Closeout Procedures.
 - 2. Division 22 Sections.
 - 3. Division 23 Sections.
 - 4. Division 26 Sections.
 - 5. Division 27 Sections.
 - 6. Division 28 Sections.
- D. Completely coordinate with work of other trades.

1.3 GENERAL REQUIREMENTS

- A. Furnish and install a complete state of the art direct digital control (DDC) Building Management System (BMS) system . The system shall be fully functional and complete in all respects including all labor, materials, equipment, and services necessary, and shall be installed by personnel regularly employed, trained, and certified by system **manufacturer**.
- B. The Building Management System (BMS) shall be an open complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown.
- C. The BMS shall meet the functional requirements of this specification, the construction documents, and shall be capable of executing all control algorithms defined in Section 25 90 00 – BMS Sequence of Operation.
- D. The Building Management System (BMS) contractor shall furnish, install, and wire a fully integrated Facility automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with proprietary communications capabilities as herein specified.
- E. The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers, and operator workstations.
- F. Devices of the same type shall be products of a single manufacturer. Each major component within the system shall have the manufacturer's name and address, and the model and serial

number in a conspicuous place. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products shall have been in a satisfactory commercial or industrial use for five years prior to use on this project. The five-year use shall include applications of equipment and materials under similar circumstances and of similar size to this project. The equipment items shall be supported by a service organization. Items of the same type and purpose shall be identical, including equipment, assemblies, parts, and components.

- G. Provide dedicated labor to set up or modify trends and assist the Owner with developing existing or new trends.
- H. Provide dedicated labor to develop customized reports and assist the Owner with developing customized reports. This time is in addition to the time required to perform the functions specified herein.
- I. Provide dedicated labor to support the third-party commissioning agent's commissioning of the BMS.
- J. Provide a BMS in accordance with UL 916 and with the following characteristics:
 - 1. The system shall perform supervisory monitoring and control functions including but not limited to Scheduling, Alarm Handling, Trending, and Report Generation as specified.
 - 2. The system shall include monitoring and control (M&C) software which shall allow for graphical navigation between systems, 2-Dimensional (2D) and 3-Dimensional (3D) graphical representations of systems, access to real-time data for systems, ability to override points in a system, access to all supervisory monitoring and control functions.
- K. Provide the necessary documentation (including rights to documentation and data), configuration information, configuration tools, application programs (with comments explaining program logic), application source code for programmable controllers, drivers, and other software shall be licensed to and remain with the Owner such that the Owner or its agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the BMS contractor.
- L. After becoming familiar with all details of the work, verify all dimensions in the field, and shall advise the Mechanical Contractor of any discrepancy before performing any work.
- M. The contract drawings will not indicate all offsets, fittings, and accessories that may be required. Investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall provide all work necessary to meet such conditions.
- N. Provide all control wiring for fan and pump VFDs and motor starters. Verify all control wiring prior to start-up to ensure no damage to equipment or personnel. Ensure all BMS safeties and interlocks are wired correctly. Add and remove jumpers across BMS terminals, as needed, when various options are not being utilized.
- O. The BMS shall be connected to the Owner's IT network, whereby the BMS shall transmit e-mail alarm messages to the Owner's employees. The BMS contractor shall provide all equipment and labor necessary to ensure a fully functional remote notification system, including but not limited to the following: coordinate the content of the alarm messages, which alarms require messaging, which employees require the e-mails, and all technical aspects.
- P. Provide actuators for all control dampers provided by Division 23. All smoke and combination fire/smoke dampers provided by Division 23 shall include integral UL-listed damper actuators.
- Q. Provide damper position switches for all control, smoke and combination fire/smoke dampers as indicated on the contract drawings.
- R. Division 26 contractor to provide 120VAC power to junction boxes local to BMS equipment as indicated on Electrical power drawings. Division 25 contractor shall extend power to all BMS control equipment and devices from the junction boxes.

- S. Division 25 contractor to provide 24VAC step-down transformers and power trunk wiring for all BMS Controllers.
- T. Provide a letter of substantial completion indicating that all performance and verification tests (PVTs) have been completed and the BMS is ready for third-party commissioning.
- U. The BMS contractor programming shall be completed offsite and tested offline prior to implementing into the BMS controllers and fine tune programming during the point-to-point checkout process.
- V. All writable object properties and other programming parameters needed to comply with the project specification shall be adjustable for devices at any network level, including those accessible with web-browser communication, and regardless of programming methods used to create the applications.

1.4 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Furnish control valves, sensor wells, flow meters, and gauge taps to Section 23 21 13.
- B. Furnish flow meters to Section 23 21 13.
- C. Furnish duct-mounted airflow stations to Section 23 31 13 for installation.

1.5 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Provide control wiring in conduit to equipment furnished under the following sections:
 - 1. Section 23 05 15 – Variable Frequency Drives and Controls.
 - 2. Section 26 24 19 – Motor Control Equipment.
- B. Provide all control wiring between A/C units and the remote condensing units.
- C. Install room temperature sensors and provide control wiring for all air conditioning units.
- D. Install room temperature sensors and provide control wiring for all air curtains.
- E. Provide wiring between the chiller control panel and the associated differential pressure switches.
- F. Provide all wiring for boiler sensors and equipment shipped loose, e.g. Flow switches, boiler control sensors, pump control wiring, etc..
- G. Coordinate damper actuator requirements for any control dampers furnished and installed by others, to ensure compatibility with BMS controllers. Provide damper actuators for all control dampers in cases where dampers are furnished and installed by others without actuators.

1.6 BMS INTEGRATION

- A. Integrate to the equipment and systems listed in this section. Provide all hardware, wiring, conduit, software configuration, and labor to successfully integrate the listed equipment and systems. Provide 2D and/or 3D graphic screens, as needed, for all the equipment and systems integrated to the BMS. The graphic screens shall depict the equipment, systems and all the software points available. The operator shall be able to view and control all aspects of the systems from any BMS operator workstation. All listed equipment and systems shall be provided with network interface capable of communication via Ethernet or RS-485 Serial Communication. Communication protocols shall include BACnet and Modbus. All software points in the equipment/system shall be visible to the BMS for monitoring and/or control.
 - 1. The following plumbing equipment shall be integrated in the BMS, coordinate requirements with Division 22:
 - a. Water Heaters
 - b. Digital Mixing Valves
 - c. Booster Pump Controls
 - d. Gas Manifold
 - e. Water Purifications Controls

- f. Domestic Water Flow Meters
 - g. Natural Gas Flow Meters
 - h. Laboratory Air Compressor
 - i. Laboratory Vacuum System
2. The following mechanical equipment shall be integrated into the BMS, coordinate requirements with Division 23:
 - a. Variable Frequency Drives (VFD).
 - b. Chillers.
 - c. Boilers.
 - d. Humidifiers.
 - e. BTU/Hydronic Flow Meters.
 - f. Variable Refrigerant Flow (VRF) Systems.
 - g. Computer Room Air Conditioning (CRAC) Units.
 - h. Packaged Roof Top (RTU) Units.
 - i. Air Source Heat Pump (ASHP) Units.
 - j. Water Source Heat Pump (WSHP) Units.
 3. The following electrical equipment shall be integrated in the BMS, coordinate requirements with Division 26:
 - a. Automatic Transfer Switches (ATS)
 - b. Emergency Generator
 - c. Switch Gear
 - d. Electric Energy Meters
 4. The following third-party controls systems shall be integrated into the BMS:
 - a. Laboratory Control System
 - b. Laboratory Monitoring System
 - c. Fire Alarm Control System
 - d. Lighting Control System
 - e. Fuel Oil Control System
 - f. Energy Monitoring and Control System
- B. Integrate all new Programmable System Controllers (PSC), Supervisory Controllers (SC), Application Specific Controller (ASC) and third-party equipment and systems into the existing BACnet system. The incumbent BMS contractor shall coordinate with the BMS contractor to provide a completely functional system.
1. Incumbent BMS contractor's responsibilities:
 - a. Provide the following to the BMS contractor:
 - 1) A copy of the as-built drawings for the primary level network riser.
 - 2) An AutoCAD compatible version of the system architecture diagram for the primary level network riser.
 - 3) Product specification sheets for all network equipment.
 - 4) As-built wiring specifications for the existing network.
 - 5) All BIBBS and PICs for the existing BACnet equipment.
 - 6) Any additional information requested by the BMS contractor.
 - b. Follow the steps outlined in the "Controller Integration to Existing BMS Network" paragraph in this section for the integration process.
 - c. During the integration process, coordinate with the BMS contractor to resolve all issues prior to turnover.
 - d. Submit a migration strategy, as specified herein, to the A/E and Owner prior to implementation.

2. Section 25 10 00 - Building Management System (BMS) responsibilities:
 - a. Provide the following to the incumbent BMS contractor:
 - 1) Approved submittal package, submittal package contents are specified in this section.
 - 2) All BIBBS and PICs for the new BACnet equipment.
 - 3) Any additional information requested by the incumbent BMS contractor.
 - b. Develop a system architecture diagram showing all of the new controllers, all of the existing controllers, all new and existing network equipment, all node addresses, and controller types. Submit the system architecture diagram in the as-built shop drawings.
 - c. Provide the new controllers as specified herein.
 - d. Provide all wiring and power to all new controllers and network equipment as specified herein.
 - e. Provide all new routers and repeaters as required for a fully functional system.
 - f. Start-up and execute the static and dynamic control system tests, as specified in this section.
 - g. During the integration process, coordinate with the incumbent BMS contractor to resolve all issues prior to turnover.

1.7 QUALIFICATIONS

- A. The BMS system shall be designed, installed, commissioned, and serviced by factory-trained personnel and qualified sub-contractors. Contractor shall have an in-place support facility within 50 miles of the job site with technical staff, spare parts inventory, and necessary test and diagnostic equipment. Provide toll-free phone number access to 24-hour support center, staffed with factory-trained personnel to assist in troubleshooting and problem resolution. Distributors or licensed installing contractors are not acceptable. Provide out-sourced products as specified.
- B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of building management systems for this type of facility and shall be manufacturer's latest standard design that complies with the specification requirements.
- C. BMS shall comply with UL 916 PAZX and other subsystem listings as applicable, and herein specified, and be so listed at the time of bid. All control systems used for smoke control shall be listed in accordance with UL 864, category UUKL for their intended purpose, and installed in accordance with the applicable building codes for the project.
- D. All electronic equipment shall conform to the requirements of FCC Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- E. The BMS contractor shall be regularly engaged in the manufacturing, installing, and maintaining of BMS systems with similar size and complexity to this project.
- F. The BMS contractor shall have a minimum of 10 years of demonstrated technical expertise with projects in the industry.
- G. The Building Management System manufacturer shall provide documentation supporting compliance with ISO 9002 (Model for Quality Assurance in Production, Installation, and Servicing). The intent of this requirement is to ensure that products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.
- H. The following are the minimum personnel qualifications for the specific individuals assigned to this project.
 1. The project manager shall have at least 5 years of experience in the role of project management.
 2. Application Engineers shall have at least 5 years of experience engineering building automation systems in critical environments.
 3. Programmers shall have at least 5 years of experience writing and troubleshooting programming code.

4. Field Technicians shall have at least 5 years of experience with ABSL-3 and BSL-3 types of systems. In addition, technician shall have firsthand experience with tuning PID control parameters for control loops.

1.8 SUBMITTALS

A. Product Data:

1. Include technical bulletins and catalog data for each control system component. Clearly identify, by use of symbol or tag number, service of each item. Clearly identify model number of the device including any device options. Each product data sheet shall clearly reference page and paragraph number of specification section to which it applies. Failure to comply with this requirement will result in automatic rejection without review.
2. Submit complete data on controllers, instrumentation, and software. Include signal type, signal characteristics and ranges, installation instructions, calibration data, typical alarm printouts, advisory messages, logging formats, and other pertinent data archive information available on the proposed system. Include all commercial software required for servers, bridges, workstations, and controllers including latest version numbers.
3. All products, material, and equipment shall be listed, labeled, or certified by Underwriters' Laboratory.

B. Shop Drawings:

1. Design drawings shall be submitted electronically in portable document format (PDF)
2. Resubmitted Shop Drawings: Provide typed responses to all comments. All changes shall be clearly identified with revision clouds and revision numbers. The resubmittal package will be rejected without review if all comments are not addressed, and all changes are not clearly identified.
3. Submit shop drawings and product data as single complete submission. Partial submissions will be rejected. Control valve, flow meter, and air flow measuring station schedules with product data may be submitted separately. Submit the following:
 - a. System Architecture: Show location of the server, workstations, Programmable System Controller (PSC), Supervisory Controller (SC), Application Specific Controller (ASC), Network Controllers (NC), routers, repeaters auxiliary equipment, I/O device, panel, and other major system component. Indicate all network interface devices (gateways, drivers, open communication modules).
 - b. Instrument Index (Bill of Material): For all systems, provide a complete list of all instruments and final control elements (valves/dampers) furnished. Provide instrument description, manufacturer, model number.
 - 1) Instrument List shall have (as a minimum) the following categories:
 - a) Vendor Tag Number: Provide a unique tag number to identify each device. Owner will use this number as reference to generate Owner tag numbers, and to account for each device.
 - (1) The tag number shall conform to the following format: AAA-XXXXX-AAA-N. "A" designates an alpha identifier. "X" designates an alphanumeric identifier. "N" designates a numeric identifier. The first field shall be associated with equipment. The second field will identify the unique equipment and shall be consistent with the contract documents. The third field of alpha codes is for the device type, followed by a sequential number.
 - (a) Example: AHU-1234-PSL-1.
 - (2) The tagging shall follow the existing site standard for the City of Lincoln.
 - b) Description of Instrument: Define device's function (e.g., differential pressure transmitter, room temperature sensor, photocell etc.).
 - c) Instrument Manufacturer/Model Number.
 - d) Equipment Cross Reference: Where applicable, list equipment the instrument is associated with (e.g., freezer, incubator, room number etc.).

- e) Instrument accuracy.
 - f) Instrument range.
 - g) Instrument display (engineering units).
- c. System Flow Diagrams: Show location of devices, interconnections, wire numbers, pneumatic tubing, junction boxes, computer I/O connections, bulkheads, grounding, and terminals.
 - 1) Include indication of control algorithms or logic used for each system in the sequence of operation. Provide logic tables wherever possible to easily communicate interlock or failure logic.
 - 2) Prepare 11 inches by 17 inches drawings at a minimum.
 - 3) Provide a unique flow diagram for each HVAC and mechanical system. Typical drawings are not acceptable. Each drawing shall identify each instrument with a unique tag number.
 - 4) Provide typical drawings for terminal equipment accompanied by a schedule listing the unique equipment information.
- d. Electrical Diagrams: Show all wires and terminations. All terminals shall be identified in the as-built drawings. Include starter and Variable Frequency Drive wiring diagrams depicting safeties and automated start/stop contacts. Indicate hardwired interlocks.
- e. System Sequence of Operation: Provide for all equipment controlled or monitored by the BMS. Submit unique sequences for each system, typical sequences are not acceptable. The sequence shall include the unique point identifier for each point referenced in the system. The identifier shall be in the body of the sequence and listed whenever the instrument or device is mentioned. E.g., "The reheat valve (TCV-RMSH1234-1) shall modulate to maintain the room temperature (TT-RMSH1234-1) at setpoint".
 - 1) Refer to Section 25 90 00 for the sequence of operations.
 - 2) Contractor shall thoroughly review and vet all sequences provided in Section 25 90 00 prior to programming, startup, and commissioning. Submittal to clearly identify any changes or exceptions to the project sequence of operations. Submit Request for Information (RFI) forms when clarification is required.
 - a) Copying sequences from contract documents does not absolve the Division 25 contractor of the responsibility stated above, and submittals with copied sequences may be rejected.
- f. Control Valve Schedules: Include valve curves (flow versus percent open), service (e.g., hot/chilled/condenser water or steam), quantity, actuator type and model number, spring range (where applicable), sizes, capacity in GPM for water (LB/hour for steam), CV of valve, actual pressure drop across valve in psi, failed position, shutoff ratings, and valve characteristics (equal percent or linear).
- g. Hydronic Flow Meter Schedules (water & steam): Include hydronic flow meter size, maximum flow, calibrated flow, minimum allowable flow for accuracy, and minimum upstream and downstream straight pipe requirements. Coordinate locations, sizes, and straight pipe requirements with Section 23 21 13 prior to procurement. Air Flow Measuring Station Schedules: Include air flow measuring station width, height, depth, velocity pressure at setpoint, minimum upstream and downstream duct requirements, minimum allowable velocity pressure to accurately read flow, and maximum allowable velocity pressure. Coordinate locations, sizes, and straight duct requirements with Section 23 31 13 prior to procurement. Instrument Mounting/Field Connection Diagrams: Include pipe, tank and duct mounting details of sensor types to be used.
- h. Panel Layout/Diagrams: Panel Layout/Diagrams including bill of material and mounting details for recessed, semi-recessed, surface mounted and free-standing panels. Provide installation details and mounting requirements. For panels installed in finished areas, provide a detail showing how the panels are arranged on the finished wall. Panel design shall be approved prior to fabrication and installation.

- i. **Points Schedules:** Provide schedule which lists every physical and virtual point in the BMS as indicated on contract drawings and required to meet the sequence of operation in a tabular format. At a minimum, the list shall include the following fields: unique point identifier, point type, software address, associated PSC or SC, associated room number (where applicable), associated equipment/device tag (where applicable), signal range, measurement range, point is alarmable, alarm threshold, alarm delay, point is trended, trend interval.
- j. **User Interface Graphics:** Provide custom graphics for each individual piece of mechanical equipment being controlled. Include graphics for lighting, when integrated with the BMS.
- k. **Symbols, Definition and Abbreviations:** Symbols, definitions, and engineering unit abbreviations used in information displays, submittals and reports shall be as shown in the contract drawings. Symbols, definitions, and abbreviations not in the contract drawings shall conform at a minimum to IEEE Std 100 and the ASHRAE FUNDAMENTALS I-P, as applicable.
- l. **System Units and Accuracy:** System displays, printouts, and calculations shall be performed in English (inch-pound) units. Calculations shall have accuracy equal to or exceeding sensor accuracy as specified in this Section. Displays and printouts shall have precision and resolution equal to or exceeding the worst-case sensor accuracy as specified in this Section.
- m. **Special Warranties:** Provide warranties for all third-party equipment purchased by the contractor. Including but not limited to air compressors, lighting control systems, and gas detection systems. The duration of all third-party warranties shall meet or exceed the warranty period specified in this section.
- n. If any portion of the BMS is utilizing BACnet as a communication protocol, provide all Protocol Implementation Conformance Statements (PICS) and BACnet Interoperability Building Blocks (BIBBS) for all BMS equipment utilizing BACnet as specified herein.

C. **Project Information:**

- 1. **Verification Reports:** Submit sample forms to be used for installation and operational verification reports. Submit the proposed performance verification tests to the Owner for review and approval prior to the start of testing. Submit the final completed reports to the A/E and Owner. The testing reports include:
 - a. Static System Checkout Sheets, as specified herein.
 - b. Dynamic Performance Test Sheets, as specified herein.
 - c. NIST traceable instrument calibration reports for test instrumentation used by the contractor to execute the Static System Checkout.
- 2. **Programming Software:** At the end of the project submit the most recent version of the programming software for each type (manufacturer and model) of Programmable System Controller (PSC) shall be submitted and shall be licensed to the project site. The software user's manual shall be submitted for each piece of software provided.
- 3. **Operation and Maintenance Manuals (O&M):** At the end of the project submit two copies of the Operation and Maintenance Manuals, indexed and in booklet form shall be submitted. The requirements are specified in this section.
- 4. **Training Documentation:** At the conclusion of the training sessions, training manuals shall be delivered for each trainee on the course attendee list with two additional copies delivered for archival at the project site. Two copies of the course attendee list shall be delivered with the archival copies. The Training Documentation may be submitted as a Technical Data Package.
- 5. **Migration Strategy:** Prior to integrating the existing DDC controllers into the new Building Management System, outline the migration process, timelines, potential migration problems and the actions the contractor intends to take to mitigate potential problems. The migration strategy shall be approved by the A/E and Owner prior to implementation.
- 6. **Migration Strategy:** Prior to integrating the new DDC controllers into the existing Building Management System, outline the migration process, timelines, potential migration problems

and the actions the contractor intends to take to mitigate potential problems. The migration strategy shall be approved by the A/E and Owner prior to implementation.

7. Alarm Matrix: Coordinate with Owner to determine which point types shall be alarmed and the alarm parameters for each type. Provide a comprehensive matrix of all points within the scope of this project which shall be alarmed. The matrix shall include point name, node address, point description, associated room number, range of sensor, high alarm limit, low alarm limit, set point, time delays, and whether or not the point alarms remain active when the associated HVAC equipment is de-energized. The matrix shall be reviewed and approved by the Owner prior to implementation.
8. Commissioning Plan: Submit a commissioning plan. The specified commissioning procedures outlined in this specification section shall be used as a guide for developing a detailed commissioning plan. At a minimum, the following test procedures shall be addressed:
 - a. Hardware identification and assembly verification.
 - b. Wiring installation verification.
 - c. Binary Inputs (BIs).
 - d. Binary Outputs (BOs).
 - e. Analog Inputs (AIs).
 - f. Analog Outputs (AOs).

1.9 SEQUENCING AND SCHEDULING

- A. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- B. Coordinate work under provisions of Section 01 91 13 to ensure system is complete and fully commissioned.
- C. Coordinate installation and startup of system components with installation of mechanical systems equipment.

1.10 DELIVERY AND STORAGE

- A. Products shall be stored with protection from the weather, humidity, and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.11 OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The BMS Operation and Maintenance Instructions shall include:
 1. As-built Instrument List as specified in the "Shop Drawings" paragraph above for each piece of control equipment.
 2. HVAC control system sequences of operation formatted as specified.
 3. Procedures for the HVAC system startup, operation, and shutdown including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.
 4. Final As-Built Drawings shall be submitted electronically in PDF and in AutoCAD format. All the same documents listed in "Shop Drawings" paragraph above shall be submitted.
 - a. PDF document shall be organized with either bookmarks or hyperlinks to allow navigation from an electronic table of contents directly to individual control drawings, product data, schedules, wiring diagrams, etc.
 - b. AutoCAD version shall be determined at project completion.
 5. Routine maintenance checklist. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

6. Qualified service organization list.
7. Provide completed verification reports as specified herein.
 - a. All Static Performance Test Sheets, refer to the "Verification Tests" paragraph in this section for details.
 - b. All Dynamic Performance Test Sheets, refer to the "Verification Tests" paragraph in this section for details.
 - c. NIST traceable instrument reports for test instrumentation used by the contractor to execute the Static System Checkout.
8. Provide a recommended spare parts list, accompanied by unit pricing.

1.12 MAINTENANCE AND SERVICE

- A. Beginning at the point of beneficial use, provide 12 months' full maintenance service by skilled, competent employees of the system manufacturer. Perform inspection, testing, cleaning, and part or component replacement as specified and as required to maintain the warranty. Work includes providing necessary preventive and unscheduled maintenance and repairs to keep the BMS operating as specified. Work shall comply with manufacturer's recommendations and industry standards. Provide technical support via telephone during regular working hours.
- B. Preventative Maintenance:
 1. Include quarterly (two 8-hour days each) preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required to maintain specified or normal operation. Use only parts and supplies as used in manufacturer and installation of original equipment.
- C. Service Call Reception:
 1. An Owner representative will advise the BMS contractor by phone or in person of all maintenance and service requests.
 2. The contractor shall have procedures for receiving and responding to service calls 24 hours per day, seven days a week, including weekends and holidays. A single telephone number shall be provided by the contractor for receipt of service calls during regular working hours. Service calls shall be considered received by the contractor at the time and date the telephone call is placed by the authorized Owner representative.
 3. The contractor shall separately record each service call request. The completed form shall include the serial number identifying the component involved, its location, date, and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion.
 4. The contractor shall respond to each service call request within two working hours. The status of any item of work must be provided within four hours of the inquiry during regular working hours, and within 16 hours after regular working hours.
- D. Service Call Work Warranty: Provide an unconditional warranty on service call work. The warranty shall include labor and material necessary to restore the equipment involved in the initial service call to a fully operable condition. In the event the contractor's service call work causes damage to additional equipment, the contractor shall be liable for labor and material to restore the system to full operation. The contractor response to service call warranty work shall be the same as required by the initial service call.
- E. System Modifications: Provide recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Instructions, and other documentation affected. The contractor shall make available to the Owner software updates for all software furnished under this specification during the life of this contract. There shall be at least one scheduled update near the end of the contract period, at which time the contractor shall make available the latest released version of all software provided under this specification and shall install and commissioning it upon approval by the Owner.

- F. Continuing Maintenance Service: Provide a continuing maintenance proposal from installer to Owner, in form of a standard yearly (or other period) maintenance agreement, starting on the date the initial warranty period concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.13 SYSTEM ACCURACY

- A. Input Accuracy: Sensors, transmitters and DDC Hardware shall be selected, installed, and configured such that the maximum end-to-end error (from the sensor to the server) in the point value is less than 150 percent of the maximum allowable error specified for the sensor or instrumentation.
- B. Control Stability and Accuracy:
 - 1. Airflow:
 - a. For laboratories, vivarium, and specialized areas: Plus or minus 3 percent.
 - b. For non-Laboratory areas: Plus or minus 5 percent.
 - c. For air handling systems: Plus or minus 5 percent.
 - d. For mechanical areas and electrical areas: Plus or minus 10 percent.
 - 2. Temperature:
 - a. For laboratories, vivarium, and specialized areas: Plus or minus 1 deg F.
 - b. For non-Laboratory areas: Plus or minus 2 deg F.
 - c. For air handling systems: Plus or minus 2 deg F.
 - d. For hydronic systems: Plus or minus 2 deg F.
 - e. For mechanical areas and electrical areas: Plus or minus 5 deg F.
 - 3. Humidity:
 - a. For laboratories, vivarium, and specialized areas: Plus or minus 2 percent RH.
 - b. For non-Laboratory areas: Plus or minus 5 percent RH
 - c. For air handling systems: Plus or minus 5 percent RH
 - d. For mechanical areas and electrical areas: No humidity control.
 - 4. Pressure:
 - a. For room pressure monitoring: Plus or minus 0.01 in WC.
 - b. For air handling systems: Plus or minus 0.05 in WC.
 - c. For steam systems: Plus or minus 0.25 psi.
 - d. For compressed air systems: Plus or minus 0.25 psi.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Honeywell, Inc. (ComfortPoint Open BMS, or newer).
- B. Johnson Controls, Inc. (Web-based Metasys).

2.2 SYSTEM REQUIREMENTS

- A. The communication speeds between ASCs, PSCs, and SCs shall be stable, robust, and sufficient to ensure that no degradation of system response time shall occur under any operating condition of the facility.
- B. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each PSC shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.
- C. Provide a sufficient quantity of SCs, PSCs, and ASCs to meet the physical and software I/O point requirements shown on the contract drawings, specified herein, and to meet the sequence

of operations in Section 25 90 00. Each SC and PSC shall contain all input/output points necessary to provide control and monitoring of the connected system in accordance with the sequence of operation. Provide at least **20 percent** spare points in each SC and PSC for future expansion. Spare points shall contain a combination of all point types. Spare points of only one type per panel are not acceptable. List quantity and type of spare points available per controller on the shop drawing submittal. Under no circumstance shall all input/output points in a controller be completely used.

- D. System performance shall ensure that any alarm occurring at any ASC, PSC, or SC (provided under the scope of this project) is annunciated at all workstations and all alarm printers within 15 seconds under all operating conditions of the facility.
- E. System performance shall ensure that any point commanded from any operator workstation, PSC, or SC (provided under the scope of this project) shall commence within 2 seconds under all operating conditions of the facility, with some form of acknowledgment provided at that time.
- F. System performance shall ensure that a change in value, greater than the change of variable (COV) limit, of any point within the system (provided under the scope of this project) is updated on all open graphic screens at all workstations within **5 seconds** under all operating conditions of the facility.
- G. The SCs shall poll the software points connected to its respective secondary level network for trend data. At least one SC shall be provided for each secondary level network. The trend data shall remain in the RAM of the SC until the server retrieves the data. The time intervals between retrievals shall be governed by two factors. The time interval shall not be so short that the communication speed of the network is hindered in any way but shall not be so long that an interruption in the network for more than 7 days will cause the data in the controller to overwrite trend data which has not been retrieved. Using the server to poll software points directly for trend data is unacceptable.
- H. The BMS shall synchronize all DDC hardware, which has a real-time clock, at least once per day. Provide automatic daylight savings time corrections.
- I. Provide engineered BMS networks. The network bandwidth usage under a heavily loaded condition shall not exceed **60 percent** for either the primary level network or the secondary level networks.
 - 1. A heavily loaded primary level network is characterized as one performing the following activities simultaneously:
 - a. Transmitting batches of trend data for every point in the building in response to polling requests at 15-minute intervals.
 - b. Transmitting 500 point values to the server in response to polling requests at 5-second intervals.
 - c. Transmitting 100 point override commands from the server to every SC or PSC at 10 second intervals.
 - 2. Heavily loaded secondary level networks are characterized as ones performing the following activities simultaneously:
 - a. Transmitting trend data for every point on the secondary level network to the supervisory controller in response to polling requests at 5-minute intervals.
 - b. Transmitting every point value to the supervisory controller in response to polling requests at 5 second intervals.
 - c. Transmitting 100 point override commands from the supervisory controller to the Application Specific Controllers at 10 second intervals.

2.3 NETWORK ARCHITECTURE

- A. The design of the BMS shall network all servers, operator workstations, supervisory controllers (SC), Programmable System Controllers (PSCs), application specific controllers (ASCs), and protocol gateways. The network architecture shall consist of two levels: a primary level

network which shall be an Ethernet based network as specified herein and a secondary level network which shall be a twisted-pair type network as specified herein.

B. Primary Level Network.

1. Primary level network is the building's IT network, provided by Division 27. The BMS primary network shall support communication using a VLAN, which shall be configured by the BMS contractor and coordinated with the Owners IT department.
2. The workstations, server, SCs, PSCs (depending on the manufacturer), and IP Routers shall reside on industry standard Ethernet utilizing standard IP protocols, IEEE Std 802.3.
3. The PSCs and SCs shall be able to communicate global data across the network, including but not limited to outdoor air temperature / humidity / CO₂, economizer mode changeover, humidity control in spaces, heat recovery system enable, and restart after power failure.
4. The primary level network shall allow the SCs, and PSCs to access any data from, or send control commands and alarm reports directly to, any other SC or PSC or combination of multiple SCs and PSCs on the network without dependence upon a central or intermediate processing device.
5. SCs and PSCs shall send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device. The network shall also allow any SC or PSC to access, edit, modify, add, delete, back up, restore all system point database and all programs.
6. The Ethernet network shall provide speeds of at least 100 Mbps on the entire network using the IP protocol. The Bit Error Rate (BER) of the data communications components shall be no greater than one error in 10E9 for the entire network. The Network shall use the following protocols for layers 1 through 7 as defined in the ISO OSI Model (at a minimum):
 - a. OSI Layer 1. The physical layer shall be in conformance with IEEE Std 802.3 (Ethernet) and operate at least 100 megabits per second Mbps (100Base-T). Higher speed protocols may be used. If higher speed physical layers are used, bridging hardware shall be provided to ensure compatibility with 100 Mbps devices.
 - b. OSI Layer 2. The data-link layer shall be the IEEE Std 802.2 Logical Link Control (LLC), Type 1, Class 1, in combination with the IEEE Std 802.3 Protocol.
 - c. OSI Layer 3. The network layer shall be the Internet Protocol (IP; RFC 791), the Internet Control Message Protocol (ICMP; RFC 792), and the Address Resolution Protocol (ARP; RFC 826).
 - d. OSI Layers 4 - 7. Network shall support all layer 4 protocols supported by IP (RFC 791) including but not limited to ICMP (RFC 792), IGMP (RFC 1112), TCP (RFC 793), UDP (RFC 768), IGP (RFC 1371, and GRE (RFC 2784).
7. BACnet Communication Protocol:
 - a. Provide a BMS which communicates BACnet protocol via the IP Ethernet based primary level network.
 - b. The BMS shall be in accordance with ANSI/ASHRAE 135-2008. Minimum system functionality must include monitoring, commanding, and alarming for daily operator functions from any operator workstation.
 - c. The system shall be open in that it is designed and installed such that the Owner is able to perform repair, replacement, upgrades, and expansions of the system without further dependence on the original hardware vendor.
 - d. All control equipment which communicates on the primary level network shall be BACnet laboratories Tested (BTL) certified.
 - e. Minimize the use of proprietary BACnet objects and properties.
 - f. Conform to the BACnet Testing Lab's Device Implementation Guidelines.
 - g. Provide BACnet objects, properties, and services required to support the application and supervisory monitoring and control functionality including:
 - 1) System start/stop and overrides.
 - 2) Scheduling.

- 3) Alarming.
- 4) Trending.
- h. All devices shall have a Protocol Implementation Conformance Statement (PICS) that identifies all of the portions of BACnet that are implemented. The PICS shall be submitted in the shop drawing package.
- i. All devices shall have BACnet Interoperability Area and associated BACnet Interoperability Building Blocks (BIBBS). The BIBBS shall be submitted in the shop drawing package.

C. Secondary Level Network:

- 1. The secondary level network is a lower tier network connected to PSCs, SCs and IP routers. This level of communication shall support a family of ASCs. Provide a fully functional secondary level network. All ASCs shall successfully communicate on the secondary level network.
- 2. The use of ASCs to control AHUs, HRUs, large pieces of HVAC equipment, and mechanical systems is not acceptable.
- 3. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 meter (3 feet).
- 4. Each segment of the secondary level network will have a maximum number of nodes which can be accommodated. No more than 90 percent of the nodes on any given segment shall be utilized.
- 5. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over any network is not acceptable.
- 6. BACnet Communication Protocol:
 - a. Provide a BMS which communicates the BACnet MS/TP protocol via the **EIA-485 based** secondary level network.
 - b. All cable characteristics and wiring lengths shall conform to the manufacturer's cable and wiring specifications.
 - c. The network shall have no control devices connected to it.
 - d. Provide and power all necessary BACnet MS/TP repeaters.

2.4 NETWORK HARDWARE

- A. Ethernet Switch: Switches shall be IEEE Std 802.3 bridges which shall function as the center of a distributed-star architecture and shall be "learning" bridges with spanning tree algorithms per IEEE Std 802.1D. The switch shall support the connected media types and shall have a minimum of 150 percent the required ports and no fewer than 4 ports. One port shall be switch selectable as an uplink port. Ethernet switches shall be installed in rooms as shown on drawings. The switches shall be wall mounted.
- B. Fiber Optic Patch Panel: In the event that fiber optic cable is provided as an Ethernet backbone, the cable shall be terminated on both ends at a fiber optic patch panel. A fiber optic patch cable shall be provided to connect the fiber optic patch panel to the Ethernet switch.
 - 1. The fiber Optic Patch Panels shall be wall mountable and designed to provide termination facilities for up to 24 fibers. Unit shall also have capability to be equipped with spliced trays, six packs (for adapters), and blank panels for easy termination of the fiber bundles and tube cables.
 - 2. Fiber-optic terminating equipment shall provide for mounting of ST or SC connectors on an optical patch panel. Fiber-cable management and cable-routing hardware shall be provided by the Contractor to assure conformance to minimum fiber and cable bend radii. Connectors on the patch panel shall be ST or SC feed through.
 - 3. Access to both sides of the panel shall be provided by the Contractor.
 - 4. The patch panel for the connectors shall be mounted to facilitate rearrangement and identification.
 - 5. Each apparatus shall have cabling and connection instructions associated with it.

- C. Fiber Optic Media Converter: Fiber Optic media converter shall provide media conversion between layer 1 copper and fiber media to support data rates equal to the greater of the physical layer or 100 Mbps as specified in IEEE Std 802.3.
- D. IP Router: Provide IP router network equipment. The routers shall be fully configurable for protocol types, security, and routing selection of sub-networks. The router shall meet all requirements of RFC 1812.

2.5 COMPUTER HARDWARE

- A. Nameplates: Laminated plastic nameplates shall be provided for each server and workstation. Each nameplate shall identify the function, network address and identifier of the server or workstation. Laminated plastic shall be 0.125 inches thick, **white with black center core**. Nameplates shall be a minimum of 1 by 3 inches with minimum 0.25 inches high engraved block lettering. All nameplates shall be attached to the device in conspicuous location.
- B. All computer hardware provided must meet the minimum hardware requirements for all software to be installed on it, as specified by the software manufacturer or the minimum requirements in this section (whichever is stricter). If multiple software packages are to be installed on the same server/desktop/laptop, then contractor must coordinate the increased hardware required to meet the needs of all combined software. In the absence of clear software or customer IT guidance, this section is intended to define the minimum acceptable hardware.
- C. Server Hardware (Critical Environments):
 - 1. Computer Server Hardware (server) shall be a standard unmodified digital computer of modular design currently being manufactured. The modular components of the server shall be products of a single manufacturer which advertises service in all 48 contiguous states. Provide (1) server as shown on System Architecture diagrams. Server hardware shall meet the following minimum requirements (when not required by the BMS software):
 - a. Processor Speed: Quad-Core Intel® Xeon® (or better), 8MB Cache, 3.3GHz, 1066MHz FSB.
 - b. Random Access Memory (RAM): 48GB DDR, 667MHz, 2x512MB Single Ranked DIMMs.
 - c. Communications Ports: (4) USB 3.0 ports, multi-port serial port adapter, in addition to any ports required for the keyboard and mouse.
 - d. Drives and Controller: Each controller and drive shall provide at least 2.0 TB usable disk space with an average seek time of 7 milliseconds or less using hardware RAID (Redundant Array of Inexpensive Disks) at level 1(RAID-1). Provide SSD solid state drives.
 - e. CD/DVD-RW Drive: Combo CD-RW with 32x read, 24x write and 16x rewrite and DVD-RW with 12x read; 4x re-write; 2x write.
 - f. Video Output Card: Support at least 24-bit color at a minimum resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.
 - g. Network Interface Card (NIC): Integrated 100Base-T Ethernet NIC with an RJ45 connector.
 - h. Monitor: Sized as shown but no less than 17 inches with a minimum resolution of 1280 by 1024 pixels, non-interlaced, a maximum dot pitch of 0.28 mm, and a minimum refresh rate of 70Hz.
 - i. Keyboard: 101-key keyboard, having a minimum 64-character standard ASCII character set based on ANSI INCITS 154.
 - j. Mouse: 2-button mouse with a minimum resolution of 400 dots per inches.
 - k. Hot-swappable redundant power supplies.
 - l. Internal removable disk backup with a minimum of 200GB storage.
 - m. Provide any additional hardware required to successfully integrate to third-party automation systems, as indicated on contract drawings.
- D. Server Hardware (Office Building):

1. Computer Server Hardware (server) shall be a standard unmodified digital computer of modular design currently being manufactured. The modular components of the server shall be products of a single manufacturer which advertises service in all 48 contiguous states. Provide (1) server as shown on System Architecture diagrams. Server hardware shall meet the following minimum requirements (when not required by the BMS software):
 - a. Processor Speed: Quad-Core Intel® Xeon® (or better), 4MB Cache, 3GHz, 1066MHz FSB.
 - b. Random Access Memory (RAM): 32GB DDR, 667MHz, 2x512MB Single Ranked DIMMs.
 - c. Communications Ports: (4) USB 3.0 ports, multi-port serial port adapter, in addition to any ports required for the keyboard and mouse.
 - d. Drives and Controller: Each controller and drive shall provide at least 1.0 TB usable disk space with an average seek time of 7 milliseconds or less. Provide SSD solid state drives.
 - e. CD/DVD-RW Drive: Combo CD-RW with 32x read, 24x write and 16x rewrite and DVD-RW with 12x read; 4x re-write; 2x write.
 - f. Video Output Card: Support at least 24-bit color at a minimum resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.
 - g. Network Interface Card (NIC): Integrated 100Base-T Ethernet NIC with an RJ45 connector.
 - h. Monitor: Sized as shown but no less than 17 inches with a minimum resolution of 1280 by 1024 pixels, non-interlaced, a maximum dot pitch of 0.28 mm, and a minimum refresh rate of 70Hz.
 - i. Keyboard: 101-key keyboard, having a minimum 64-character standard ASCII character set based on ANSI INCITS 154.
 - j. Mouse: 2-button mouse with a minimum resolution of 400 dots per inches.
 - k. Internal removable disk backup with a minimum of 200GB storage.
 - l. Provide any additional hardware required to successfully integrate to third-party automation systems, as indicated on contract drawings.
- E. Operator Workstation Hardware (Desktop):
 1. Computer Workstation Hardware (workstation) shall be a standard unmodified digital desktop computer of modular design as shown. The modular components of the desktop shall be products of a single manufacturer which advertises service in all 48 contiguous states. Provide Desktops as shown on System Architecture diagrams. Workstation hardware shall meet the following minimum requirements (when not required by the BMS software):
 - a. Processor Speed: Intel i5 (or better), 3.0GHz.
 - b. Random Access Memory (RAM): 8 GB RAM.
 - c. Communications Ports: One serial port, one enhanced parallel port and two USB 3.0 ports in addition to any ports required for the keyboard and mouse.
 - d. Drive and controller: 160 GB formatted disk space with an average seek time of 7 milliseconds or less. Provide SSD solid state drives.
 - e. CD-RW Drive: 24x read; 12x re-write; 24x write.
 - f. Video Output Card(s): Support at least 32-bit color at a minimum resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz and shall support the quantity of monitors provided for each workstation.
 - g. Network Interface Card (NIC): Integrated 100Base-TX Ethernet NIC with an RJ45 connector.
 - h. Monitor: Monitor sized as shown on drawings but no less than 19 inches with a maximum supported resolution of no less of 1280 by 1024 pixels, flat screen, non-interlaced, and a maximum dot pitch of 0.28 mm. The workstation located in work room 1NA102 shall be provided with (5) monitors.

- i. Keyboard: 101-key keyboard having a minimum 64-character standard ASCII character set based on ANSI INCITS 154.
 - j. Mouse: 2-button mouse with a minimum resolution of 400 dots per inches.
- F. Laptop Hardware:
- 1. Laptop Hardware shall be a standard unmodified digital laptop computer. The modular components of the laptop shall be products of a single manufacturer which advertises service in all 48 contiguous states. Provide Laptops as shown on System Architecture diagrams. Laptop hardware shall meet the following minimum requirements (when not required by the BMS software)
 - a. Processor Speed: Intel i5 (or better), 3.0GHz.
 - b. Random Access Memory (RAM): 8 GB RAM.
 - c. Communications Ports: One serial port and two USB 2.0 ports in addition to any ports required for the keyboard and mouse.
 - d. Drive and Controller: 200 GB formatted disk space with an average seek time of 7 milliseconds or less. Provide SSD solid state drives.
 - e. CD-RW Drive: 24x read; 12x re-write; 24x write.
 - f. Network Interface Card (NIC): Integrated 100Base-TX Ethernet NIC with an RJ45 connector, and wireless LAN 802.11n or newer.

2.6 COMPUTER SOFTWARE

- A. Operating System (OS): Provide an operating system for all servers, workstations and laptops provided for the project. The operating system (OS) shall fully support all installed software and peripherals and shall be able to obtain screen capture of the monitor display being viewed.
- B. Standard Office Software: Provide standard office software. The office software shall be coordinated with the client prior to installation. The software shall consist of spreadsheet and word processing portions of the project site's standard office software.
- C. Document Viewer: Provide a PDF document viewer, along with any other viewer software required to open and display any files stored or accessed as part of the M&C software, including any relevant help files, training files, etc.
- D. Login and Passwords:
 - 1. Coordinate login/password management requirements with Owner Cyber Security requirements. The Monitoring and Control (M&C) software shall provide user-based access to M&C functionality. The M&C Software shall obtain user information from the Operating System and shall recognize at least 20 separate users and have at least 4 levels of user permissions. User permission levels (from most restrictive to most permissive) shall include:
 - a. Permission Level 1: View System Graphic Displays.
 - b. Permission Level 2: Permission Level 1 plus acknowledge alarms and set up (configure) trends and reports.
 - c. Permission Level 3: Permission Level 2 plus point commanding and set up (configure) alarms, schedules, and demand limiting.
 - d. Permission Level 4: Permission Level 3 plus create and modify System Graphic Displays, create custom programs, and create software points.
 - 2. Passwords shall not be displayed. The system shall maintain a disk file logging all activity of the system. If the file format is not plain ASCII text, provide a means to export or convert the file to plain ASCII text. This file shall maintain, as a minimum, a record of all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications. Passwords shall not be logged. The activity log shall be maintained at the server hardware. The system shall automatically provide a mechanism for archiving the log files for long term record storage.

3. Setup system permission level templates, so that as users are added to the system the template can be applied to the users.

E. System Graphic Displays:

1. The M&C software shall include graphical displays through which an operator can perform real-time access and manipulation of the M&C functions as specified and shown. The graphical displays shall consist of building-level systems (air handler units, EFs, VAV boxes, AHUs, HRUs, etc.) graphic displays, alarm displays, scheduling displays, and trending displays.
2. Identify all points the Owner wants displayed on the graphic screens. Provide a list of graphical symbols to the Owner for review and approval prior to developing the graphic screens.

F. Navigation Scheme:

1. System graphic displays of building-level systems and points shall be hierarchical displays using a building-to-equipment point-and-click navigation scheme. Each display shall show the building name and number. Each display shall show system wide data such as outside air temperature and humidity in the case of an HVAC system application.
 - a. Each Building or Building Sub-Area display shall show the building footprint and basic floor plan and shall clearly show and distinguish between the individual zones and the equipment serving each zone and space. The building display shall also show all space sensor and status readings, as applicable, for the individual zones such as space temperature, humidity, differential pressure, occupancy status, etc. The building display shall show the locations of individual pieces of monitored and controlled equipment.
 - b. Each equipment display shall show a 3-dimensional representation of the individual pieces of equipment using the symbols and M&C point data types as specified. Different colors and textures shall be used to indicate various components and real time data. Color and texture meanings shall be consistent across all displays.
 - c. Each display shall clearly distinguish between the following point data types and information:
 - 1) Real-time data.
 - 2) User-entered data.
 - 3) Overridden or operator-disabled points.
 - 4) Devices in alarm (unacknowledged).
 - 5) Out-of-range, bad, or missing data.

G. Navigation Commands:

1. The system graphic displays shall support English language operator commands via point-and-click mouse or keyboard entry for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands shall be usable from any operator workstation with individual operator passwords as specified.
 - a. Command Input: Operator's commands shall be full words and acronyms selected to allow operators to use the system without extensive training or any data processing backgrounds. The system shall prompt the operator in full words and acronyms for all required information, identifying acceptable command formats. The operator's response shall be a point-and-click selection, word, phrase, or acronym including parameters where required.
 - b. Command Input Errors: The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors. The system shall explain to the operator why the command cannot be executed. Conditions for which operator error assist messages shall be generated include:
 - 1) The command used is incorrect or incomplete.

- 2) The operator is restricted from using that command.
- 3) The command addresses an out-of-range or bad data point.
- 4) The command addresses a point that does not exist.
- 5) The command would violate constraints.
- c. Operator's Commands: The operator's commands shall provide the means for entry of control and monitoring commands, and for retrieval of information. The operator's commands shall perform tasks, including:
 - 1) Request a display of any database point or calculated point or any group of related points and calculated points.
 - 2) Start-up and shutdown selected systems or devices.
 - 3) Override any point to an operator selected value.
 - 4) Release the override of a point.
 - 5) Modify time and event scheduling.
 - 6) Initiate reports.
 - 7) Generate and format reports.

H. Display Editor:

1. The display editor shall enable the user to create, modify, and delete displays and graphic symbols. The primary use shall be for adding and modifying one-line diagrams, status displays, system summaries, and system directories, as new controllers, points, data, and other necessary changes are made. The basic functions shall include:
 - a. Create and save displays and graphic symbols.
 - b. Group and ungroup graphic symbols. The grouped symbol shall be manipulated as a single symbol.
 - c. Modify a portion of a graphic symbol.
 - d. Save graphic symbols as a library object.
 - e. Rotate and mirror a graphic symbol.
 - f. Delete a graphic symbol.
 - g. Place a graphic symbol on a display.
 - h. Cancel the display of a graphic symbol.
 - i. Assign conditions which automatically initiate the display.
 - j. Overlay alphanumeric and graphics.
 - k. Save new, modified, or existing graphics as new graphics.
 - l. Integrate real-time data with the display.
 - m. Define the background color.
 - n. Define the foreground color.
 - o. Locate the symbols.
 - p. Position and edit alphanumeric descriptors.
 - q. Establish connecting lines.
 - r. Establish sources of latest data and location of readouts.
 - s. Display analog values as specified.
 - t. Cursor control (up, down, right, left).
 - u. Create and display alphanumeric displays.
 - v. Assign graphics a depth such that when there are coincident graphics the one with the lower depth is displayed.
 - w. Symbols Library: The library of callable display symbols shall include: Pump, Motor, Two- and Three-way Valves, Flow Sensing Element, Point and Averaging Temperature Sensors, Pressure Sensor, Humidity Sensor, Single and Double Deck Air Handling Unit, Fan, Chiller, Boiler, Air Compressor, Chilled Water Piping, Steam Piping, Hot

Water Piping, Ductwork, Unit Heater, Pressure Reducing Valve, Damper, Electric Meter, Limit Switch, Flow Switch, High- and Low- Point and Averaging Temperature Switches, High- and Low- Pressure Switches, Coil, Solenoid Valve, Filter, Condensing Unit, Cooling Tower, Variable Frequency Drive (VFD), Heat Exchanger, Current Sensing Relays. Symbols shall at a minimum conform to ASHRAE Fundamentals Handbook where applicable.

I. Scheduling:

1. The M&C software shall be capable of changing the value of any point in the database. A minimum of 200 user-definable schedules shall be supported and the specified scheduling functions shall be operator accessible and adjustable via graphics display. The graphics display shall include the following fields and functions:
 - a. Current date and time. The OS and M&C software shall automatically make Daylight Savings Time adjustments. Daylight savings time adjustment shall be capable of being disabled by the operator.
 - b. Building name and number.
 - c. System identifier and name.
 - d. System group. Systems shall be capable of being grouped by the user to perform according to a common schedule.
 - e. Weekly schedules. Each system shall have a weekly schedule based on a seven day per week schedule with independent schedules for each day of the week including no less than 6 value changes per day.
 - f. Holiday and special event schedules. System scheduling shall support holiday and special event calendar schedules independent of the daily schedule. Special event schedules shall include one-time events and recurring events. Scheduling of one-time events shall include the beginning and ending dates and times of the event. Holiday and special event schedules shall have precedence over device weekly schedules.

J. Alarms: The M&C software shall be capable of generating alarms and handling network alarms from the control network. M&C Software shall be capable of handling and managing no less than 20,000 alarm points daily.

K. Alarm Data:

1. Alarm data to be displayed and stored, as applicable and as specified, shall include:
 - a. Identification of alarm including building, system (or sub-system), and device name.
 - b. Date and time to the nearest second of occurrence.
 - c. Alarm type:
 - 1) Unreliable: Indicates that the source device has failed due to the sensing device or alarm parameter being out-of-range or bad data.
 - 2) High Alarm.
 - 3) Low Alarm.
 - d. Alarm set point and dead band (if analog).
 - e. Engineering units.
 - f. Current value or status of the alarm point.
 - g. Alarm priority: There shall be two alarm priority levels; critical and informational. Critical alarms shall remain in alarm until acknowledged by an operator and the alarm condition no longer exists; informational alarms shall remain in alarm until the alarm condition no longer exists or until the alarm is acknowledged.
 - h. Alarm Message: A unique message with a field of 60 characters shall be provided for each alarm. Assignment of messages to an alarm shall be an operator editable function.
 - i. Alarm Secondary Message: Secondary messages shall be assignable by the operator for printing to provide further information, such as telephone lists or maintenance

functions, and shall be editable by the operator. The system shall provide for 100 secondary messages, each with 25 lines of 60 characters each.

- j. Messages shall be sent via either SMS text message or email. Alarm distribution shall be configurable at the BMS operator workstation. Operator shall be capable of selecting specific recipients or groups of recipients for each alarm.
- k. Acknowledgement status of the alarm and, where acknowledged, the time and date of acknowledgement.
- l. User who acknowledged the alarm.

L. Alarm Notification and Routing:

- 1. The M&C software shall be capable of performing alarm notification and routing functions. Upon receipt or generation of an alarm the M&C software shall immediately perform alarm notification and routing according to an assigned routing for that alarm. The M&C software shall support at least 100 alarm routes; an alarm route shall be a unique combination of any of the following activities:
 - a. Generate a pop-up display on designated workstation monitors. The pop-up display shall include identification of the alarm, date and time of the alarm, alarm message, and current value/status of the alarm point. Alarms shall be capable of being acknowledged from the pop-up display by operators with sufficient permissions. Pop-up displays shall be displayed until acknowledged.
 - b. Print alarms to designated alarm printers. The printed message shall be the same as the pop-up message.

M. Alarm Display and Acknowledgement: The M&C software shall include an alarm display. A minimum of the most recent 100 system alarms shall be available for display at each workstation as shown, along with all associated alarm data. Alarms shall be capable of being acknowledged from this display. Multiple alarms shall be capable of being acknowledged using a single command. Operator acknowledgment of one alarm shall not automatically be considered as acknowledgment of any other alarm nor shall it inhibit reporting of subsequent alarms.

N. Alarm Storage and Reports: The M&C software shall store each alarm and its associated alarm data to hard disk. The stored data shall be user-sortable and formatted for printing.

O. Trending:

- 1. The M&C software shall be capable of performing real-time trending of a minimum of **5,000** points simultaneously with a minimum trending capacity of 100 points per second. The M&C software shall be capable of displaying and printing a graphical representation of each trend, and of multiple trended points on the same graph. The software shall be capable of saving trend logs to a file. If the file format is not plain ASCII text in a Comma-Separated-Value (CSV) format, provide a means to export or convert the file to plain ASCII text in a CSV format. Each trend shall be user-configurable for:
 - a. Point to trend.
 - b. Sampling interval with a minimum sampling interval no greater than 1 second, and a maximum sampling interval no less than 1 hour.
 - c. Start and Stop Time of Trend: Start and stop times shall be determined by one or more of the following methods:
 - 1) Start Time and Stop Time.
 - 2) Start Time and Duration.
 - 3) Start Time and number of samples.
 - d. Coordinate the points which require trending, the trend configuration, and the reports with the client. Provide all labor necessary to configure the trends and associated reports.

P. Report Generation:

1. Software shall be provided with commands to generate and format reports for displaying on current Workstation, printing, and storing on disk. Reports shall be stored by type, date, and time. The destination of each report shall be selectable by the operator.
2. Dynamic operation of the system shall not be interrupted to generate a report.
3. The report generation mode, either automatic or requested, shall be operator assignable.
4. The report shall contain the time and date when the samples were taken, and the time and date when the report was generated.
5. The software shall be capable of saving reports to a file. If the file format is not in a format compatible with the provided Office Automation Software, provide a means to export or convert the file to a compatible format.
6. Software shall be provided to format and store all data, trends, profiles, reports, and logs specified herein in a comma-delimited text format to any media supported by the operating system.
7. The software shall allow for automatic or manual generation of reports.
 - a. For automatic reports, the operator shall be able to specify the time the initial report is to be generated, the time interval between reports, end of period, and the output format for the report. The operator shall be able to modify or inhibit a periodic report.
 - b. Manual report generation shall allow for the operator to request at any time the output of any report. The software shall have a report generation utility capable of generating the following standard reports:

Q. Energy Usage Report:

1. Where energy meters are indicated on the contract documents and monitored by the BMS, the BMS shall provide an energy usage summary, operator selectable, for a unit, building, area, installation, and the entire BMS, as appropriate for the meters installed. The report shall be divided by utility and shall be capable of reporting on at least four separate utilities. The report shall include the following information:
 - a. Beginning and ending dates and times.
 - b. Total energy usage for each utility for the current and previous day.
 - c. Total energy usage for each utility for the current and previous month.
 - d. Outside air (OA) temperature and OA relative humidity (RH) or dew point for:
 - 1) Average for current day, and average for previous day.
 - 2) Minimum and maximums of previous day
 - 3) Average values of each for previous month
 - 4) Average values of each for current month

R. Alarm Report: Outstanding alarms by building or unit, including time of occurrence.

S. Override Report: Points overridden, including time overridden, and identification of operator overriding the point.

T. Run Time Reports: A report totalizing the accumulated run time of individual pieces of equipment. The operator shall be able define equipment groupings and shall be able to generate reports based on these groupings.

U. Programming Language:

1. The M&C Software shall incorporate a programming (scripting) language for creating custom applications. Actions that shall be available through the programming language shall include the following functions:
 - a. Override points.
 - b. Monitor points.
 - c. Clock / Timer Functions.

- d. Math Functions: Addition, subtraction, multiplication, division, exponentiation, trigonometric and logarithmic functions.
- e. Loops ("for" and "while").
- f. Conditional Branches ("if-then-else").
- g. Variable Define / Assignment / Use.
- h. Provide data to a graphic display.
- i. Get data from a graphic display.
- j. Initiate alarm conditions.
- k. Initiate Reports.
- l. Logic Functions ("and", "or" and "not").
- m. Bitwise logic functions.
- n. User defined subroutines and functions.

V. Remote Access:

- 1. The M&C Software shall allow for remote access via a secure Internet connection. M&C Software shall allow for basic Cybersecurity features, such as firewall protection that would be configured by the Owner.
- 2. Remote access shall allow for viewing all BMS graphics, making commands (such as setpoint changes), viewing reports (such as trend logs), and viewing the alarm history.
- 3. Remote access shall be configured with access restrictions, such as name and password requirements, to regulate the users that have remote access capabilities.

2.7 CONTROLLERS

A. Supervisory Controller (SC):

- 1. Provide supervisory controllers (SCs) which comply with the following requirements. The SC shall have two components. The first is a communication interface between the primary level network and secondary level network. The second is supervisory interface which manages the BMS point database. Provide one controller with both components integral if the controller is available from the BMS manufacturer, or two separate components in the same enclosure.
 - a. Communication Interface: Shall be the primary system point of contact between the secondary level network and the primary level network through which all communication traffic to/from the two networks passes. Communication interface shall communicate at a minimum of 10/100 Mbps on the primary level network.
 - b. Supervisory Interface: Shall manage alarm and trend data. Trend data shall be stored at the supervisory interface and uploaded to the server when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. Uploading trend samples directly from the control device to the server is unacceptable.
 - 1) All trend data shall be available for use in third-party personal computer software.
 - 2) Include a minimum of 24 MB of memory. Maintain all trending information in non-volatile memory or 72-hour battery backed RAM. Each unit shall have an accurate real time clock that can be synchronized.
 - 3) Any point, physical or calculated, may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored.
- 2. The Secondary level network shall be engineered to meet the following criteria:
 - a. For office systems, assume 1/8 of all the points on the secondary level network are being trended at 5-minute intervals. PSC and network design shall allow trend collection of all points with no loss of trend data and be capable of storing data for a minimum of 7 days before data is overwritten.
 - b. For any laboratory or ABSL-2 or 3 systems, assume 1/2 of all the points on the secondary level network are being trended at 5-minute intervals. PSC and network

design shall allow trend collection of all points with no loss of trend data and be capable of storing data for a minimum of 7 days before data is overwritten.

3. If a SC is available from the BMS manufacturer with I/O point capacity, the SC may be provided with point (I/O) capacity as defined in the (PSC) specification section. The SCs shall also comply with all the requirements of the Programmable System Controller (PSC) if the SC is provided with I/O point capacity.

B. Programmable System Controller (PSC):

1. General Requirements:

- a. The PSC shall reside on either the Secondary level network backbone or the Primary level network. PSCs communicating on the Secondary level network backbone shall communicate at a minimum rate of 76 kilobits per second (Kbps). PSCs communicating on the Primary level network shall communicate at a minimum rate of 10/100 Megabits per second (Mbps). Regardless of which network the PSC resides, all PSCs shall successfully communicate to the server and workstations.
- b. Provide one PSC per air handling unit (AHU), Heat Recovery Unit (HRU), and any major Mechanical system shown on BMS Network Architecture.
- c. Include minimum 1 MB of memory. Maintain programming and point database in non-volatile memory (EEPROM) or 72-hour battery backed RAM. Each unit shall have an accurate real time clock that can be synchronized.
- d. Permit readout of variables, override of control, modification of attributes and scheduling changes while printing messages, trends, reports, or alarms.
- e. Each PSC shall contain analog inputs (AI), binary inputs (BI), analog outputs (AO), or binary outputs (BO).
- f. Incorporate LED status lights in PSC to indicate operational position of binary outputs (ON/OFF).
- g. Controllers shall provide operators with the ability to manually override automatic or centrally executed commands at the PSC via local, point discrete on-board Hand/Off/Auto override switches for binary control type points and gradual switches for analog control type points. Override switches shall be operable whether the panel processor is operational or not.
 - 1) Switches shall be mounted either within the PSC key accessed enclosure or externally mounted with each switch keyed to prevent unauthorized overrides.
 - 2) PSC shall monitor the status of all overrides and inform the operator that automatic control has been inhibited.
- h. PSC shall count/accumulate/totalize multiple pulse type inputs (kW meters, steam flow meters, water meters and similar inputs) and convert those pulse signals into engineered values for control and read-out.
- i. A PID control loop algorithm shall provide accurate control of sensed variable.
- j. Transmit messages to other units on communication network. Messages transmitted shall be positively acknowledged as received or negatively acknowledged as not received. Negative acknowledgements shall immediately force retransmission of message.

2. Controllers:

- a. Stand-alone, multi-tasking, multi-user, minimum 16-bit CPU-based controllers for all applications. All controllers shall provide for direct interface to industry standard sensors and input devices.
- b. Control Loop Scan Frequency: Less than one second.

3. Points:

- a. Input Types:
 - 1) RTD (100- or 1000-ohm platinum).
 - 2) Thermistors

- 3) Contact open/closed.
- 4) 4-20 mA.
- 5) 3-15 psi.
- 6) 0-12 VDC.
- 7) Pulse accumulator.
- b. Output Types:
 - 1) 0-12 VDC.
 - 2) Pulse-width modulation.
 - 3) Maintained/momentary on/off.
 - 4) 4-20 mA.
 - 5) 3-15 psi.
4. Software:
 - a. Provide integral software with required control algorithms and alarm routines.
 - b. Permit programming of PSC database from: a laptop, PSCs on the primary level network, server, or any operator workstation.
 - c. Each PSC shall perform normal control and energy management routines as defined by the operator.
 - d. Normal Control Routines:
 - 1) Distributed digital control of system temperature, humidity, pressure, and flow.
 - 2) Three mode PID (proportional, integral, and derivative) control.
 - 3) Logging and alarm logic.
 - 4) Normal Power restoration sequential restart program.
 - 5) Emergency Power sequential start program.
 - 6) Non-volatile control strategies.
 - 7) High and low limits with alarms for analog input/output points of each controlled variable.
 - 8) Adjustable on-off delays.
 - 9) Totalization of analog/binary values.
 - 10) Pulse totalization.
 - 11) Reset of receiver controller setpoints.
 - 12) Trend information and storage.
 - 13) Equipment Alternation.
 - e. Energy Management Routines:
 - 1) Time of day scheduling.
 - 2) Start/stop time optimization.
 - 3) Peak demand limiting.
 - 4) Economizer control.
 - 5) Enthalpy changeover.
 - 6) Event initiated programs.
 - 7) Lighting Control Time based occupied/unoccupied modes.
 - f. Execute temperature control functions within unit. Execute loop control via direct digital control algorithms. Allow user to customize control strategies, sequences of control, define control loop algorithms and choose optimum loop parameters for loop control. Control loops shall support full proportional, integral, and derivative control applications.
 - g. Permit creation, modification, or removal of control algorithms within a PSC, while operating and performing other control functions. Each control loop shall be user definable in terms of:
 - 1) Sensors/actuators as part of control strategy.

- 2) Control mode.
- 3) Gain.
- 4) Control action.
- 5) Sampling time.
- h. Permit user to create customized control strategies based upon arithmetic, Boolean or time delay logic. Arithmetic functions shall permit simple relationships between variables (i.e., +, -, /, x) as well as more complex relationships (i.e., square root).
- i. Data Sharing: PSCs shall share appropriate point information such that control sequences or control loops, executed at one unit, receive input signals from appropriate sensors connected to other units within network. When data highway fails or other PSCs malfunction, control loop shall continue to function using last value received from network.
- j. Fail-Safe Operation:
 - 1) Provide self-diagnostics that continuously monitor operation of unit. Automatically report malfunction of controller, distributed module, or associated communication link. Display failure condition with time and date.
 - 2) Upon detection of a memory error, each processor shall correct error or halt to prevent erroneous operation. Report "halts" as an alarm on the BMS. Upon communication being reconnected, a "Return to Normal" message shall be generated at both locations.
 - 3) Upon power restoration after failure, provide automatic sequential restart of equipment based on current program time and program requirements without operator intervention. Provide prioritized restart of systems and equipment as defined on Contract Documents.
 - 4) A dedicated fail-safe relay in PSC controller shall change state on a hardware and/or software fault. Relay contacts shall be used to set a fixed fail-safe position for designated output-controlled devices.
- k. Alarm Management:
 - 1) Monitor and direct alarm information to operator devices. Each PSC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network communications traffic, and prevent alarms from being lost. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point.
 - 2) Direct alarms to the server and workstations for annunciation or printout, as directed by Owner. Provide the ability to acknowledge alarms from any workstation, as allowed by operator security settings. Provide time and date of acknowledgment.
- 5. PSC shall provide high resolution sampling capability for verification of control loop performance. Operator initiated automatic and manual loop tuning algorithms shall be provided for operator selected PID control loops. Provide ability to view or print trend and tuning reports.
 - a. In automatic mode, controller shall perform a step response test with a minimum one-second resolution, evaluate trend data, calculate new PID gains and input these values into the selected loop.
 - b. For troubleshooting in manual mode, operator shall be able to select variables to override default values. Calculated PID gains shall then be reviewed before they are inserted into the selected loop.
 - c. Loop tuning shall be capable of being initiated either locally at PSC, from the server or any workstation. For all loop tuning functions, access shall be limited to authorized personnel through password protection.
- 6. PSC shall automatically accumulate and store run-time hours for all major mechanical equipment (AHUs, EFs, Pumps, etc.).

7. Nameplates: Laminated plastic nameplates shall be provided for each PSC. Each nameplate shall identify the function, network address and identifier of the server or workstation. Laminated plastic shall be 0.125 inches thick, **black with white letters**. Nameplates shall be a minimum of 1 by 3 inches with minimum 0.25 inches high engraved block lettering. All nameplates shall be attached to the device in conspicuous location.

C. Application Specific Controller (ASC):

1. Controllers:

- a. ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. ASC shall be a microprocessor based, multi-tasking, real time digital control processor. ASC shall provide control of the terminal device independent of the manufacturer of the terminal device. ASC shall not be used to control AHUs, HRUs, or major pieces of mechanical equipment, such as, but not limited to: Chiller, Cooling Towers, Preheat or Reheat systems, or Exhaust Fan systems.
- b. Provide each ASC with sufficient memory to accommodate point databases, operating programs, local alarming, and local trending. All databases and programs shall be stored in non-volatile EEPROM and EPROM, or minimum of 72-hour battery backup shall be provided. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.
- c. Controller shall be part of a secondary level network for interface to industry standard air terminal equipment.
- d. Provide wiring terminals, input/output points, local communication, and electrical power.
- e. Processor shall be minimum 12 bit, with communication rate of 9600 baud or higher.
- f. Input/Output System: Provide required input/output point types necessary to accomplish sequence of operations provided in Section 25 90 00 – BMS Sequence of Operation, and as shown on contract drawings.
- g. The installed application shall be suitable for the piece of equipment and shall function as specified in the sequence of operations.
- h. Assign and change setpoints and control parameters using a laptop or through manual commands at any operator workstation.
- i. Provide operator with ability to remotely monitor or adjust controlled variables.
- j. The BMS shall provide power to all ASCs via a power trunk. No more than 80 percent of the capacity of any given transformer shall be utilized.
- k. ASCs installed on terminal units which re-calibrate daily by modulating the terminal unit damper shall re-calibrate in a staggered fashion. The ASCs shall be programmed to re-calibrate in 5-minute increments so that no more than one ASC, associated with a system, re-calibrates at the same time. The programming shall be stored in non-volatile EEPROM and EPROM, or minimum of 72-hour battery backup shall be provided, the programming shall that not be lost in the event of a power failure or controller failure.
- l. ASCs installed on terminal units serving critical areas (such as vivarium and laboratories) shall not re-calibrate daily by modulating the damper. Provide ASCs which re-calibrate without disrupting the airflow into the critical area. If the BMS manufacturer does not offer this option, the terminal units shall be controlled by a PSC with the use of differential pressure transmitters for monitoring terminal unit air flow. Floating control is not acceptable.

2. Air Velocity Transducer:

- a. Air velocity sensor (Pitot-tube or "Crossflow"), provided by terminal unit manufacturer , connects to differential pressure transmitter, and measures average differential pressure. This value is converted to airflow through a square root function.
- b. Measurement Range: 400 to 4000 fpm.
- c. Measurement Resolution: Plus or minus 16 fpm.
- d. Measurement Repeatability: Plus or minus 32 fpm.

- e. Measurement Accuracy: 400 to 4000 fpm: Plus or minus 5 percent of measured value.

2.8 SURGE PROTECTION

- A. Power-Line Surge Protection: Equipment connected to AC circuits shall be protected against or withstand power-line surges. Equipment protection shall meet the requirements of IEEE C62.41.1. Fuses shall not be used for surge protection.
- B. Surge Protection for Transmitter and Control Wiring:
 - 1. DDC hardware shall be protected against or withstand surges induced on control and transmitter wiring installed outdoors and as shown. The equipment protection shall be protected against the following two waveforms:
 - 2. A waveform with a 10-microsecond rise time, a 1,000-microsecond decay time and a peak current of 60 amps.
 - 3. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.
- C. Transient Surge Protection:
 - 1. Provide each controller and sensor with means of suppression of transients from inductive devices in system, capable of generating or sustaining transients.
 - 2. Provide the server and workstations with immunity from electrical sags, surges, transients, noise, and outages with uninterruptible power supplies.

PART 3 - EXECUTION

3.1 PROJECT MANAGEMENT

- A. Provide a designated project manager who will be responsible for the following:
 - 1. Construct and maintain project schedule.
 - 2. On-site coordination with all applicable trades, subcontractors, and other integration vendors.
 - 3. Authorized to accept and execute orders or instructions from Owner.
 - 4. Attend project meetings as necessary to avoid conflicts and delays.
 - 5. Make necessary field decisions relating to this scope of work.
 - 6. Coordination/Single point of contact.

3.2 CONTROL SYSTEM INSTALLATION

- A. General Installation Requirements:
 - 1. The BMS shall be completely installed, tested and ready for operation. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The BMS installation shall provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. The BMS installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.
 - 2. The control equipment shall be installed in a control enclosure mounted on the terminal unit or adjacent to the terminal unit in an accessible location. The contractor's responsibilities include but are not limited to all interconnecting wiring, all interconnecting tubing, factory calibration, all field wiring, all field tubing, and all linkage connections between the actuator and the terminal unit.
- B. Installation:
 - 1. Prior to activating any BMS controller, the BMS contractor shall provide a plan for the startup of all BMS controllers as well as a plan for all point-to-point checkout procedures to the construction manager, mechanical contractor, and Owner to work in a synergy manner to start up HVAC equipment within project schedule deadlines.

2. Provide supervision of installation of all control components to ensure conformity with manufacturer's instructions and reviewed submittals, including components furnished but installed by others. Verify locations to ensure that accurate primary signals will be obtained.
3. Refer to Divisions 23, 25 and 26 for additional methods and materials.
4. Calibrate airflow sensors with readings obtained from Test and Balance contractor. Verify that field mounted indicators display using the same engineering units as monitored by BMS.
5. Provide start-up, calibration, and adjustment of all airflow and pressure controls.
6. All devices shall be installed in accordance with manufacturer's recommendations and as specified and shown. Control devices to be installed in piping and ductwork shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used. Spare thermowells shall be installed adjacent to each thermowell containing a sensor and as shown.
7. All devices and instruments located outdoors shall be provided in NEMA 4 enclosures. Heat load calculations shall be performed to determine if the device's ambient temperature range will be exceeded. Wherever the temperature range is exceeded, provide enclosure heating and cooling. Where it is unfeasible to provide a NEMA 4 enclosure provide a three-sided instrumentation and device shelter. All equipment installed outdoors shall be rated for the full range of outdoor ambient conditions.
8. Provide minimum 10 feet of extra cabling for temperature and relative humidity sensors located in common areas to accommodate relocation. Neatly coil and fasten extra sensor wiring in accessible area above sensor location.
9. All wall mounted sensors and thermostats shall be mounted to be accessible in accordance with ADA Guidelines unless otherwise noted on the contract drawings. Coordinate final locations of all wall-mounted sensors/thermostats with the Owner prior to installation.
10. All alarm and indicating devices must follow NFPA 72 codes for signaling, including synchronization of strobe lights in a common area.
11. All valves installed outdoors shall be provided with NEMA 4 actuator housings and heaters if required by the manufacturer.
12. Mount the sensors for monitoring outdoor air conditions (e.g., outdoor temperature and humidity transmitters) in an instrument shelter, located on roof. Refer to the contract documents for location.
13. Where control devices are to be surface mounted on components scheduled to be insulated, provide insulation between device and component to prevent condensation or heat transfer.
14. Verify location of room thermostats, room temperature/humidity sensors, duct temperature/humidity transmitters, airflow stations, static pressure probes, control panels, and other exposed control equipment with contract drawings before installation. Provide an insulated backplate for thermostats and wall mounted temperature sensors installed on exterior walls.
15. Mount low limit temperature detectors (freezestats) using flanges and element holders. Wire multiple contacts in series. Mount thermostats on full width and height support rack within custom air handling units.
16. Duct Penetrations: Where instruments penetrate ductwork, provide gaskets, flanges, and apply sealant to create an airtight seal.
17. All BMS junction box wall penetrations in gypsum wall board (GWB) within containment areas provide the following:
 - a. Conform to all means and methods specified in Division 26.
 - b. Provide a finished GWB zip strip bead around the entire perimeter of the wall opening. The zip bead is to be finished with GWB spackle, at exposed wall surface, to be flush with adjacent surface.

- c. Maintain a 1/4 inches joint between the zip bead framing and exterior perimeter of the junction box. The 1/4 inches gap is to be infilled with a backer rod material and a minimum of 1/4 inches deep sealant at the exterior surface of the gap. Final finish of sealant to be flush with junction box.
 - d. All junction boxes are to be mounted so that the edge of the box is flush with the final GWB finish, to allow the cover plate to be installed flush to the final finish.
 - e. Provide cover plates to extend past the sealed perimeter joint by a minimum of 1/4 inches.
 - f. Set cover plate in a bed of sealant at perimeter. Final finish exterior of cover place with a bead of sealant.
- 18. Provide multi-section dampers with interconnecting hardware or jackshaft for unison operation when required.
 - 19. Mount SCs and PSCs controlling large pieces of HVAC and mechanical equipment adjacent to associated equipment on vibration free walls or freestanding angle iron supports. Do not mount on AHU housing. Coordinate final location of all Controllers and Enclosures with all other trades prior to installation. Provide nametags for instruments and controls inside the control enclosure and identify associated system on face of the enclosure. Mount a laminated copy of panel of As-Built drawing(s) inside each cabinet.
 - 20. Coordinate control wiring and safety contacts required for motor control centers and VFD controllers with Division 26 and shown on electrical details. Wire safeties so that they will not be overridden when hand-off-auto (HOA) switches are in hand position.

C. Software Installation:

- 1. Install software as follows:
 - a. Operating System (OS): Install the OS on each Server and Workstation and configure usernames and passwords.
 - b. Office Automation Software: Install the office automation software on each server and workstation.
 - c. Monitoring and Control Software: Install the monitoring and control software as shown. The server version of the software shall be installed on server hardware, and client versions shall be installed on the workstations.

D. Control Enclosure Installation:

- 1. Unitized cabinet type for each system under automatic control. Provide quantity of enclosures required to house all relays, transducers, solenoid valves, pneumatic devices, and other interface controls. Mount temperature, humidity, airflow, and pressure indicators, (or operator interface display with keypad), pressure gauges, pilot lights, pushbuttons, and switches flush on cabinet panel face.
- 2. Provide NEMA-1 general purpose enclosure for all applications where panel will be installed indoors. Any control panel for use in wash-down locations or installed outdoors shall be rated NEMA-4. Enclosures installed outdoors shall be provided with heating or cooling to meet the operating temperature requirements of the equipment within the enclosure. All cabinets shall use a common key. Provide means of storing control system instructions and drawings inside cabinet.
- 3. Provide surface mounted or freestanding, steel supported types for mechanical equipment rooms. Provide fully recessed wall-mounted types elsewhere.
- 4. All enclosures shall be fully recessed in walls, except in mechanical equipment rooms and above ceilings.
- 5. Interior arrangement of control enclosure components shall be such that tubing, and wire raceways shall be separated and aligned horizontally and vertically, in a fashion that allows for an organized appearance and a practical means for the tubing/wire to exit the raceway to its intended component.
- 6. All tubing shall enter the enclosure through standard bulkhead compression fittings. All tubing lines shall be labeled using "Brady" markers or similar at both ends of the tubing.

7. All wire shall enter the enclosure via conduit fittings. All wires shall terminate on terminal blocks and then continue from the terminal block to the device. Direct connection to the device is not permitted. Use of wire nuts is not permitted, except in applications in which a control device is provided from the factory with "pigtails". All wires shall be labeled using "Brady" markers or similar at both ends of the terminal blocks.
8. Terminal blocks which are not integral to other equipment shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.
9. Each enclosure shall include a convenience duplex receptacle, a circuit breaker, and a local disconnect.
10. Refer to Section "Equipment Tags" for additional requirements.

3.3 WIRING INSTALLATION

A. Standard Wire and Cable:

1. Wire and Cable shall be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Refer to Section 26 for means, methods, and materials. Instrumentation grounding shall be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Ground rods installed by the contractor shall be tested as specified in IEEE Std 142. Cables and conductor wires shall be tagged at both ends, with the identifier shown on the shop drawings. Wiring external to enclosures shall be run as follows:
 - a. Wiring other than low-voltage control and low-voltage network wiring shall be installed in raceways.
 - b. Low-voltage control and low-voltage network wiring not in suspended ceilings over occupied spaces shall be installed in raceways, except that nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.
 - c. Low-voltage control and low-voltage network wiring in suspended ceilings over occupied spaces shall be installed in raceways, except:
 - 1) Nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.
 - 2) Plenum rated cable in suspended ceilings over occupied spaces may be run without raceways.
 - d. Per NEC Article 725 (excluding thermocouple wiring). Control or signal circuits not run entirely in conduit, in areas classified as plenum space and vertical shafts shall be energized from listed Class 2 power supplies and shall be installed in Type "CL2P" listed plenum cable exclusively. Plenum rated cable shall be permitted in applications above an accessible ceiling or in between drywall where there is no insulation.
 - e. For Hazardous location circuits, refer to NFPA Article 500 for installation requirements.
 2. All wiring in plenums and above a suspended ceiling shall be secured to the structure and routed through J-hooks. Under no circumstances may the cabling be laid upon the top of a suspended ceiling.
- B. Conduit: Provide EMT conduit for all exposed wiring installed inside the building. Plenum rated cable, without conduit, can be used only above accessible ceilings. For spaces that are inaccessible, such as shafts, EMT conduit is required. Use rigid conduit for all wiring outside or underground.
- C. Terminal Blocks: Terminal blocks which are not integral to other equipment shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.
- D. Control Wiring for Binary/Analog Signals: Provide the manufacturer recommended wire type for all analog and binary control signals. Control Wiring for Analog Signals shall be copper, single

or multiple-twisted, minimum 2 inches lay of twist, 100 percent shielded pairs (as required), and shall have a 300-volt insulation. If shielding is required by the manufacturer, the cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall tinned-copper cable drain wire, and overall cable insulation. Acceptable Manufacturers: Anixter or Belden. Substitutions require approval prior to installation.

- E. Wiring for 120-Volt Circuits: Division 25 contractor shall extend power to all BMS control equipment and devices from the nearest junction box. Provide power to all controllers, devices, and instruments which serve HVAC and mechanical equipment fed by power. Wiring for 120-volt circuits shall be 14 AWG or thicker stranded copper and shall be rated for 600-volt service.
- F. Wiring for 24-Volt Power trunks: The Division 25 contractor shall provide power to all ASCs via a power trunk. Division 26 shall provide 120VAC power at junction boxes for BMS use at locations shown on the electrical power drawings. Division 25 Contractor shall extend 120VAC power to local stepdown transformers/power supplies. Division 25 Contractor shall provide stepdown transformers/power supplies and 24 vac power trunks wiring as required to power all ASC. No more than 80 percent of the capacity of any given transformer shall be utilized.
 - 1. It is acceptable to use local step-down transformers at Fan Power Boxes, Fan Coil Units, and other terminal equipment where power is provided.
- G. Primary Level Network Wiring Specification:
 - 1. Provide all cables, switches, and signal repeaters to ensure a fully functional Ethernet network.
 - 2. Design the network to accommodate all of the PSCs, SCs, Ethernet gateways, and workstations/servers provided for the BMS system. The appropriate quantity of switches and signal repeaters shall be provided to meet the network requirements; the locations shall be coordinated with the A/E and other trades. Provide 120 VAC to all network equipment. If any portion of the BMS is on UPS, then all network hardware shall be UPS powered.
 - 3. Interior LAN Copper Cable: Interior Copper LAN cable shall meet or exceed all requirements of Category 6 cable as specified in TIA/CEA-568-B.1. Terminations, patch panels, and other hardware shall meet or exceed Category 6 specifications and shall be as specified in Division 27. Cabling products shall be tested and certified for use at data speeds up to at least 100 Mbps. Other types of media commonly used within IEEE Std 802.3 LANs (e.g., 10Base-T and 10Base-2) shall be used only in cases to interconnect with existing media. Short lengths of media and transceivers may be used in these applications. Provide separately orderable media, taps and connectors.
 - 4. Coordinate: node names, IP addresses, access privileges, and system configuration with the Owner prior to start-up.
 - 5. **Provide** modular 8-pin, Category 6 information outlets at all controllers communicating on the primary level network. The cable shall be terminated inside the field panel at the information outlet. Division 25 contractor to provide a patch cable to connect the field panel to the information outlet.
 - 6. Ethernet cable shall be provided to connect the operator workstation/server to each PSC. The Ethernet network shall meet the following criteria:
 - a. Do not exceed 328 feet 100 meters from the PSC to the nearest hub, router, switch, or signal repeater. This shall include the length of the patch cable between the information outlet and the PSC.
 - b. All new Ethernet networks shall be a minimum of Category 6 certified 1Mb Base-T Ethernet cable, for future expansion.
 - c. Use plenum-certified Ethernet cable when run through a plenum.
 - d. Ethernet cable shall only be buried in an insulated electrical tunnel. Ethernet wiring is not certified for direct burial.
- H. Secondary Level Control Network:
 - 1. Provide all wires, and network equipment to ensure a fully functional secondary network.

2. All cable characteristics and wiring lengths shall conform to the manufacturer's cable and wiring specifications.

3.4 EQUIPMENT TAGS

- A. Tags shall be keyed to the unique identifiers shown on the contractor's as-built drawings. All enclosures and DDC Hardware shall be labeled. All sensors and devices not located in finished office spaces shall be provided with plastic tags. All sensors and devices located in finished office spaces shall be provided with "Brady" marker, indicating the unique identifier only. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Duct static pressure taps shall be tagged at the location of the pressure tap. Tags shall be plastic and shall be mechanically attached directly to each device or attached by a stainless steel chain or wire.
- B. Device and sensor tags shall display the following information: the unique identifier, 16-character device description, PSC / ASC No. which device is controlled from. Device descriptions shall be consistent across HVAC and mechanical equipment.
- C. Tags shall be a minimum of 1 by 3 inches with minimum 0.25 inches high engraved block lettering. Laminated plastic shall be 0.125 inches thick, **black with white letters**.
- D. Tags external to protective enclosures shall be engraved plastic and mechanically attached to the enclosure or DDC Hardware.
- E. Tags inside protective enclosures may be attached using adhesive.
- F. Tags provided for low pressure gauges provided in spaces for locally monitoring room differential pressure may be attached using adhesive. Coordinate tag location with Owner prior to installation.
- G. Provide labels for all information outlets provided by the contractor. The label shall indicate the IP address of each port.
- H. All tags shall be attached to the device in a conspicuous location.
- I. All identification tagging shall be consistent and correlate across system details, drawings, points list, and sequence of operations.

3.5 CONTROLLER INTEGRATION TO EXISTING BMS NETWORK

- A. Confirm there are no duplicate software point names between the existing BMS and new BMS. Confirm no node names or addresses are duplicated. Confirm that the existing BMS is 100 percent compatible with the new BMS. Take corrective action to resolve all potential problems with the integration process prior to physically connecting the two systems together.
- B. Once the new BMS is commissioned, the contractor shall assist the Owner's representative to make the physical connection to the existing network.
- C. Once the tie-in is complete, confirm communication with the existing server.
- D. Upload all data to the existing server. Preferably upload one controller at a time until all controller information is uploaded to the existing server.
- E. Verify there were no anomalies created during the integration process and that no new alarms or failed points were created. If so, take corrective action to resolve issues.
- F. Create graphics, trends, alarm definitions and reports as specified herein.

3.6 CONTROLLER TUNING

- A. Tune each controller in a manner consistent with that described in the ASHRAE Fundamentals Handbook. Tuning shall consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop shall be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable shall settle

out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output shall be steady.

3.7 TESTING AND BALANCING SUPPORT

- A. Provide dedicated labor and any necessary physical BMS tool to support and verify work performed by the testing and balancing (TAB) contractor. Provide interface software to the TAB, so that the TAB can access and manipulate the air flow values of all DDC hardware provided for this project.
- B. Provide a trend report, by each AHU/EF system, listing all the supply and exhaust air valve airflows. Include the air valve setpoints and output position signals. Trends shall be provided per area/floor summarizing the airflow quantities to assist the building TAB contractor in determining any duct leakage or the building peak zone static pressure requirements.
- C. Assist TAB contractor to perform system pressure mapping to identify pressure reading used to determine system static setpoints. Assist TAB contractor in adjusting balancing devices in distribution systems to provide uniform static pressure profile. Terminal boxes/valves, etc. will not be allowed to be used as pressure reducing devices.

3.8 VERIFICATION TEST

- A. Perform the following performance verification tests (PVT) for each control system to ensure that the described control system components are installed and functioning per this specification.
- B. Verification test procedures, testing and activities shall be developed and conducted so as not to cause personal injury, damage to components, damage to systems, or damage the building or other property.
- C. General Requirements:
 - 1. Intent of the PVT procedure is to demonstrate that the exact functions of control systems meet requirements outlined by approved shop drawings and written Sequence of Operation.
 - 2. Verify each air handling unit, equipment system, steam, and hydronic system in automatic mode of operation, utilizing actual field devices and final control elements. Tune each control loop to minimize cycling of outputs around setpoint and eliminate overshooting on start-up.
 - 3. Indicate type and cause of failures, as well as required remedial actions, on test report. Requested tests, not outlined herein, will be evaluated for feasibility and impact on schedule and cost prior to implementation.
 - 4. Systems will not be accepted by the Owner or A/E without approval of tests and required remedial action.
 - 5. Provide a schedule to the Owner for execution of the PVT. The Owner shall participate in any or all of the contractor's PVT at the Owner's discretion.
- D. Control System Static Check:
 - 1. Prior to static check of system, identify each SC, PSC, and ASC by description, tag number, and address. Verify proper system communication with these devices, as well as values indicated.
 - 2. Operational static check shall include verification of all field wiring associated with SCs, PSCs, and ASCs. Include continuity testing between wiring from field device (sensor, actuator, or other components) to appropriate block on terminal strip in appropriate enclosure. Verify control loop wiring diagrams and panel wiring diagrams for the following:
 - a. Binary Inputs: Energize each binary input (smoke detector, end switch, control relay, flow switch, differential pressure switch, or other components) in field. Verify at panel.
 - b. Binary Outputs: Manually override each binary output (solenoid valve, motor starter, control relay, or other components) at control panel. Field-verify corresponding final element for proper stroke/status. Release override for each binary output point to allow BMS program control after testing.

- c. Analog Inputs: Compare field reading of each analog input (transmitters, thermistor, or other components) with that displayed on graphic screens, and auxiliary panels.
 - d. Analog Outputs: Manually override each analog output (I/P) to values of 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent. Field-verify corresponding final element (valve or damper) positions from fully closed to open, based upon stated spring range. Release override for each binary output point to allow BMS program control after testing.
- 3. Calibration of Test Instruments:
 - a. Use calibrated test instruments for all point checks as specified herein. The calibration of the test instruments shall be traceable to the National Institute of Standards and Technology (NIST) standards. A static system checkout shall be performed on a BMS instrument if the date of the test instrument calibration is within one year of the date of the check. Recalibrate test instruments annually and submit the NIST traceable instrument reports along with the static system checkout sheets.
- E. Control System Dynamic Check:
 - 1. Operational dynamic check shall include verification that control system, including sensors and actuators, performed as specified while interconnected to the process.
 - 2. Verify proper system communication with controllers and the ability to reset setpoints remotely from operator workstations.
 - 3. Verify the operation of each air handling unit, equipment system, steam, and hydronic systems in automatic.
 - 4. Test: system failures, start-up sequences for air handling units, exhaust fans, heat recovery units, and Hydronic systems. Verify warnings and fail to start logic. Simulate power failure and restart software for controlled equipment and systems.
 - 5. Verify and demonstrate that operator workstation interface graphic screens are displayed consistent with the drawings. Verify the status of each binary and analog value on every graphic screen is consistent with expected color convention and actual field device reading. Use only graphic screens accepted by the A/E and Owner.
 - 6. Test each control loop to verify that it indicates proper percent of scale and correct scaling of engineering units.
 - 7. Verify stability of all control loops. Record and print graphical trends for each control loop to verify loop stability is within specified limits.
- F. Alarms: Test each alarm identified in the contract documents. Verify that control system displays proper indication. Test and verify proper acknowledgement of alarms from operator workstation.
- G. Performance Reports:
 - 1. Provide static system checkout sheets which lists every physical point in the BMS and any integrated third-party communication systems in a tabular format. The list shall include the following fields: unique point identifier, software address, associated PSC or SC, associated room number (where applicable), check column indicating ID tag affixed and information is correct, actual value, initials of person performing verification, and date verification was completed successfully. The actual value is sensed by a testing instrument (for analog points) and visual indication (for binary points).
 - 2. Submit Dynamic Performance Test Sheets indicating operating conditions after detailed dynamic checkout of the systems. The dynamic performance test sheets shall represent the contractor's sequence of operations. Each paragraph shall be tested, upon successful completion of the dynamic test the person performing verification shall initial and date verification test form adjacent to the paragraph tested. Once all of the sequences are tested, the test sheets shall be submitted for record.

3.9 TRAINING

- A. Provide system demonstration and instructions under provisions of Section 01 77 00 – Closeout Procedures.

- B. For each system, demonstrate:
 - 1. Cold start.
 - 2. Sequence of operation.
 - 3. Seasonal control.
- C. Provide complete demonstration of equipment or systems requiring seasonal operation, during operating season. Perform multiple demonstrations when required within six months.
- D. Provide training of at least one full day. Train Owner personnel with functional operations of the same systems installed. **Include software programming.**
- E. Provide additional training on-site, within one year of Owner acceptance of BMS installation. Coordinate scheduling and duration with Owner; training days may not be consecutive.
- F. Provide experienced instructors to teach Owner's personnel operation, adjustment, testing, trouble shooting and maintenance of the system. Include detailed instruction manuals which contain any operations specific to this project.
- G. Video recording demonstrations and instructional sessions: Provide a copy of each video recording to Owner.

3.10 CLEANING

- A. The contractor shall clean up all debris resulting from their activities daily. The contractor shall remove all cartons, containers, crates, etc., under their control as soon as the contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

END OF SECTION

SECTION 25 30 00
BUILDING MANAGEMENT SYSTEM (BMS) - FIELD EQUIPMENT

PART 1 - GENERAL

1.1 APPLICATION OF THIS SECTION

- A. This Section applies to all heating, ventilating, and air conditioning work. Coordinate with applicable Sections as required.
- B. Refer to other Sections in Divisions 25 and 26 for general requirements pertaining to mechanical and electrical work.
- C. Undivided Responsibility: Work of this section shall be included with the work specified in the following Sections:
 - 1. Section 25 10 00 Building Management System (BMS)
 - 2. Section 25 90 00 Building Management System (BMS) – Sequence of Operation.

1.2 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Building Management System (BMS) - Field Equipment, as indicated, in accordance with provisions of Contract Documents.
- B. Section Includes:
 - 1. Instruments, sensors, control valves, and actuators.
 - 2. Panels and accessories.

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Furnish control valves, sensor wells, flow meters, and gauge taps to Division 23 for installation.
- B. Furnish duct-mounted airflow stations to Division 23 for installation.

1.4 SUBMITTALS

- A. Refer to Section 01 33 00 and Section 25 10 00.

1.5 MAINTENANCE SERVICE

- A. Refer to Section 25 10 00.

PART 2 - PRODUCTS

2.1 ELECTRONIC SENSORS AND TRANSMITTERS

- A. Temperature Elements and Transmitters (Standard Accuracy):
 - 1. Basis of Design Manufacturers:
 - a. Johnson Controls, Inc. (Web-based Metasys)
 - b. Honeywell, Inc. ComfortPoint Open BMS)
 - c. Substitutions are not permitted.
 - 2. Acceptable Devices:
 - a. 1000 Ohm Platinum RTD Type.
 - b. 100 Ohm RTD Type with 4-20mA Transmitter.
 - 3. RTD Element Accuracy: Plus/minus 0.1 deg F.
 - 4. Total Assembly Accuracy (Element and Transmitter): Plus/minus 1.2 deg F.
 - 5. Stability: plus/minus 0.15 percent deg C/YR.
 - 6. Element Housing: 304 stainless steel sheath. Element shall be fully potted to prevent moisture infiltration.

7. Select elements and transmitters which result in design operating temperatures located in mid-span of its range.
 8. Mounting Arrangements:
 - a. Room Temperature sensors shall be mounted on backplate, dimensions of sensor shall not exceed 5 by 3 by 2 inches (Height, Width, Depth). Sensor housing shall be white and made of durable plastic. Room temperature sensors shall have the following additional requirements Combination Temperature, Humidity and Carbon Dioxide Sensors are acceptable:
 - 1) Temperature sensors shall be fully compatible with terminal equipment controllers and provided with display, setpoint adjustment, occupancy override, and communication port as indicated on contract documents and sequence of operation.
 - b. Pipe mounted elements shall be insertion type into standard Thermowell. Provide brass thermowell for non-corrosive liquids and temperatures below 250 deg F. For steam/corrosive fluids and temperatures greater than 250 deg F, use 304 Stainless Steel. Thermowells shall be filled with conductive gel. Strap-on type sensors are not permitted.
 - c. Single Point duct-mounted elements shall be selected so probe lengths locate probe at center of duct. Include probe mounting flanges. Include stand-off brackets where ducts are insulated.
 - d. Bendable averaging sensor shall be of sufficient length as follows:
 - 1) Minimum of 12 inches in length for each 2 square feet of duct area where velocity is less than 1000 fpm.
 - 2) Minimum of 12 inches in length for each 4 square feet of duct area where velocity is greater than 1000 fpm.
 - 3) Custom lengths may be required where there are multiple, staggered coils. Coordinate with approved AHU shop drawings for coil information.
- B. Temperature Elements & Transmitters, Duct-Mounted (High Accuracy)
1. Basis of Design Manufacturers:
 - a. Moore Industries. Model TRY or TDY.
 - b. Or Equal.
 2. 1000 Ohm RTD Type with 4-20mA Transmitter.
 3. Digital Accuracy: Plus or minus 0.014 deg C.
 4. High accuracy temperature system calibration with NIST test data report.
 5. Stability: Plus/minus 0.1 percent of reading or 0.1 deg C, whichever is greater for 24 months.
 6. Supply Voltage: 12-24 VDC.
 7. Element Housing: 304 stainless steel sheath. Element shall be fully potted to prevent moisture infiltration.
 8. Select elements which result in design operating temperatures located in mid-span of its range. Transmitter shall be paired to the RTD sensor. Sensor and transmitter shall be trimmed to respond to two data points within a selected zero and span measurement range.
 9. Duct mounted elements shall be selected so probe lengths locate probe at center of duct. Include probe mounting flanges. Include stand-off brackets where ducts are insulated.
- C. Temperature Elements & Transmitters, Wall-Mounted (High Accuracy)
1. Basis of Design Manufacturer:
 - a. Moore Industries. Model number TRY.
 - b. Or Equal.
 2. 1000 Ohm RTD Type with 4-20mA Transmitter.
 3. Input Accuracy: Plus or minus 0.5 deg C.

4. High accuracy temperature system calibration with NIST test data report.
 5. Stability: Plus/minus 0.12 percent of reading for 12 months.
 6. Supply Voltage: 12-24 VDC.
 7. Select elements which result in design operating temperatures located in mid-span of its range. Transmitter shall be paired to the RTD sensor. Sensor and transmitter shall be trimmed to respond to two data points within a selected zero and span measurement range.
- D. Hydronic Temperature Elements & Transmitters, Pipe-Mounted (High Accuracy)
1. Basis of Design Manufacturers:
 - a. Moore Industries: Model TRY or TDY.
 - b. Or Equal.
 2. 1000 Ohm RTD Type with 4-20mA Transmitter.
 3. Digital Accuracy: Plus or minus 0.1 deg C.
 4. D/A Accuracy: Plus or minus 0.02 percent of span.
 5. High accuracy temperature system calibration with NIST test data report.
 6. Stability: Plus/minus 0.1 percent of reading or 0.1 deg C, whichever is greater for 24 months.
 7. Supply Voltage: 12-24 VDC.
 8. Element Housing: 304 stainless steel sheath. Element shall be fully potted to prevent moisture infiltration.
 9. Select elements which result in design operating temperatures located in mid-span of its range.
 10. Pipe mounted elements shall be insertion type into standard Thermowell. Provide brass Thermowell for non-corrosive liquids and temperatures below 121 deg C. Thermowells shall be filled with conductive gel. Strap-on type sensors are not permitted.
- E. Duct Mounted Relative Humidity Transmitters:
1. Basis of Design Manufacturers:
 - a. Vaisala – HMD60.
 - b. Or Equal.
 2. Duct mounted sensors shall be installed a minimum of 5 feet downstream of calculated humidifier vapor trail.
 3. Provide 2-wire loop powered transmitter to measure relative humidity with a hygrometer capacitive sensor, or bulk polymer sensor.
 4. Measurement Range: 0-100 percent RH.
 5. Output: 4-20 mA linear to stated measurement range.
 6. Accuracy (including linearity and repeatability at 77 deg F): Plus/minus 2.0 percent of span 0 to 90 percent RH).
 7. Power Requirement: 8-35 VDC or 20 mA.
 8. Stability: Within 1 percent RH per year.
 9. Accessories: Duct-mounting plate, quick mount duct flange adapter, sensor dust filter, and single point calibrator for on-line/on-site calibration.
 10. Provide other accessories as required to protect sensors for up to 2500 fpm velocities.
- F. Wall Mounted Combination Transmitters:
1. Basis of Design Manufacturer:
 - a. Vaisala – HMW90.
 - b. Or Equal.
 2. Factory calibrated, humidity and temperature sensors, duct-mounted, housed within a single enclosure.

3. Measures relative humidity with a hygrometer capacitive sensor, and temperature with a precision platinum RTD. Both temperature and humidity transmitters shall output a linear 4-20 mA DC control signal over calibrated range.
 4. Power Source: Provide 2 wire type for external 8-35 VDC/12 VAC power source.
 5. RH Accuracy: Plus/minus 2 percent RH from 0 to 90 percent RH at 77 deg F (includes linearity and repeatability). Span 0 to 100 percent RH.
 6. Temperature Accuracy: Plus/minus 1 deg F from 20 to 130 deg F.
 7. Provide sensor dust filter, quick mount duct flange adapter, and single point calibrator for on-line, on-site calibration.
 8. Select probe lengths suitable for sensor location at center of duct.
- G. Outdoor Combination Temperature and Humidity Transmitters:
1. Basis of Design Manufacturer:
 - a. Vaisala – HMS110.
 - b. Or Equal.
 2. Factory calibrated, humidity and temperature sensors, outdoor-mounted, housed within a single enclosure.
 3. Measures relative humidity with a hygrometer capacitive sensor, and temperature with a precision platinum RTD. Both temperature and humidity transmitters shall output a linear 4-20 mA DC control signal over the calibrated range.
 4. Power Source: Provide 2 wire type for external 8-35 VDC/12 VAC power source.
 5. RH Accuracy: Plus/minus 2 percent RH from 0 to 90 percent RH at 77 deg F (includes linearity and repeatability). Span 0 to 100 percent RH.
 6. Temperature Accuracy: Plus/minus 1 deg F from 20 to 130 deg F.
 7. Provide sensor dust filter and single point calibrator for on-line, on-site calibration.
 8. Provide with Sunshield for protection against wind, rain, and sun.
 9. Operating Environment:
 - a. Temperature: -40 to 140 deg F.
 - b. Humidity: 0-100 percent RH.
 - c. Maximum Wind Speed: 70 mph.
- H. Differential Pressure Transmitter - Air Media:
1. Basis of Design Manufacturers:
 - a. Setra.
 - b. Veris.
 - c. Ashcroft.
 - d. Or Equal.
 2. Range as required for application. Accuracy not less than plus/minus 0.25 percent full scale. Output signal 4 to 20 mA. Transmitter shall have 1/4 inches barbed pressure connections and separate zero and span adjustment knobs.
 - a. Exception: Where differential pressure sensors are integral to the application specific controller and it is being utilized in a non-critical or office location, accuracy shall not be less than plus/minus 1.0 percent full scale.
 3. Velocity Pressure for Terminal Units: 0 to 1.0 inches WC.
 4. Velocity Pressure for Air Flow Measuring Stations: Refer to Manufacturer's literature for range and ensure it is appropriate for the expected airflow in its intended location.
 5. Space Differential Pressure: plus/minus 0.5 inches WC.
 6. Duct Static Pressure: Bidirectional at plus/minus 5.0 inches WC.
 7. Discharge Static Pressure: Bidirectional at 150 percent of duct classification.
 8. Relief Static Pressure: plus/minus 2.0 inches WC.

9. Filter Monitoring: 0 to 2.5 inches WC.
- I. Carbon Dioxide (CO₂) Sensors:
 1. Basis of Design Manufacturer:
 - a. Vaisala – GMD20 (Duct Mounted)
 - b. Vaisala – GMW90 (Wall Mounted)
 - c. Or Equal.
 2. Sensor shall utilize using non-dispersive infrared (NDIR) sensing technology.
 3. Accuracy: plus/minus 2 percent of calibrated range.
 4. Measurement Range: 0-2000 Parts per million (PPM).
 5. Stability: The sensor shall have a maximum drift of plus/minus 5 percent of range and shall not require calibration for a minimum of 5 years.
 6. Power Supply: 24VAC/DC .
 7. Outputs: 0-10 VDC or 4-20mA, linear output to stated measurement range.
 8. Operating Environment: The sensor shall be rated for operation at ambient air temperatures within the range of 32 to 122 deg F and relative humidity within the range of 0 to 95 percent (non-condensing).
 9. Construction: The sensor chamber shall be manufactured with a non-corrosive material (such as gold-plating) that does not affect carbon dioxide sample concentration.
 10. Mounting Arrangements:
 - a. Duct mounted: Sensors shall be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage.
 - b. Wall Mounted: ABS/PC White enclosure, UL-V0 approved.

2.2 COMMERCIAL QUALITY CONTROL VALVES

- A. Applications:
 1. Isolation Valves – Full Port Ball / Butterfly Valve.
- B. Valve Classification:
 1. The valve classification and mounting flanges shall be consistent with the piping classification for the system at the location where the valve is installed.
 2. Valve bodies shall meet ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure. Unless otherwise specified or shown, valve leakage shall meet FCI 70-2 Class III leakage rating or greater.
- C. General Control Valve Requirements (non-Isolation):
 1. Two (2) inches and Smaller: Threaded -- Ball Valve.
 2. 2-1/2 inches to 6 inches: Flanged -- Ball Valve.
 3. Provide two-way control valves for two-position or modulating service as shown.
 4. All control valves must be sized per the final flow rates listed within the associated "Approved" or "Approved as Noted" equipment submittals, coordinate with Division 23.
- D. Water System Service:
 1. Two-way water valves for temperature control shall have equal percentage characteristics.
 2. Two position applications require a line size valve with negligible pressure drop.
 3. The pressure drop across a full open valve shall be between 3 and 5 psi.
- E. Ball Valve:
 1. Basis of Design Manufacturers:
 - a. Belimo.

- b. Or Equal.
- 2. Two-way valves 1/2 inches to 2 inches: Commercial quality with female NPT threads.
- 3. Service at minimum of 250 psi working pressure rating.
- 4. Internal Construction:
 - a. All ball valves shall have blowout proof stem design, Teflon thrust seal washer and stuffing box ring.

2.3 VALVE OPERATORS

A. General Requirements:

- 1. Actuator shall be 100 percent compatible with the valve to which it is mounted, without the use of custom or retrofit linkages.
- 2. Actuators shall be electric (electronic) or pneumatic as shown.
- 3. All actuators shall be failed open (FO), failed closed (FC) or fail-in-place (FIP) as shown. Failed open and failed closed actuators shall be of mechanical spring return type.
- 4. Electric actuators shall have an electronic cut off or other means to provide burnout protection if stalled.
- 5. Actuators shall have a visible position indicator.

B. Electric Valve Actuators:

- 1. Actuator shall be floating, two position, or modulating, as indicated in the control sequence and on the control diagrams. Fail-safe where specified, shall require either mechanical spring return, or battery backup located near the building automation control panel for ease of maintenance. Battery back-up units within the individual actuators are not acceptable.
- 2. Modulating valves shall respond to a 2-10 VDC or 4-20 mA signal (with the addition of a 500-ohm resistor). There shall be a visual valve position indicator and a limit switch to indicate valve fully open position to the BMS. The actuator shall have the capability of adding auxiliary switches or feedback potentiometers if required. Powering shall be either by 120 VAC, 24 VAC or 24 VDC.
- 3. The actuator shall provide the minimum torque required to close off against the system pressure in all operating modes, with an approximate running time no greater than 2 minutes for full stroke. The actuator shall be designed with current limiting motor protection. End of travel switches are not acceptable. Actuators on commercial valves shall include a release button on the actuator to allow for manual override.
- 4. Valves installed outdoors shall be provided with NEMA 4 or NEMA 3R actuator housings. Provide heaters as required.
- 5. All valves shall have a minimum resolution of 40 to 1.
- 6. All actuators shall be UL listed. Note: Coordinate Flow meter locations with mechanical engineer. Ensure adequate straight pipe requirements, reduced pipe diameters and by-pass valve configurations. Select the following if using pneumatic actuation.

2.4 DAMPER OPERATORS

A. General Requirements:

- 1. Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressure.
- 2. Provide spring return for two position control and for fail safe operation.
- 3. Actuators shall not be mounted in the air stream.
- 4. Provide electrically operated actuators, except where shown on contract documents.
- 5. Damper actuators shall provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque shall be at least 6 inches-LB per 1 square feet of damper area for opposed blade dampers and 9 inches-LB per 1 square feet of damper area for parallel blade dampers.

B. Electronic Damper Actuators:

1. Basis of Design Manufacturer:
 - a. Belimo.
 - b. Johnson Controls.
 - c. Siemens.
 - d. Or Equal.
2. Electric actuators shall have a full stroke response time in both directions of 90 seconds or less at rated load.
3. Where multiple electric actuators operate from a common signal, the actuators shall provide an output signal identical to its input signal to the additional devices.
4. Electric modulating valves shall be positive positioning, responding to a 2-10 VDC or 4-20 mA signal (with the addition of a 500-ohm resistor). Floating control valves are permitted on terminal units only, except as indicated on contract documents.
5. All electric actuators shall be UL listed.
6. Valves installed outdoors shall be provided with NEMA 4 or NEMA 3R actuator housings, provide heaters as required.
7. There shall be a visual valve position indicator and an actuator generated 2-10 VDC valve position output signal for electronic feedback to the control panel.

2.5 SYSTEMS ACCESSORIES

- A. Electric Relays - Field Installed: Form C contacts rated for application with NEMA 1, dust proof enclosure, equipped to limit transients to 150 percent of rated coil voltage. Junction box mounted, pilot duty rated, 10 A SPDT, 10-30 VAC/DC/120 VAC Coil, indicator light.
 1. Basis of Design Manufacturers: Functional Devices, Veris.
- B. Electric Relays - Panel Mounted: Minimum 2 -Form C contacts rated for application with NEMA 1, dust proof enclosure, equipped to limit transients to 150 percent of rated coil voltage. Socket mounted, pilot duty rated, 10 A SPDT, 10-30 VAC/DC/120 VAC Coil, indicator light.
 1. Basis of Design Manufacturer: IDEC.
- C. Power Relay: Minimum SPST NO or NC contacts rated for application with NEMA 1, dust proof enclosure, equipped to limit transients to 150 percent of rated coil voltage. Enclosed, up to 30 Amp @ 240 VAC resistive load or 3 HP @ 480 VAC , 10-30 VAC/DC or 120 VAC Coil, indicator light, push to test button.
 1. Basis of Design Manufacturer: Omron.
- D. Damper Limit Switches: Momentary type, adjustable limit switch for monitoring motion of damper at a prescribed arc of rotation. Switch shall have oil tight contacts that operate by way of a trip lever. Switch shall have a DPDT contact arrangement that exceeds load requirements for voltage and current. Submit installation detail on how trip lever mechanism will be actuated for approval prior to installation. The use of ball bearings or mercury is unacceptable.
 1. Basis of Design Manufacturers: Square D, AROMAT, Allen Bradley, Cutler-Hammer.
- E. Selector Switches: With indicating nameplates. Manual operation, 2 position type with SPDT contacts rated for application.
 1. Basis of Design Manufacturers: Allen-Bradley, Square D, Cutler-Hammer.
- F. Standard Pushbutton Switches: Momentary push or maintained push/pull switch as required by the application/sequence. Switch shall fit into a single gang electrical box complete with cover plate suitable for flush mounting. Provide a plastic tag attached to cover plate identifying intended use of switch. Switch contacts shall be rated for application.
- G. Differential Pressure Switch: The switch shall be a snap-acting type and shall have a user-adjustable set point. Differential pressure switches shall not contain mercury. The set point shall not be in the upper or lower quarters of the range. The over pressure rating shall be a

minimum of 150 percent of the highest design pressure of either input to the sensor. The switch shall have two sets of contacts (DPDT) and each contact shall have a rating greater than its connected load. The pressure switch shall have a repeatability of plus/minus 3.0 percent. Contacts shall open or close upon rise of pressure above the set point or drop of pressure below the set point as shown. Differential pressure switches used for monitoring fan high static pressure and fan low static pressure shall be manual reset type.

1. Basis of Design Manufacturers: Cleveland, Dwyer.

- H. Commercial Current Sensing Relay: Provide for all pumps and small exhaust fans. Provide a solid-state, adjustable, split core, current operated relay. Provide a relay that changes state in response to a change in the load on the associated equipment. Adjust the relay switch point so that the relay responds to motor operation under load as an "ON" state and so that the relay responds to an unloaded running motor as an "OFF" state. A motor with a broken belt is considered an unloaded motor.

1. Basis of Design Manufacturers: Veris, Functional Devices.

- I. Condensate Overflow Switch: Stainless steel housing, float type switch with a single pole single throw (SPST) contact. Provide mounting hardware for installation in a condensate pan.
- J. Pressure Gauges: Gauges shall be suitable for field or panel mounting as required, shall have black legend on white background, and shall have a pointer traveling through a 270 degrees arc. Gauge range shall be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy shall be plus/minus 3 percent of scale range. Gauges shall meet requirements of ASME B40.100. Devices that are served by a 25 psi air supply or less shall have a range of 0-30 psi. Devices that are served by an 80 psi air supply or greater shall have a range of 0-200 psi. Provide gauges on all pneumatic end devices (regardless of whether the device was provided by BMS Contractor or by others), including but not limited to: Damper actuators, valve actuators, solenoid valves, etc.
- K. Differential Pressure Gauges: Gauges for low differential pressure measurements shall be a minimum of 3.5 inches (nominal) size with two sets of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. The gauge shall be bidirectional with zero in the center of the dial. Gauge range shall be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy shall be plus or minus two percent of scale range. Select gauges with set point in midspan of range.

1. Basis of Design Manufacturers: Dwyer, Magnahelic.

2.6 INSTRUMENT TEST PORT

- A. Basis of Design Manufacturer:

1. Ventlock.

a. Or Equal

- B. Provide instrument test ports at every duct mounted sensor which is installed in the ductwork and does not have an access door within 5 feet of the sensor. If several sensors are grouped within a 10 feet length of duct, one test port for that specific group of instruments may be provided.
- C. The test port shall be constructed of metal and have a screw cap. The test port shall extend at least 5/8 inches beyond the insulation so that the screw cap can be fastened properly, and the port can be accessed after the duct is insulated. A flat gasket shall be provided to prevent air leakage between the base of the test port and the duct.
- D. The port shall have an inside diameter no less than 1-1/4 inches.

2.7 CONTROL ENCLOSURES

- A. Enclosures shall meet the following minimum requirements:

1. Outdoors: Enclosures located outdoors shall meet NEMA 4/3R.

2. Other Locations: Enclosures in other locations including but not limited to occupied spaces, above ceilings, and plenum returns shall meet NEMA 12 Type 1 requirements.
- B. Where controllers are not installed in Mechanical spaces or above ceilings, the control equipment shall be installed in flush mounted control enclosures no larger than 20 inches by 20 inches by 6 inches. The enclosures shall be NEMA 12 rated and no deeper than 6 inches. The body and door shall be constructed of a minimum of 14 GA steel, continuously hinged, with common keyed cam lock, and full perimeter door gasket. All wiring and tubing which enters and exits the enclosure shall be concealed. No tubing or conduit shall be exposed.
- C. Contractor is fully responsible for coordinating all panel locations with all other trades and the Government prior to installation.
- D. Provide all necessary heating and cooling to maintain the temperature inside the enclosure to meet the ambient air conditions required by the equipment housed therein.

PART 3 - EXECUTION

3.1 INSTALLATION AND COORDINATION CONTROLS

- A. Provide supervision of installation of all control components to ensure conformity with manufacturer's instructions and reviewed submittals, including components furnished but installed by others. Verify locations to ensure that accurate primary signals will be obtained.
- B. Follow Divisions 22, 23, 25, 26, 27, and 28 for methods and materials.
- C. Refer to Section 25 10 00 for installation requirements.
- D. Provide start-up, calibration, and adjustment of airflow and pressure controls.
- E. Coordinate power all requirements and circuit locations with Division 26 for all 120V and higher power required for all devices provided.

END OF SECTION

SECTION 25 90 00
BMS SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 APPLICATION OF THIS SECTION

- A. This Section applies to all heating, ventilating, and air conditioning work. Coordinate with applicable Sections as required.
- B. Refer to other Sections in Division 22, 23, 26, 27 and 28 for general requirements pertaining to Plumbing, Mechanical, Electrical, Telecom, and Fire Alarm work.
- C. Undivided Responsibility: Work of this Section shall be included with the work specified in the following Sections:
 - 1. Section 25 10 00 - Building Management System (BMS)
 - 2. Section 25 30 00 - Building Management System (BMS) – Field Equipment.

1.2 GENERAL REQUIREMENTS

- A. All timing devices, alarm setpoints and control setpoints shall be adjustable. Setpoints listed herein for duct/zone static pressure control, differential pressure control for discharge/intake isolation dampers, outside airflow control, return fan airflow tracking volume, and static pressure safeties are initial starting values.
- B. All actuator devices on major mechanical systems (AHU, EF, hydronic systems, etc.) shall be electrically operated, including all control valves and dampers. All actuator devices on terminal units shall be electrically actuated. Refer to control drawings and to Section 25 30 00 for actuator requirements.
- C. Provide software alarm points as follows:
 - 1. Digital points: Alarm upon change of state from normal condition.
 - 2. Analog points: Alarm upon a high or low value based on a deviation from setpoint as follows, unless otherwise noted:
 - a. Temperature: Plus/minus 2 deg F.
 - b. Duct Pressure: Plus/minus 0.75 inches WC.
 - c. Room Pressure: Plus/minus 0.04 inches WC, after a 15 seconds time delay.
 - d. Duct Humidity: Plus/minus 10 percent RH.
 - e. Room Humidity:
 - 1) Below 35percent RH or greater than 65percent RH for rooms without trim humidification.
 - 2) Plus/minus 10percent RH for rooms with trim humidification.
 - f. AHU Discharge Humidity: Alarm humidity at setpoint indicated in the sequence of operations for the respective AHU. Humidity alarms shall be suppressed in the event the outside air dewpoint is greater than 53deg F.
 - 3. All software alarms shall have a sliding deviation window which is directly linked to the setpoint, such that changing the setpoint shall automatically change the high and low alarm setpoints with the original deviation limits without operator intervention, unless the deviation band is required to be adjusted.
 - 4. All alarm points shall have a time delay adjustment from 0-300 seconds.
- D. The BMS shall minimize the use of interposing relays. If the BMS contractor determines there is a need to use interposing relays, the contractor shall clearly document where the proposed relays shall be used on the shop drawings.

- E. There shall be a software point displayed at the operator workstation for each air handler and exhaust fan to indicate if the specific system is enabled or disabled. The operator shall be able to manually override the "system enable" from the operator workstation to shut down the systems for maintenance. Only operators with the proper authorization shall be allowed to shut down systems.
- F. There shall be a software point displayed at the operator workstation for each hydronic system to indicate if the specific system is enabled or disabled. The operator shall be able to manually override the "system enable" from the operator workstation to shut down either system. Only operators with the proper authorization shall be allowed to shut down systems.
- G. The BMS shall monitor a general fan status for all fans. For instances of a fan wall array, provide fan status that indicates if any fan is not operating. In the event that any fan status does not coincide with the commanded state of the fan after a 30second delay, an alarm shall be annunciated by the BMS.
- H. The BMS shall monitor the run status of each VFD though a current switch. The enable/disable and speed signals shall be directly wired to the BMS controller associated with the fan or pump. The following conditions shall annunciate an alarm on the BMS:
 - 1. The fan or pump status does not coincide with the commanded state of the VFD after a 30 second delay.
 - 2. The drive indicates a VFD drive fault alarm.
- I. Hand-Off-Auto selector switch shall be provided at each VFD. The BMS shall monitor the switch and shall provide an operator alarm when the fan or pump is out of the "Auto" position.
- J. For systems where multiple fans are operating in unison with belt drives, an alarm shall be annunciated by the BMS in the event the run amps of any one operating fan is 20 percent greater or less than any other operating fan. The alarm shall be enabled 15minutes after the fans have proven "ON."
 - 1. Note: This alarm shall indicate belt slippage.
- K. No control loops shall be controlled over the communication network.
- L. At a minimum, the BMS shall monitor and control all I/O points shown on the contract drawings AND required to accomplish the sequence of operations specified herein.
- M. Provide all coordination with Division 28 necessary to ensure that interaction with the Fire Alarm or Hazardous Alarm systems are fully functional and operate in accordance with the sequence of operations specified herein and in Division 28.
- N. BMS contractor shall provide all required field installed devices as shown on contract drawings and required to meet sequences of operation described herein, unless otherwise indicated.
- O. All timing devices, alarm set points and control set points shall be adjustable. Set points listed herein for are initial starting values.

1.3 SUBMITTALS

- A. Submittal requirements for this Section are specified in Section 25 10 00 - Building Management System (BMS).

PART 2 - PRODUCTS

2.1 CONTROLLER HARDWARE & SOFTWARE

- A. Refer to Section 25 10 00.

2.2 EQUIPMENT

- A. Refer to Section 25 30 00.

2.3 DATA CONTROL (D/C) AND GRAPHICS

- A. Provide all programming required to accomplish the sequence of operations, including all data and control points not listed on input/output point summary shown on plans.
- B. In addition to graphics of building systems with dynamic data points as noted in the following data and control and graphic summary, and graphics required under digital system management sections, the following additional graphics shall be provided:
 - 1. Building layouts (floor plans).
 - 2. Any other graphics necessary for logical penetration.
 - 3. Sequence of operation (window split screen view).
 - 4. Supervisor graphics.
 - 5. System configuration.
 - 6. Display all heat pump locations on building floor plans. This applies only to equipment specified with DDC control.
 - 7. Display heat recovery unit locations and configuration (Functional Control Diagram, DDC Logic Diagram and control sequence).
 - 8. Functional Control Diagram of heat recovery systems for new building showing variable speed pumps and locations of differential pressure switches and display all points indicated on Functional Control Diagrams and I/O summary.
 - 9. Display all DDC sensors, thermostats, and humidistats on the floor plan corresponding to the heat pump or other controlled device locations.
 - 10. Display all DDC panels, indexed to correspond with system configuration.
- C. Each analog point to have unique remote, panel-resident dual high and dual low limit alarm threshold engineering units. Where specified, provide floating (band above and below setpoint) alarm limits.
- D. Each digital output to have software-associated monitored input. Anytime monitored input does not track its associated command output within programmable time interval, "command failed" alarm shall be reported.
- E. Where calculated points (such as CFM) are shown, they shall appear in their respective logical groups. Respective unconditioned raw data (such as logarithmic differential pressure) points to also be grouped in special group for display and observation independent of logical groups.
- F. Where data or control points are required to accomplish digital control or energy management sequences specified but not listed on Functional Control Diagrams or in I/O summary, installer shall provide the points necessary to accomplish the specified sequence.
- G. Primary analog input and analog output of each DDC loop to be resident in single remote panel containing DDC algorithm and function independent of any peer or multiplexing (MUX) communication links. Secondary (reset type) analog inputs may be received from the peer network, but approved default values and/or procedures shall be substituted in DDC algorithm for this secondary input in network communications fail or if secondary input becomes erroneous or invalid.

PART 3 - EXECUTION

3.1 OCCUPANCY SCHEDULE SEQUENCE OF OPERATION

- A. General:
 - 1. Occupancy schedules shall be defined and generated by the building facilities group for all heat pump zones. Each heat pump zone shall have a designated Occupied mode, Based on time-of-day. Outside Occupied mode, zone shall be allowed to setback or revert to Occupied mode as described in specific sequences of operation.
 - 2. Each zone shall be maintained within their specified Occupied and Unoccupied setpoints, as indicated on the mechanical schedules. During Occupied periods, zones may be reset to

“Standby” in the event no motion has been detected for a set period. Confirm schedule with Owner and zones that are permitted to be reset during Occupied hours.

3. Each individual heat pump zone shall be able to be grouped into larger zones. For example, the heat pumps on Second Floor could be grouped into a larger group, which can have the same occupancy schedule.
4. Refer to specific sequence of operation for additional Occupancy control requirements.

3.2 ERV-1 AND DH-01 SEQUENCE OF OPERATION

- A. Basic Operations (ERU-01 and DH-01). Programming for the ERU controllers shall accomplish the following sequences. At time of shop drawing submittal provide manufacturers recommended sequences to compare with the sequences below:
 1. An airflow measuring station (provided by temperature control contractor) on the outside air ductwork for the ERU to verify minimum ventilation airflow rate is maintained during occupied hours.
 2. Coordinate air flow setpoint with the balancing contractor.
 3. ERU fans can run in a manual operation, and in an automatic mode thru the BAS.
 4. The intake hood and exhaust hood dampers shall be provided on inlet and outlet of the hoods. These dampers shall be closed if the ERU is commanded off, open if the ERU is on.
- B. Safety Controls:
 1. Provide low limit thermostat with manual reset downstream of DH-01. When the low limit thermostat senses a temperature less than adjustable 38 deg F, the supply and exhaust fans shall stop.
 2. Provide external end switch on the supply and exhaust dampers which isolate the ERU air handling unit. The supply and exhaust fans shall not be allowed to start unless the isolation dampers are proven open by the end switches.
 3. Provide exhaust fan suction pressure switch with manual reset to shut down the exhaust fans if the exhaust fan discharge static pressure exceeds switch setpoint.
 4. Upon activation of duct smoke detector in the fire alarm system, a signal for the supply and exhaust fans shall stop via fire alarm relays.
 5. The supply and exhaust isolation damper end switches, supply fan discharge pressure switch, exhaust fan suction pressure switch, fire alarm relays and the low limit thermostat shall be wired directly to the supply and exhaust fans, independent of the BAS to allow the supply and exhaust fans to shut down.
 6. Provide differential pressure switches across each individual filter bank to alarm BAS when loaded.
- C. Supply and Exhaust Fan Control:
 1. If safety controls are normal and all isolation dampers are proved opened, via the damper end switches, the ECMs for the supply and exhaust fans shall be enabled by the BAS and shall run continuously.
 2. The ERV supply fan shall maintain the design ventilation airflow set point (as indicated on the mechanical schedules) higher than the exhaust CFM. Setting shall be coordinated with balancing provider. For multiple supply fans, the fans shall operate in unison.
 3. If at any point the airflow monitoring station is reading +/- 10% compared to the design ventilation set point for greater than 15 minutes an alarm shall be generated at the BAS.
 4. Locate supply duct static pressure sensor in the ductwork downstream of the unit.
 5. The ECMs shall vary the speed of the exhaust fan motors as required to maintain adjustable exhaust airflow as measured by the inlet static pressure. Refer to the mechanical schedule for its design airflow. Setting shall be coordinated with balancing provider. For multiple exhaust fans, the fans shall operate in unison. Proper exhaust is provided when the exhaust fans maintain the desired setpoint.
- D. Occupied Operation:

1. ERU supply fan shall be enabled to operate continuously and to supply at the design airflow.
2. ERU exhaust fan shall be enabled to operate continuously and to exhaust at the design airflow exhaust duct setpoint.
3. The outside air damper and exhaust damper shall open during occupied periods.
4. Each ERU shall have an individual occupied schedule and does not need to operate when the associated heat pumps are in operation. This will allow the ERU to be off during the hours that the heat pumps may cycle on to maintain unoccupied set points. Coordinate this with building maintenance staff, since the ERU may be scheduled off at night.

E. Unoccupied Operation:

1. ERU supply and exhaust fan shall shut off. The outside air damper and exhaust damper shall close during unoccupied periods for ERU supply and exhaust fan shut down.

F. Frost Protection:

1. When outside air temperature is below 35 deg F, the supply fan shall not start until the exhaust fan has operated for an adjustable 5 minutes.
2. A factory-installed frost protection system shall be enabled when exhaust air temperature falls below adjustable 35 deg F. This frost protection system will enable the preheat electric heating DH-01 to prevent frost.

G. An alarm shall activate if exhaust air temperature falls below 32 DEG F.

H. The cooling/heating system for the ERV-01 shall maintain a discharge temperature of approximately 55 to 65 deg F (adj). 55 deg F for summer and 65 deg F for winter.

3.3 IF A SPACE HUMIDITY SENSOR ON FIRST AND SECOND FLOOR (SEE PLANS FOR LOCATIONS) SHOWS THAT IT IS ABOVE 60% RELATIVE HUMIDITY (DURING OCCUPIED MODE OF OPERATION), OPERATE THE COOLING SYSTEM IN FULL COOLING MODE. PROVIDE AND ALARM ON THIS SPACE HUMIDITY

3.4 TYPICAL HEAT PUMP SEQUENCE OF OPERATION

A. General:

1. Provide a single application specific controller for each heat pump. This controller shall provide multiple monitored points for owner selection of points to include on the heat pump graphic page. Provide a list of available monitored points in the first shop drawing submittal. Owner/engineer will select the points to include on the graphics page.
2. BMCS shall automatically control the heating and cooling mode of the associated heat pump based on input from the space temperature sensor. System shall be programmable with the ability to schedule ventilation, night set back temperatures, and occupied/unoccupied temperatures.
3. Heat pump units shall be enabled and disabled via the BMCS.
4. The BMS shall monitor the supply fan status, via single current switch. In the event the fan status does not match the commanded state after a 45-second delay, an alarm shall be annunciated at the BMS.
5. The control system shall report all heat pump alarms to the DDC workstation.
6. Operation:
 - a. The heat pump unit (HP-##) is scheduled for automatic operation based on:
 - 1) Occupied mode.
 - 2) Unoccupied mode.
 - a) Night set back mode.
 - (1) Warm up mode.
 - (2) Cool down mode.
 - 3) Safety modes.

- b. All suggested set points, settings, and times are to be adjustable and coordinated with the owner.
 - c. BMCS shall receive an error signal indicating any fault.
- 7. Occupied mode operation:
 - a. Occupied mode of operation is determined by time-of-day schedule as determined by the contract documents.
 - b. Supply fan shall energize.
 - c. Cycle compressor as required to maintain space sensor heating setpoint of 70 deg. F (adj.) or cooling setpoint of 72 deg. F (adj.).
 - d. Control valve shall be proven open before the compressor is allowed to run.
- 8. Unoccupied mode operation:
 - a. Unoccupied mode of operation is determined by time-of-day schedule as determined by the contract documents.
 - b. Supply fan shall de-energize.
 - c. Control valve shall close.
 - d. The space set point shall be 78 deg. F (adj.) in cooling and 60 deg. F (adj.) in heating.
 - e. Night heating is available when the space temperature drops below 60 deg. F (adj.). Night cooling is available when the space temperature is above 78 deg. F (adj.).
 - f. Warm up operation:
 - 1) 1 hour before scheduled occupancy as determined by time-of-day schedule, unit will heat the space to meet the occupied temperature setting of 70 deg. F (adj.).
 - g. Cool down operation:
 - 1) 1 hour before scheduled occupancy as determined by time-of-day schedule, unit will cool the space to meet the occupied temperature setting of 72 deg. F (adj.).
- 9. Fire Alarm Shutdown: For HP-100 and HP-101, upon activation of duct smoke detector in the fire alarm system a signal for the supply fan shall stop via fire alarm relay. Coordinate an interlock or relay to provide a shutdown connection as needed.

3.5 TYPICAL HEAT PUMP LOOP PUMP P-01 AND P-02 SEQUENCE OF OPERATION

A. General:

- 1. Adjustable frequency drive (AFD) for lead pump shall be enabled by the BMCS and shall run continuously. If one of the lead pumps fails to operate, AFD for lag pump shall start. Lead pump shall be alternated to ensure equal run time of pumps.
- 2. The speed of the pump shall be varied as required to satisfy differential pressure sensor. The sensor shall be located on the heat pump loop as indicated on drawings. System shall use low select logic.
- 3. The BMS shall monitor the pump status, via single current switch. In the event the pump status does not match the commanded state after a 45-second delay, an alarm shall be annunciated at the BMS.
- 4. Geothermal borefield incoming temperature shall be monitored.
- 5. Main heat pump water supply temperature after the boiler connection shall be monitored.
- 6. Main heat pump water return temperature leaving the building to the borefield shall be monitored.

3.6 BOILER HEATING HOT WATER SYSTEM SEQUENCE OF OPERATION FOR B-01 AND P-03

A. General:

- 1. Refer to Contract drawings for diagram of this system.
- 2. The boiler system shall operate only as needed.
- 3. The boiler system shall consist of electric boiler, hot water pump and heating hot water sensor in the heat pump loop supply to the building.

4. The boiler and heating hot water pump shall be powered from normal power. The BMS controls shall be powered from normal power.
 5. The heating hot water pump shall be provided with on/off controls.
 6. BMS contractor shall provide all required field installed devices as shown on contract drawings unless otherwise indicated.
 7. One dedicated PSC controller shall be provided for the control of the boiler heating hot system. The use of an Application Specific Controller (ASC) is unacceptable.
 8. There shall be a software point displayed at the operator workstation for the boiler heating hot water system labeled "Boiler Heating Water System enable/disable". The operator shall be able to manually command the point which enables and disables the boiler heating hot water system. Only operators with proper authorization shall be able to enable/disable the system.
- B. System Start-up:
1. The boiler heating hot water system shall be enabled to start by manual command from operator at workstation.
 2. Upon start-up of the boiler heating hot water system, the following sequence shall occur:
 - a. Upon boiler circulation pump running via current switch, the boiler system shall be started.
- C. Normal Mode:
1. Boiler Operation:
 - a. The BMS shall monitor the heat pump loop water system supply temperature. If the loop temperature is below 45 deg F (adj) for 15 minutes, the boiler and pump will be cycled on to operate at full capacity until the loop temperature rises back up to 47 deg F.
 - b. Short Cycle Timer: To prevent boiler short cycling, once the boiler is started it must run for a minimum of 30 minutes and once the boiler is stopped it must remain off for a minimum of 10 minutes.
- D. System Off Mode:
1. The boiler system shall shut off as defined above.
 2. Upon shut down of the boiler heating hot water system, the following sequence shall occur:
 - a. All control loops and alarms shall be disabled.
 - b. The BMS shall disable the boiler.
 - c. The boiler circulation pump shall be stopped.
- E. System Safeties:
1. Boiler loss of flow : On a loss of boiler water flow, as sensed by hardwired interlocks, boiler shall shut down. An alarm shall be annunciated at the BMS.
 2. Boiler proof-of-run failure: Boiler failure shall be monitored on boiler control panel. If a boiler failure is detected, an alarm shall be annunciated at the BMS, and boiler shall be locked out until operator manually restarts boiler via software interlock.
- F. System Monitoring:
1. The BMS shall monitor the pump status, via current switch. In the event the pump status does not match the commanded state after a 45-second delay, an alarm shall be annunciated at the BMS.
 2. BMS shall monitor the heating water system supply and return water temperatures.

3.7 ELEVATOR AND TELECOM ROOM MINISPLIT SYSTEMS

- A. Minisplit system has its own control. Install and wire these controls as needed.
- B. Provide a BMS space sensor to monitor and alarm if above setpoint of 80 deg F (adj).

3.8 TRANSFER FANS

- A. Transfer fan shall cycle based on the room temperature of 75 DEGF (adj.). If the space temperature is above its setpoint then the transfer fan shall run. If the space temperature is below its setpoint then the transfer fan shall stop.
- B. The fan is equipped with a manual speed controller that should be adjusted by the air balancer.
- C. Alarms:
 - 1. The BMS shall alarm if the fan does not prove running, as sensed by its current switch, within 30 seconds of being commanded to run.
 - 2. If the space temperature is above 80 deg F (adjustable), then the BMS shall alarm.

3.9 ELECTRIC CABINET UNIT HEATERS

- A. Each heater has its own unit mounted thermostat.
- B. Provide a flat plate DDC sensor at the following locations:
 - 1. Vestibule 102
 - 2. Vestibule 103
 - 3. Vestibule 110
 - 4. Both Stairs at the Lower Level
 - 5. Soffit/Plenum served by CUH-108
- C. Provide an alarm at the main panel if the temperature in any of these locations drops below 45 deg F (adj.) for a period of 10 minutes (adj.)

3.10 PROVIDE GRAPHICS FOR ALL OF THESE SYSTEMS

- A. A separate graphic shall be provided for each heat pump.
- B. Provide an overall plan showing all of the heat pump zones and the temperature at the zone. The operator shall then be able to look at each heat pump individually.

3.11 I/O POINTS LIST (ALL POINTS SHALL BE SHOWN ON GRAPHICS) TEMPERATURE CONTROL CONTRACTOR SHALL PROVIDE ALL POINTS AS NEEDED TO MEET THE SEQUENCES OF OPERATION. THIS LIST IS SENSORS THAT ARE NEEDED FOR GRAPHICAL PURPOSES IN ADDITION TO THE SEQUENCE REQUIREMENTS.

Provide points below from Packaged Controllers and DDC System as needed.

Point	DI	DO	AI		AO	ADJ	Alarm
Geothermal Loop, Pumps & Boiler Heating System							
Geothermal System Enable		X				X	
Geothermal System Status (Flow Switch)	X						
Boiler Heating System Enable		X				X	
Boiler Heating System Status	X						X
Geothermal Low Water Temperature Setpoint		X				X	
System Water Return Temperature from Borefield			X				X
System Water Supply Temperature To Borefield							
Boiler Hot Water Supply Temperature after Boiler			X				
System Water Supply Temperature after Boiler			X				X
Geothermal Pump Enable (Typ 2)		X				X	
Geothermal Pump Status (Typ 2)	X						X
Geothermal Pump VFD (Typ 2)					X	X	X
Geothermal System Differential Pressure Setpoint		X				X	
Geothermal System Differential Pressure			X				X
Boiler Pump Enable		X					
Boiler Pump Status	X						X
Outside Air Temperature			X				
Outside Air Humidity			X				
Heat Pump Unit (Typ)							
Occupied and Unoccupied Schedule (Each)						X	
Occupied Temp Setpoints (Heat and Cool each)					X		X
Unoccupied Temp Setpoints (Heat and Cool each)					X		X
Room Temperature			X				X
Return Water Temperature From HP Controller					X		X
Heat or Cool Mode From HP Controller	X						
Compressor Status From HP Controller	X						
Fan Status From HP Controller	X						
Discharge Air Temperature			X				
Isolation Control Valve		X					
Supply Duct Smoke Detector		X					

Point	DI	DO	AI		AO	ADJ	Alarm
ERV Air Handling System ERV-1							
Supply Duct Smoke Detector		X					X
Supply Fan Start/Stop		X				X	X
Supply Fan Status	X						X
Supply Fan ECM Motor Modulation					X	X	X
Outside Airflow From AFMS-1			X			X	X
Filter Differential Pressure Setpoint (Typ)	X						
Filter Differential Pressure (Typ)			X				X
Building Pressure Setpoint					X	X	
Building Pressure			X				X
Outside Air Damper at Hood (End Switch)	X						X
Exhaust Air Damper at Hood (End Switch)	X						X
Outside Air Temperature Before Duct Heater			X				
Outside Air Temperature After Duct Heater			X				X
Exhaust Air Temperature Leaving ERV HX			X				
Exhaust Air Temperature Leaving Through Hood			X				
Preheat Coil DH-1 Modulation					X		
Discharge Air Temperature Setpoint					X	X	
Discharge Air Temperature			X				X
DX Coil Compressor Stages (Heating or Cooling)					X	X	
DX Compressor Status	X						X
ERV Electric Heating (SCR)					X	X	
CO2 Sensor in Exhaust Air Before ERV			X				X
Exhaust Fan Start/Stop		X				X	X
Exhaust Fan Status	X						X
Exhaust Fan ECM Modulation (Building Pressure)					X	X	X
Humidity on Level 01			X				X
Humidity on Level 02			X				X
Electric Unit Heaters							
Space Temperature in the Entry Plenum			X				X
Space Sensors in Vestibules and Stairs (See Plans)			X				X
Mini-Split Units (Typ 2)							
Space Temperature			X				X

Point	DI	DO	AI		AO	ADJ	Alarm
Transfer Fans							
Space Temperature			X				X
Fan Enable/Disable		X					
Fan Status	X						

END OF SECTION



DIVISION 26

ELECTRICAL



SECTION 26 00 10
ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Electrical General Requirements, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.
- C. Drawing Use and Interpretation:
 - 1. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except:
 - a. Specific installation details.
 - b. When specific dimensions are indicated for electrical equipment, it is intended that these be limiting dimensions. When proposed equipment exceeds these limiting dimensions, notify Architect. Features and functions of specified equipment shall not be superseded by these limiting dimensions.
 - 2. For exact locations of building elements, refer to dimensioned architectural/structural drawings.
 - 3. Field measurements take precedence over dimensioned drawings.
 - 4. Intention is to indicate size, capacity, approximate location, direction, and general relationship of one work phase to another, but not exact detail or arrangement.
- D. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination drawings.
 - 1. No exceptions shall be made for submitted equipment that does not meet the physical dimension requirements of the originally specified equipment.
- E. Concrete Anchoring:
 - 1. Cracked concrete is the baseline condition for the design of cast-in-place and post-installed anchors in alignment with both ACI 318 and International Building Code.

1.2 SYSTEM DESCRIPTION

- A. Provide materials to provide systems in compliance with performance requirements specified.
- B. Provide modifications required by reviewed shop drawings and field coordinated drawings.
- C. Electrical equipment associated with mechanical and plumbing equipment connections including, but not limited to, overcurrent protection, feeder sizes, motor controller and disconnect sizes, shall be coordinated with approved mechanical and plumbing shop drawings. Any revisions to electrical equipment as a result of approved mechanical and plumbing shop drawings shall be the responsibility of the Contractor. HDR shall not be responsible for issuing changes to drawings or specifications associated with these revisions. Contractor shall send a confirming RFI associated with any revisions so that HDR can acknowledge the change and confirm it is acceptable. The Contractor shall be responsible for documenting all revisions on the record drawings. Refer to Section 01 61 00 for additional information.

1.3 REFERENCES

- A. Perform work in accordance with but not limited to:
 - 1. Federal, state, and local codes, regulations, and ordinances.
 - 2. All authorities having jurisdiction.
 - 3. Underwriters Laboratories, Inc. (UL) requirements.

4. Occupational Safety and Health Act (OSHA).
5. Factory Mutual System (FM) requirements.
6. International Building Code (IBC).
7. NFPA-70: National Electrical Code (NEC).
8. NFPA-70E: Standard for Electrical Safety in the Workplace.
9. NFPA-72: National Fire Alarm and Signaling Code.
10. NFPA-101: Life Safety Code.
11. NFPA-780: Lightning protection code.
12. ACI 318: Building Code Requirements for Reinforced Concrete.

1.4 SUBMITTALS

- A. Shop Drawings:
 1. Electrical Equipment Coordination Drawings.
 - a. Dimensioned coordination drawings showing the final layout of all submitted electrical distribution equipment (panelboards, transformers, switchboards, switchgear, enclosed bus assemblies, generators, UPS's, etc.) in all electrical vaults, rooms and closets with the actual equipment submitted.
 2. Electrical Conduit Routing Drawings.
 - a. Provide Drawings of proposed routing and details of construction, including raceway and rebar relationship, for raceways embedded in floor slabs, walls and columns.
- B. Product Data:
 1. Concrete Anchors:
 - a. Document Manufacturer Approval or Listing for cracked concrete application.
 - 1) Drop-in anchors are not cracked concrete rated and will not be allowed.
- C. Contract Closeout Information:
 1. Final performance test reports.

1.5 PROTECTION

- A. Provide covering and shielding for equipment to protect from damage.
- B. Protect nameplates on motors and similar equipment, to prevent defacing.
- C. Repair, restore or replace damaged, corroded and rejected items.
- D. Comply with manufacturer's storage, shipping and receiving requirements required to maintain full warranty.

1.6 JOB CONDITIONS

- A. Examine Contract Documents to determine how other work will affect execution of electrical work. All work required for this coordination shall be included in bid.
- B. Arrange and pay for permits, licenses, and inspections.
- C. Cause as little interference or interruption of existing utilities and services as possible.
 1. Schedule work which will cause interference or interruption in advance with Owner, Architect, authorities having jurisdiction and affected trades.
- D. Determine and verify locations of existing utilities on or near site.
 1. Notify Engineer of any discrepancies prior to commencing work.
- E. Temporary construction power and communications (See Division 01).
- F. Record drawings:

1. Keep a complete set of electrical drawings in job site office for indicating actual installation of electrical systems and equipment.
2. Use this set of drawings for no other purpose.
3. Where any material, equipment, or system components are installed differently from that indicated, indicate differences clearly and neatly using ink or indelible pencil.
4. Drawings may be electronic if using an electronic redline or markup program and utilizing contract drawing files as a base.
5. At project completion, submit record set of drawings. Refer to Section 01 78 39 for specific requirements.

1.7 ENVIRONMENTAL CONDITIONS

A. General:

1. Provide NEMA 1 enclosures for electrical equipment unless otherwise indicated.

B. Conduit: See Section 26 05 33.

C. Cable: See Section 26 05 19.

D. Boxes and Fittings: See Section 26 05 34.

E. Damp and Wet Locations:

1. Exterior applications:
 - a. Provide NEMA 3R enclosures for electrical equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Concrete Anchors:

1. Hilti.
2. Simpson Strong-Tie.
3. Powers Fasteners.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. Material and Equipment:

1. Current and standard design of manufacturers regularly engaged in their production.

B. Where UL approval or listing is required in electrical specifications, suitable approval or listing from other nationally recognized testing laboratory (NRTL) is acceptable.

C. Use UL labeled electrical materials and fabricated assemblies.

D. Structural Steel for Supports:

1. ASTM A36.
2. Galvanize members installed in areas of high humidity or condensation.
3. Furnish other members with shop coat of rust inhibiting primer.
4. Shop fabricate for field assembly using bolts.
5. Minimize field welding.
6. Retouch primer and galvanizing after field welding.
7. Unless support is otherwise indicated where weight of equipment exceeds 400 pounds, submit engineering design and calculations signed and sealed by a registered Engineer licensed to practice Structural Engineering in the state in which the project is located.

- E. Rain Hoods and Counter Flashings, not exposed to view:
 - 1. Stainless steel: Minimum 1 mm 20 GA.
 - 2. Sheet copper: Minimum 0.7 kg 24 oz.
- F. Rain Hoods and Counter Flashings, exposed to view:
 - 1. See Section 07 62 00.
- G. Access Doors, Panels and Frames:
 - 1. See Section 08 31 13.
 - 2. Provide where indicated on Drawings.
 - 3. Where not indicated on Drawings, provide access panels and/or doors at walls, and inaccessible ceilings as required to permit access to equipment, devices and piping requiring service, adjustment, or inspection.
 - 4. Size:
 - a. As required to allow access, inspection, service, and removal of items served.
 - b. Minimum 460 by 460 mm 18 by 18 inches.
- H. Concrete Anchors:
 - 1. Cast-in-place or post-installed anchor approved for cracked concrete applications.
 - a. Do not use drop-In Anchors.
- I. Firestopping:
 - 1. Maintain fire and smoke ratings where electrical items penetrate fire and fire/smoke rated building elements.
 - 2. Firestop penetrations of fire rated walls, floors, and assemblies.
 - a. Penetrations shall comply with UL listing and Fire Resistance Directory requirements for construction or assembly.
 - b. Use materials and methods as specified in Section 07 84 00.
- J. Industrial Control Panels:
 - 1. The Equipment panel short circuit rating shall be greater than the available fault current rating at the panel. Panels shall not be installed where the available fault current exceeds its short-circuit current rating as marked in accordance with NFPA 70, Section 409.
 - 2. Industrial control panels shall be marked with the following information that is plainly visible after installation:
 - a. Short-circuit current rating of a listed and labeled assembly.
 - b. Short-circuit current rating established using an approved method.
 - c. Exception: Where control panels contain only control circuit components.
 - 3. Available fault current shall be determined based on the available fault current (KAIC) rating identified on panelboard schedule serving equipment or the available fault current identified at equipment per the final short circuit study as required by specification section 26 05 73. Where available fault current is more than available fault current rating of control panel, control panel shall be modified to obtain minimum fault current rating using an approved method.
 - 4. Industrial Control panels shall include (but not be limited to) equipment as follows:
 - a. Variable frequency drives.
 - b. Motor starters.
 - c. Elevator equipment/controllers.
 - d. Fire pump equipment/controllers.
 - e. Duplex starter panels.
 - f. Lighting control panels.

PART 3 - EXECUTION

3.1 GENERAL

- A. When changes in location of any work are required, obtain approval of Architect before making change.
- B. Do not change indicated sizes without written approval of Architect.
- C. Provide offsets and crossovers in conduits, raceways, cable trays, and ducts.

3.2 CUTTING AND PATCHING

- A. Provide cutting, fitting, repairing, patching, and finishing of installed work.
 - 1. Include installed work of other sections where it is to disturb such work to permit installation of electrical work.
 - 2. Repair or replace existing or new work disturbed.
- B. Avoid cutting, where possible, by setting sleeves or frames, and by requesting openings in advance.
- C. Before cutting, obtain approval of Structural Engineer.
 - 1. Use only approved methods.
 - 2. Cut holes approved by Engineer neatly to admit work.
 - 3. Do not weaken walls or floors; locate holes in concrete to avoid structural members.
- D. Locate openings and sleeves to permit neat installation of conduits and equipment.
- E. Do not remove or damage fireproofing materials.
 - 1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
 - 2. Repair or replace fireproofing removed or damaged, at no extra cost.
- F. See Section 01 73 29.

3.3 EXCAVATING AND BACKFILLING

- A. Excavating, trenching, and backfilling:
 - 1. See Section 31 23 00.

3.4 INSTALLATION

- A. Install equipment in accordance with manufacturer's recommendations.
- B. Anchoring Devices and Supports.
 - 1. Use anchoring devices and structural supports suitable for equipment and install in accordance with manufacturer's recommendations.
 - 2. Check loadings and dimensions of equipment with shop drawings.
 - 3. Do not cut, or weld to, building structural members.
 - 4. Provide equipment supports even though not detailed on architectural and structural drawings.
- C. Verify equipment will fit support layouts indicated.
- D. Provide boxes, sleeves, and devices for installation.
- E. Make penetrations through roofs prior to installation of roofing.
- F. For penetrations required after installation of roofing:
 - 1. In built-up roofing (BUR), provide curbs, cants, and base flashings.
 - 2. In elastic sheet roofing (ESR), arrange and pay for flashing work by authorized roofer.
- G. Install rain hoods and metal counter flashings as indicated and make penetrations of electrical work through walls and roofs water and weathertight.

1. Furnish clamps, waterproofing material, and labor.
 2. Where metal flashings are applied over concrete, paint concrete with 3 mm 1/8 inches of mastic cement first.
 3. Set flashing in mastic cement, watertight.
- H. Have repair and replacement of roof construction, damaged by this work, done in manner which will not nullify roof warranty.
- I. Install equipment to permit easy access for normal maintenance.
1. Maintain easy access to switches, motors, drives, pull boxes, receptacles, etc.
 2. Relocate items which interfere with access.
- J. Provide concrete foundations (isolation pads) or housekeeping pads for floor mounted electrical equipment as follows unless otherwise indicated:
1. Install nominal 100 mm 3.5 inches high concrete housekeeping pads. Outside dimension of pad shall be at least 100 mm 3.5 inches larger in all directions than base of equipment or 228 mm 9 inches from center of anchor, whichever is greater.
 2. Use 20.7 MPa 3,000 psi concrete.
 3. Reinforce with No.13 No.4 bars, 300 mm 12 inches on-center each way, with short No.13 No.4 dowels into floor at 600 mm 24 inches on-center each way.
 4. Top surface shall be level. The use of shims underneath equipment is strictly prohibited.
 5. Chamfer top edges 20 mm 3/4 inches.
 6. Make faces smooth.
 7. Set anchor bolts for equipment.

3.5 PAINTING

- A. See Section 09 91 13 and Section 09 91 23.

3.6 FIELD QUALITY CONTROL

- A. Perform indicated tests to demonstrate workmanship, operation, and performance.
1. Conduct tests in presence of Architect and, if required inspectors of agencies having jurisdiction.
 2. Arrange date of tests in advance with Architect, manufacturer, and installer.
 3. Give minimum of 24 hours' notice to inspectors.
 4. Furnish or arrange for use of electrical energy, steam, water, diesel fuel, or gas required for tests.
 5. Furnish lubricating materials required for test.
- B. Repair or replace equipment and systems found inoperative or defective and retest.
1. If equipment or system fails retest, replace it with products conforming with Contract Documents.
 2. Continue remedial measures and retests until satisfactory results are obtained.
- C. Test equipment and systems as indicated for each item, unless otherwise recommended by manufacturer.

3.7 FINAL PERFORMANCE TEST

- A. Perform panel load balance, short circuit, and freedom from ground, and ground test (including ground fault protection where provided).
1. As part of putting systems in operation, provide tabulated results of load balance and voltage at each switchboard, panelboard, and motor control center. Use true RMS measuring metering devices.
 2. Provide neutral to ground resistance tests to prove neutral is grounded in only one location.

3. Provide ground test at service entrance and provide report on resistance to earth of the grounding electrode system.
4. See individual specifications for additional testing and commissioning.

3.8 ADJUST AND CLEAN

- A. Inspect equipment and put in good working order.
- B. Clean exposed and concealed items.
- C. Where new work occurs in existing areas where no other work has been done, clean area and restore to original condition.

3.9 PUTTING SYSTEMS IN OPERATION - START-UP

- A. Put systems into satisfactory operation prior to final acceptance, at time agreed to by Construction Manager, Owner, and Architect.
- B. Operate systems in good working order for period of 5 working days.

3.10 DEVICE MOUNTING

- A. See symbol legend for device mounting heights unless otherwise noted.
 1. Mounting heights indicated on legend shall supersede Architectural and Interiors elevations.
- B. Dimensions are to center of device unless otherwise indicated.
- C. All light switches and/or lighting control wall stations shall be mounted within 12 inches measured horizontally from the door frame or wall opening used to enter the space.
- D. Coordinate device locations with equipment/furnishings abutting walls such as, but not limited to, architectural millwork, casework, lockers, mirrors, and equipment. Refer to architectural and casework/equipment elevations to facilitate coordination of device placement. Devices shall be relocated at Contractor's expense if conflict exists after installation.
- E. Coordinate device mounting height with wainscoting where provided. Where top of wainscot and device mounting height overlaps, shift device down to provide 50 mm 2 inches gap between top of device and top of wainscot.
- F. Coordinate device locations with wall-mounted alcohol-based hand rub dispensers.
 1. Electrical receptacles, switches, or other devices shall not be installed above, below, or closer than 1 inch to a dispenser.
- G. Locate exit signs and fire alarm flashing lights so that all are visible from corridor locations. Relocate and/or add signs as required to resolve conflicts.

END OF SECTION

SECTION 26 00 11
WIRING EQUIPMENT FURNISHED BY OTHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish conduit, wiring, outlet boxes, receptacles, circuit breakers, fittings, switches, starters, (with overloads), to make final connections to equipment.
- B. Connect:
 - 1. Division 08 Equipment.
 - a. Automatic door equipment.
 - 2. Division 10 Equipment.
 - a. Electric signs.
 - 3. Division 12 Equipment.
 - a. Systems furniture.
 - b. Motorized shades.
 - 4. Division 14 Equipment.
 - a. Elevator equipment.
 - 5. Divisions 22, 23, and 25.
 - a. Heating, ventilation, cooling, plumbing and integrated automation system equipment.
 - 6. Division 27.
 - a. Telecommunications equipment.
 - 7. Division 28.
 - a. Fire Alarm equipment.
 - b. Electronic security equipment.
- C. Completely coordinate with work of other trades.

PART 2 - PRODUCTS

2.1 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Automatic Door Equipment:
 - 1. Provide conduit, wiring, outlet boxes, etc., to make final connections to motors, switches, safety mats, proximity detectors, remote control units, electric dead bolts, etc.
 - 2. See Section 28 31 00 for connections to fire alarm system.
 - 3. Switches for control of automatic doors provided by door manufacturer, installed by electrical.
 - 4. See door schedule, spec 08 71 00, for a complete list of door requirements.
 - a. Provide circuits from the Life Safety or Emergency Branch panel serving area for all auto doors in path of egress. See Life Safety Plans for additional information.
- B. Electric Signs:
 - 1. Furnish conduit, wiring, and outlet boxes, to make final connections to exterior electric signs. Sign(s) shall be controlled by exterior lighting controls. See Section 26 09 43.
- C. Systems Furniture:
 - 1. Provide power connection to pre-wired systems furniture. Coordinate final connection requirements.

2. Coordinate circuit breaker type for circuits feeding internal wiring of systems furniture. If a shared neutral is provided within the systems furniture, a multi-pole circuit breaker of appropriate ampacity shall be provided.
- D. Motorized Shades:
1. Provide all conduit, wiring, outlet boxes, etc., to make final connections to motorized shades, associated controllers, and local switches.
 2. Coordinate additional controls with patient room nurse call system. Provide additional contacts and / or relays as required.
- E. Elevator System:
1. Provide following for each elevator:
 - a. Fusible switch:
 - 1) Refer to Section 26 28 16.
 - 2) Locate on wall or fabricated rack near door of machine room.
 - 3) Provide conduit and wire from switch to controller.
 - b. Additional disconnect for machine room-less elevator.
 - 1) Provide additional non-fused disconnect switch, of same ampacity as the fusible switch listed above, within elevator shaft within reach of technician working on top of elevator cab at top of shaft.
 2. Unless otherwise required by the elevator consultant, provide following for each elevator system:
 - a. Dedicated branch circuit for each of the following elevator appurtenances: (Each circuit shall be provided with a fused disconnect switch or circuit breaker lockable in the open position, located in the elevator machine or control room as close as possible to the strike side of the door.)
 - 1) Elevator cab lighting and ventilation.
 - a) 30 A, 120 V circuit on the Emergency or Life Safety Branch.
 - 2) Elevator Intercom.
 - a) 20 A, 120 V circuit on the Emergency or Life Safety Branch.
 - 3) Security system equipment related to card reader devices in elevator machine room.
 - a) 20 A, 120 V circuit on the Emergency or Life Safety Branch.
 - b. Branch circuits for each of the following devices:
 - 1) 20 A, 120 V Class A GFCI duplex receptacle in each elevator pit.
 - 2) 20 A, 120 V Class A, GFCI duplex receptacle at top of each elevator hoistway.
 - 3) 20 A, 120 V Class A GFCI duplex receptacle in each elevator machine and/or control room.
 - 4) Vapor-tight fixture in each elevator pit, with switch and pilot light located outside of pit at 1220 mm 48 inches above floor. Pit light shall not be protected by GFCI and shall be connected to separate branch circuit from pit receptacle.
 - 5) Vapor-tight fixture at top of each elevator hoistway, with switch and pilot light located near access point. Pit light shall not be protected by GFCI and shall be connected to separate branch circuit from hoistway receptacle.
 - c. Car telephone outlet J-box with empty 19 mm 3/4 inches conduit to telephone cabinet.
 - 1) Locate at midpoint of each shaft or at elevator controller as directed by elevator installer.
 - d. Provide NEMA 3R equipment in elevator machine room if it is sprinklered.
 3. See Section 28 31 00 for connections to Fire Alarm System.
 4. Coordinate controls connection to automatic transfer switches serving elevators. See specification Section 26 36 23.

5. The shunt trip breaker for each elevator shall be a UL listed device with shunt trip voltage isolation relay monitored by fire alarm system in accordance with NFPA 72. Shunt trip disconnect for elevator shall be rated for use in wet location if elevator machine room is sprinklered.

F. Mechanical Specification Divisions Equipment:

1. Provide all conduit, wire, and electrical connections for all Mechanical Specification Divisions equipment.
2. Install all motor starters furnished by mechanical and plumbing contractors and provide disconnect switches, except in packaged or prewired units, as indicated in Division 21, 22, 23, and 25 Mechanical and Plumbing Equipment Schedules.
 - a. Connect all motors.
 - b. Provide starters with thermal overload protection for all motors not having such protection, except as otherwise indicated.
 - c. Starters: See Section 26 24 19.
3. Provide proper thermal overload heater elements in all starters.
4. Coordinate all equipment shutdown emergency power off (EPO) switch requirements with mechanical / controls contractor.
5. Provide connection to all air handling unit internal receptacle, lighting, and UV germicidal circuits. Coordinate interconnections within unit with mechanical contractor.
6. Provide circuits for 120 V connections required for automatic sensors for sinks and toilets.
7. Provide circuits for 120 V, 208 V or 277 V connections as required for pipe heat tracing.
8. Circuits and connections to ancillary 120 V mechanical equipment (e.g., control panels) that are internal to poly-phase equipment but are not specifically indicated on Drawings or the Schedules are the responsibility of the Electrical Contractor. The Contractor shall utilize the miscellaneous 120 V circuits shown on the Drawings for this purpose. Any additional conduit and wire required for the connections shall be provided to the Owner at no cost.
9. Fire, smoke, and fire/smoke dampers:
 - a. Provide power connection to all fire, smoke, and fire/smoke damper actuators. The Contractor shall utilize the miscellaneous 120 V circuits shown on the Drawings for this purpose. Connect up to 12 per 120 V circuit. Total load on circuit shall not exceed 1200 VA upon actuator operation.
 - b. Include step-down transformers required to complete 24 V or 12 V connections to actuators.
 - c. Each damper shall include a local fusestat disconnect fused at 3 A.
10. Duct Smoke Detectors:
 - a. Provide duct smoke detectors on supply and return of each air handling unit and each return duct feeding multiple floors prior to common return per NFPA standards. Exact location as shown on Mechanical plans.
 - 1) Provide relay for fan shutdown of HVAC units upon activation of smoke duct detector.
 - 2) Provide an air aspirating system in supply ductwork for control of AHU fan shutdown and large isolation fire/smoke dampers serving 100% outside air units as specified in Section 28 31 00.
 - b. Provide duct smoke detectors on each smoke, and fire/smoke damper per NFPA standards. Location of dampers shown on Mechanical Plans.

G. Telecommunications Equipment:

1. Provide complete raceway system, minimum size conduit 30 mm 1-1/4 inches (or as indicated on telecommunications drawings or within Division 27 specifications), from main head end equipment to each end device, or cable tray, as applicable, including any necessary standard size backboxes, wireways, junction boxes, pullboxes and manholes.

2. Provide 120 V and/or 208 V AC power wiring and connections to telecommunications servers, racks, power supplies, etc.
3. Provide heavy duty nylon pull string or wire suitable for use in pulling in wire in conduit.
4. Provide proper telecommunications grounding for all telecommunications racks and/or equipment within telecommunications rooms as required for compliance with ANSI/TIA-607-E.
5. Division 27 installer:
 - a. Furnish conduit requirements and special backboxes to the Electrical Specifications Divisions installer.
 - b. Provide any additional conduits not shown on drawings and/or increase the size of conduits to effect the installation of the telecommunications equipment.

H. Audio-Visual Equipment:

1. Provide complete raceway system, minimum size conduit 30 mm 1-1/4 inches (or as indicated on drawings or within Division 27 specifications), from main head end equipment to each end device, or cable tray, as applicable, including any necessary standard size backboxes, wireways, and junction boxes.
2. Provide 120 V and/or 208V AC power wiring and connections to audio-visual servers, racks, power supplies, etc.
3. Provide heavy duty nylon pull string or wire suitable for use in pulling in wire in conduit.
4. Division 27 installer: Furnish conduit requirements and special backboxes to the Electrical Specifications Divisions installer.
 - a. Install backboxes for all ceiling and wall mounted speaker systems.
5. Division 27 installer: Provide any additional conduits not shown on drawings and/or increase the size of conduits to effect the installation of the audio-visual equipment.

I. Fire Alarm Equipment.

1. Provide 20A, 120 V power circuits for Fire Alarm System equipment (e.g., fire alarm control and data gathering panels, system printer, etc.). Utilize Emergency or Life Safety Branch circuits and power sources as required for compliance with code, requirements of Authorities Having Jurisdiction and equipment manufacturer.
2. Fire, smoke, and fire/smoke dampers:
 - a. Provide power circuits for connections to all fire, smoke, and fire/smoke damper actuators. The Contractor shall utilize 20 A, 120 V power circuits for this purpose. Utilize Emergency or Life Safety Branch circuits for motorized dampers that are used for smoke control systems (i.e., those required to facilitate the evacuation of the occupants) and operated from the Fire Alarm System. Other motorized dampers shall be connected to the Normal power system. Connect up to 12 per 120 V circuit. Total load on circuit shall not exceed 1200 VA upon actuator operation.
 - b. Include step-down transformers required to complete 24 V or 12 V connections to actuators.
 - c. Each damper shall include a local fusestat disconnect fused at 3 A.
3. Duct Smoke Detectors:
 - a. Provide duct smoke detectors on supply and return of each air handling unit and each return duct feeding multiple floors prior to common return per NFPA standards. Exact location as shown on Mechanical plans.
 - 1) Provide relay for fan shutdown of HVAC units upon activation of smoke duct detector.
 - b. Provide duct smoke detectors on each smoke and fire/smoke damper per NFPA standards. Location of dampers shown on Mechanical Plans.

J. Electronic Security Systems:

1. Provide complete raceway system, minimum size conduit 20 mm 3/4 inches, from main head end security equipment to each end device, including any necessary standard size backboxes, wireways, junction boxes, and pullboxes.
2. Provide 120 V AC power wiring and connections to all electronic security systems power supplies.
3. Provide heavy duty nylon pull string or wire suitable for use in pulling in wire in conduit.
4. Division 28 installer: Furnish conduit requirements and special backboxes to the Electrical Specifications Divisions installer.
5. Provide any additional conduits not shown on drawings and/or increase the size of conduits to effect the installation of the security equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Perform work in accordance with applicable Electrical Specifications Divisions.
- B. Wire equipment complete, properly connected, and energized.
- C. Furnish conduit and wiring as required for directly-connected switches as indicated or required.

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Low Voltage Electrical Power Conductors and Cables, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.
- C. Low voltage to include all systems with line voltage of 0 V to 1000 V.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.4 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

2.2 SEE DIVISION 01 FOR DEFINITION OF BASE AND OPTIONAL MANUFACTURERS.

- A. Conductors and Cables:
 - 1. Base.
 - a. American Insulated Wire Corp.
 - b. General Cable Corporation.
 - c. Senator Wire & Cable Company.
 - d. Southwire Company.
- B. Splices and taps for smaller than No. 6 AWG wire:
 - 1. Base:
 - a. 3M.
 - b. Ideal Electric.
 - c. Heyco Molded Products.
 - d. Elastimold.
 - e. Buchanan Construction Products.
 - f. WAGO.
- C. Insulated Multi-tap connectors:
 - 1. Base:

- a. Burndy.
 - b. ILSCO.
 - c. NSI.
- D. Variable Frequency Drive (VFD) Cable:
 - 1. Base:
 - a. Belden.
 - b. Southwire.
- E. Two (2) Hour-Rated Mineral Insulated (MI) Cable:
 - 1. Base:
 - a. Pentair.
- F. Two (2) Hour-Rated Metal-Clad (MC) Cable:
 - 1. Base:
 - a. Draka.
 - b. Omni Cable.
 - c. Raychem.
- G. Other manufacturers desiring approval comply with Section 01 61 00.

2.3 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70 and NEMA WC 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc., as required for a complete functional circuitry system.
- D. Thermoplastic-Insulated Conductors and Cables:
 - 1. Listed and labeled as complying with UL 83.
- E. Thermoset-Insulated Conductors and Cables:
 - 1. Listed and labeled as complying with UL 44.
- F. Size conductors to match over current/overload protective device unless larger conductors are indicated or required due to voltage drop or other considerations.
- G. For line voltage of 100 V and larger: Use no wire smaller than No. 12 AWG, except only where specifically indicated.
- H. No. 10 AWG conductor to be used for 20 A, 120 V circuits exceeding 30 M 100 feet.
- I. No. 10 AWG conductor to be used for 20 A, 277 V circuits exceeding 60 M 200 feet.
- J. Grounding conductors shall be insulated, unless installed exposed in plenum spaces or otherwise noted.
- K. For line voltage of 0 to 30 V for lighting control/signal circuits: Use no wire smaller than No. 18 AWG.
 - 1. Wire gauge shall be increased up to No. 14 AWG where voltage drop is a concern.
 - 2. Wire shall be a shielded twisted pair with stranded copper conductors.
 - 3. Minimum insulation value shall be 300 V for Class 2 circuits and 600 V for Class 1 circuits.
- L. For line voltage of 100 V and larger: Use no wire smaller than No. 12 AWG, except as follows:
 - 1. Smaller size wire may be used only where specifically indicated.
- M. Color-coding: Color code conductors in accordance with NFPA 70 as follows:
 - 1. Color code all wiring.

2. Use the color-coding schedule within Section 26 05 53.
3. Color-coding of conductor ends will only be acceptable for feeder phase conductors.
4. Color-coding of conductor ends will only be acceptable for neutral and grounding conductors No. 4 AWG and larger.

2.4 CONDUCTOR MATERIAL

- A. Provide copper conductors except where aluminum conductors are specifically indicated or permitted for substitution. All conductor sizes indicated are based on copper unless specifically indicated as aluminum.
- B. Copper Conductors:
 1. Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
- C. Tinned Copper Conductors: Comply with ASTM B33.

2.5 SINGLE CONDUCTOR INSULATED BUILDING WIRE

- A. Insulation:
 1. For service entrance: Type THWN/THHN or XHHW-2.
 2. For feeders and branch circuits as defined by NFPA 70: Type THWN/THHN or XHHW-2.
 3. For exterior feeder and branch circuits as defined by NFPA 70: Type XHHW-2.
 4. For branch circuits served by GFCI circuit breakers: Type XHHW-2.
- B. Conductor Stranding:
 1. Feeders and Branch Circuits:
 - a. Size No. 10 AWG and Smaller: Solid.
 - b. Size No. 8 AWG and Larger: Stranded.
 2. Power and communication connections to motors and to generators shall be with stranded conductors.
- C. Insulation Voltage Rating: 600 V.
- D. Provide UL listed 2-hour fire rated circuits where indicated on the drawings and/or required by Code. Utilize 2-hour rated type MI, RHW-2 or MC power cable except where circuit is enclosed in 2-hour rated construction or encased in concrete or brick not less than 2 inches thick.

2.6 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
 1. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- B. Wiring Connectors for Splices and Taps:
 1. General: Do not make splices and taps with crimp or indenter-type connectors.
- C. Splices and taps for smaller than No. 6 AWG wire:
 1. Use Wirenuts, spring-type connectors or compact splicing connectors.
- D. Splices and taps for No. 6 AWG wire and larger:
 1. Use compression connectors with pre-stretched insulation to equal insulation of wire being spliced.
- E. Pre-Insulated Multi-Tap Connectors:
 1. Removable wire port plugs and set screw covers. Pre-filled with oxide inhibitor.
- F. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Copper Conductors sized No. 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.

2.7 ACCESSORIES

A. Electrical Tape:

1. Vinyl Color Coding Electrical Tape:
 - a. Integrally colored to match color code indicated; listed as complying with UL 510.
 - b. Minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 deg F.
2. Vinyl Insulating Electrical Tape:
 - a. Complying with ASTM D3005 and listed as complying with UL 510.
 - b. Minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 deg F and suitable for continuous temperature environment up to 221 deg F.

B. Heat Shrink Tubing:

1. Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

C. Oxide Inhibiting Compound:

1. Listed; suitable for use with the conductors or cables to be installed.

D. Wire Pulling Lubricant:

1. Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature. Do not use cable pulling lubrication compound containing petroleum or other products which may deteriorate insulation cable

E. Ties:

1. Material and tensile strength rating suitable for application.

2.8 SPECIAL USE CABLES

A. Variable Frequency Drive (VFD) Cable:

1. Multi-conductor shielded cable approved for direct burial, free air or raceways, in wet or dry locations, sunlight resistant, -40 deg C UL cold bend, Oil Res. I & II, Class Div. 1 & 2, rated 90 deg C wet or dry, UL 1000 volts flexible motor supply cable.
2. Construction:
 - a. Three (3) stranded tinned copper circuit conductors with XLPE insulation.
 - b. One (1) full-size insulated ground wire.
 - c. Double-sided aluminum foil tape shield plus one (1) full-size drain wire under shield tape.
 - 1) Tinned copper braid (85%) over shield tape jacket.
 - d. Copolymer jacket.
3. Cable shall meet or exceed the following requirements:
 - a. UL 1277 - 600 Volt RMS Type TC-ER Unlisted Singles.
 - b. UL 2277 - 1000 Volt RMS Flexible Motor Supply Cable; WTTC.
 - c. UL 44.
 - d. UL 1581.
 - e. ICEA S-73-532/NEMA WC-57.
 - f. ICEA S-95-658/NEMA WC-70.

B. 2-hour fire-rated Mineral Insulated (MI) Cable:

1. Furnish and install a complete UL Listed wiring system consisting of specified wiring cable, components, and accessories listed specifically for use with the system.
 - a. Description:
 - 1) ANSI/NFPA 70, Type MI.
 - b. Conductor:
 - 1) Solid high conductivity copper.
 - c. Insulation Voltage Rating:
 - 1) 600 volts.
 - d. Cable Temperature Rating:
 - 1) 90 deg C.
 - e. Termination Temperature Rating:
 - 1) 90 deg C.
 - f. Insulation Material:
 - 1) Magnesium oxide.
 - g. Sheath Material:
 - 1) Seamless soft-drawn copper.
 - h. Fire Rating:
 - 1) Complete cable system shall have a 2-hour fire rating as listed and classified by Underwriters Laboratories, Inc.
2. Cable shall meet or exceed the following requirements:
 - a. ANSI/NFPA 70 - National Electrical Code.
 - b. ANSI / UL 2196 "Tests for Fire Resistive Cables".
 - c. CSA C22.2#124.
 - d. Electrical Circuit Protective System listing in the UL Fire Resistance Directory.

C. 2-hour fire-rated Metal-Clad (MC) Cable:

1. Furnish and install a complete UL Listed wiring system consisting of specified wiring cable, components, and accessories listed specifically for use with the system.
 - a. Description:
 - 1) UL Listed, NEC Type MC in accordance with UL 1569.
 - b. Conductor:
 - 1) Annealed copper, Class "B" strand, designed to ensure tensile strength under fire conditions.
 - c. Insulation Voltage Rating:
 - 1) 600 volts.
 - d. Cable Temperature Rating:
 - 1) 90 deg C.
 - e. Termination Temperature Rating:
 - 1) 90 deg C.
 - f. Inner Jacket:
 - 1) Thermoset, low smoke zero halogen silicone rubber.
 - g. Armor:
 - 1) Continuously welded and corrugated copper.
 - h. Outer Jacket:
 - 1) Flame retardant polyvinyl chloride (PVC) or low smoke zero halogen (LSZH) polyolefin.

- i. Configuration:
 - 1) Single or multi-conductor.
- j. Fire Rating:
 - 1) Complete cable system shall have a 2-hour fire rating as listed and classified by Underwriters Laboratories, Inc.
- 2. Cable shall meet or exceed the following requirements:
 - a. 2 hour fire rated per UL standard 2196 following ASTM E119 (1,850 deg F with water hose stream)
 - b. Electrical Circuit Integrity Systems (FHIT) — System No. 120 of the UL Fire Resistance Directory
 - c. Exceeds NEC Article 695 & 700 fire endurance requirements
 - d. Rated FT-4 / IEEE 1202 Vertical Flame test; -ST1, limited smoke.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Requirements:

- 1. Perform work in accordance with NECA 1 (general workmanship).
- 2. Unless dimensioned, circuit routing indicated is diagrammatic.
 - a. When circuit destination is indicated without specific routing, determine exact routing required.
- 3. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
- 4. Maintain separation of wiring for Emergency, and Optional Standby systems in accordance with NEC Sections 700 and 702.
- 5. Paralleled Conductors in Multiset Feeders: Install conductors of the same length and terminate in the same manner.
- 6. Terminate cables using suitable fittings.
- 7. Install conductors with a minimum of 12 inches of slack at each outlet.
- 8. Neatly trail and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- 9. Group or otherwise identify neutral and equipment grounding conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- 10. Remove appropriate amount of conductor insulation for making connections without cutting, nicking, or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
- 11. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
- 12. Insulate ends of spare conductors using vinyl insulating electrical tape.
- 13. Provide firestopping for electrical penetrations of fire-rated floor and wall assemblies to preserve restore original fire-resistance rating of assembly.
- 14. Conductors not noted on plan shall be sized to overcurrent protective device feeding circuit. See feeder schedule on plans for requirements.
- 15. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

B. Connections:

- 1. Make wiring connections using specified wiring connectors.
- 2. Mechanical Connectors:
 - a. Secure connections according to manufacturer's recommended torque settings.

3. Compression Connectors:
 - a. Secure connections using manufacturer's recommended tools and dies.
- C. Installation in Raceway:
 1. Install wiring in conduit unless otherwise indicated.
 - a. Install no more than 3 phase conductors (A-B-C) in one conduit.
 - b. Provide a separate neutral conductor for each phase conductor in receptacle branch circuits, appliance branch circuits, and lighting branch circuits.
 - c. When more than three current-carrying conductors (which includes separate neutral conductors for single phase circuits) are installed in a single conduit, wiring shall be derated in accordance with NEC 310.15.
 2. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 3. Pull all conductors and cables together into raceway at same time.
 4. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 5. Use suitable pulling means and wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- D. Splicing Requirements:
 1. Arrange circuiting to minimize splices.
 2. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 3. Include circuit lengths required to install connected devices within 10 feet of location indicated.
 4. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 5. Underground conductors shall not be spliced.
- E. Lighting control cabling:
 1. 0-10 V control wires shall be allowed to be routed in the same conduit as line voltage wires (in a Class 1 configuration) when routed from fixture to fixture (and to area lighting controller(s) as applicable) within a room, provided that the 0-10 V wire insulation meets NEC requirements.
 2. When 0-10 V wires are routed between rooms or if the cable length exceeds 50 feet, wires shall be routed in a Class 2 configuration as follows:
 - a. When above an accessible ceiling and concealed from view, 0-10 V wires may be routed on the outside of the line voltage conduit and attached to conduit via Velcro cable straps.
 - b. When routed in an exposed ceiling or above an inaccessible ceiling, 0-10 V wires shall be routed in their own dedicated conduit.
 3. Plenum-rated, pre-terminated CAT5 or similar digital lighting management (DLM) cables with RJ45 connectors are not allowed to be routed in the same conduit as line voltage wires.
 - a. When above an accessible ceiling and concealed from view, DLM wires may be routed on the outside of the line voltage conduit and attached to conduit via Velcro cable straps.
 - b. When routed in an exposed ceiling or above an inaccessible ceiling, DLM wires shall be routed in their own dedicated conduit.
 4. All lighting control cabling originating at a wall-mounted switch box shall be routed in a conduit stub-up from the box to above an accessible ceiling, or in conduit directly to a load controller or luminaire in an exposed ceiling area.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, tools, equipment, and services for Grounding and Bonding for Electrical Systems, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 837, Qualifying Permanent Connections Used in Substation Grounding.
- C. National Fire Protection Association (NFPA):
 - 1. 70, National Electrical Code (NEC).
- D. Underwriters Laboratories, Inc. (UL):
 - 1. 467, Electrical Grounding and Bonding Equipment.
- E. Comply with NFPA 780 and UL 96A when interconnecting with lightning protection system.
- F. Comply with ANSI/TIA-607 when interconnecting with telecommunications grounding system.
- G. Assure ground continuity is maintained throughout the entire Project.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Fabrication and/or layout drawings:
 - a. Plan drawings showing type, size, and locations of all grounding system components.
- B. Product Data:
 - 1. Manufacturer's specifications and evidence of required approvals for all materials and components.
- C. Contract Closeout Information:
 - 1. As-built plan drawings showing the dimensioned locations of all grounding features specified in "Field Quality Control" paragraph in Part 3, including the following:
 - a. Test wells.
 - b. Ground rods.
 - c. Ground rings.
 - d. Ground plates.
 - e. Grounding arrangements and connections for separately derived, lightning protection and telecommunications systems.
 - f. Grounding for sensitive electronic equipment.
 - 2. Ground rod and/or grounding system resistance and continuity test reports signed by the Project's supervising electrical foreman.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Ground rods and bars and grounding clamps, compression connectors and lugs:
 - a. Burndy.
 - b. Harger Lightning Protection.
 - c. Heary Brothers.
 - d. Joslyn.
 - e. Robbins Lightning Protection.
 - f. Blackburn.
 - g. Thompson.
2. Exothermic weld connections:
 - a. Erico Products Inc., Cadweld.
 - b. Harger Lightning Protection.
 - c. Thermoweld.
3. Inspection test well:
 - a. Erico.
 - b. Quazite Composolite.
 - c. Armorcast Products Company.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 COMPONENTS

A. Wire and Cable:

1. Bare conductors.
 - a. Soft drawn stranded copper meeting ASTM B8.
 - b. Soft drawn tinned stranded copper meeting ASTM B33.
 - c. Solid conductors meeting ASTM B3.
2. Insulated conductors: Same as bare conductors with XHHW insulation, color coded green.

B. Material:

1. Copper, except where aluminum conductors are specifically indicated or permitted for substitution. Refer to Section 26 05 19 for more information regarding aluminum conductor requirements.

C. Vault and Equipment Room Ground Bus Bars:

1. Solid copper:
 - a. 1/4 inches thick.
 - b. 4 inches wide.
 - c. Length as indicated on drawings, or 24 inches minimum.
2. Predrilled grounding lug mounting holes spaced 1-1/8 inches apart in NEMA standard 2-hole patterns.
3. Stainless steel or galvanized steel mounting brackets.
4. Insulated standoffs for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

D. Grounding Electrodes:

1. Ground rods: 3/4 inches x 10 feet.
 2. Ground plates: Copper plates, minimum 0.10 inch thick, 24 inch square.
 3. Copperclad:
 - a. Heavy uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
 - b. Corrosion resistant bond between the copper and steel.
 - c. Hard drawn for a scar-resistant surface.
- E. Mechanical connectors:
1. UL 467.
 2. Permitted only where specifically indicated or specified.
- F. Grounding Connectors and Lugs:
1. Compression type:
 - a. Standards: UL 467 and IEEE 837.
 - b. High copper alloy content.
 - c. Non-reversible.
 - d. Terminals for connection to bus bars shall have two bolt holes.
- G. Piping, Tubing, and Conduit Clamps:
1. High-copper alloy cast U-bolt fitting.
 2. 90 degree lay-in cable clamp.
 3. Burndy Type GAR.
- H. Exothermic Weld Connections:
1. Copper oxide reduction by aluminum process.
 2. Molds properly sized for each application.
- I. Conduit: See Section 26 05 33.
- J. Grounding type insulated bushings: See Section 26 05 33.
- K. Inspection test well:
1. 12 inches H x 12 inches W x 12 inches L.
 2. Single piece polyolefin body.
 3. Removable top cover with "GROUND" wording clearly visible.
 4. Tier 15 Design Load of 15,000 pounds.
 5. Erico Cat No. IH1250D or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
1. Install products in accordance with manufacturer's instructions.
 2. Size grounding conductors and bonding jumpers in accordance with NFPA 70 Article 250, except where larger sizes are indicated on the Drawings.
 3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections.
 4. Where ground conductors pass through floor slabs or building walls provide non-metallic sleeves and install per Section 26 00 10.
 5. Do not splice grounding conductors except at ground rods.
 6. Install ground rods and grounding conductors in undisturbed, firm soil.
 - a. Provide excavation required for installation of ground rods and ground conductors.

- b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
 - c. Unless otherwise specified, make all splices, taps and connections with compression type connectors or exothermic welds.
 - d. Provide sufficient slack in grounding conductor to prevent conductor breakage during backfill or due to ground movement.
 - e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
7. Do not use exothermic welding if it damages the structure to which the grounding conductor is being welded.

B. Grounding Electrode System:

- 1. Provide a grounding electrode system in accordance with NFPA 70 Article 250 and as indicated on the Drawings.
- 2. Grounding conductor terminations:
 - a. Ground bars mounted on wall; use compression type terminal and bolt it to the ground bar with two bolts.
 - b. Ground bus in electrical equipment; use compression type terminal and bolt it to the ground bar.
 - c. Piping systems; use mechanical type connections.
 - d. Building steel, below grade and encased in concrete; use compression type connector or exothermic weld.
 - e. Install grounding jumper of same size around water meter and interconnection valves using ground clamps.
 - f. At above grade terminations, label the conductors per Section 26 05 53.

C. Main Switchboard Ground:

- 1. Install main grounding conductor in steel conduit and connect to grounding electrode system using an exothermic weld or UL listed compression fitting.
 - a. Unless otherwise indicated, install main ground unspliced in exposed conduit.
 - b. Make connections easily accessible for inspection, not underground or concealed in floors or walls.
- 2. Bond grounding conductor to conduit at entrance and exit, of same type and quality as other conductors in building.
- 3. Locate neutral ground disconnecting link or links in main switchboard so that low-voltage neutral bar with interior secondary neutrals can be isolated from common equipment grounding bus.

D. Pad Mounted Equipment Local Ground Ring:

- 1. Ground ring consists of ground rods and a grounding conductor looped around the structure.
- 2. Placed at approximately 3 feet from the equipment and 2 feet-6 inches below grade.
- 3. Provide a minimum of four ground rods placed at the corners of the ring and additional rods so that the maximum distance between ground rods does not exceed 25 feet.
- 4. Grounding conductor: Bare conductor, size as indicated on the Drawings or No. 2/0 AWG minimum.

E. Manhole and Handhole Grounding:

- 1. Provide a ground rod in each manhole and handhole with exposed metal parts.
 - a. Expose a minimum of 4 inches of the rod above the floor for field connections to the rod.

2. Provide a bare copper ground conductor looped around the interior of the manhole, connected to the ground rod and to the ground conductors embedded in each ductbank entry.
 3. Connect exposed metal parts (e.g., conduits, and cable racks, ladders, cable shields, etc.) to the ground loop.
- F. Raceway Bonding/Grounding:
1. Provide continuous ground return path for current through metallic conduit from load to source ground bus in addition to internal green safety ground conductor. Ground conduits to metal frame of electrical equipment and panels with double locknuts or with grounding bushings using bonding jumpers.
 - a. Provide grounding type bushings and bonding jumpers on feeder conduits at inside of enclosures using multiple concentric knockouts.
 - b. Grounding conductor insulation shall be identical to the phase conductors, unless otherwise indicated on the Drawings.
 2. Make metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.
- G. Cable Tray Grounding:
1. Cable tray shall be UL-listed for use as an equipment grounding conductor.
 2. All cable tray splices shall be UL-approved for grounding or shall be provided with a field-installed bonding jumper sized for the maximum overcurrent device rating of the cable tray.
 3. Bond all cable tray to the electrical and communication room's ground bus.
- H. Exposed Metallic Conduit Grounding:
1. Low voltage circuits: Threaded grounding bushing.
- I. Ground all neutral conductors, conduit systems, cabinets, equipment, motor frames, etc., in accordance with NEC and applicable codes.

3.2 DISTRIBUTION

- A. Make metallic raceway fittings and grounding clamps tight to ensure that equipment grounding system will operate continuously at ground potential to provide low impedance current path to insure proper operation of overcurrent devices during possible ground fault currents.
- B. Do not solder grounding circuit connections.
- C. Provide each conduit with grounding type insulated bushing where metallic conduits terminate without mechanical connection to metallic housing (switchboards, motor control centers, etc.).
 1. Connect each bushing to grounding bus in equipment with bare copper conductor.
- D. In nonmetallic conduits or ducts, maintain continuity of equipment grounding system by bar or conductor installed and connected by approved method to conductive noncurrent-carrying equipment at both ends.
- E. Ground all metal raceways, electrical devices, and equipment (panelboards, receptacles, accessible fixtures, switchgear, transformers, motors, motor equipment, etc.).
- F. Make ground continuity positive throughout entire project.

3.3 FIELD QUALITY CONTROL

- A. Leave grounding system uncovered until observed by Engineer and/or Authority Having Jurisdiction.
- B. Provide a continuity test on the components of the grounding electrode system.
- C. Complete grounding system: Resistance of 5 ohms or less.

- D. Test resistance of installed ground system after backfilling and before connection to any other grounded system including underground piping, utility services or other building ground systems.
1. Test ground grid resistance by fall-of-potential method.
 2. Perform test at the main ground bar.

END OF SECTION

SECTION 26 05 33

CONDUITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Conduits, as indicated, in accordance with provisions of Contract Documents.
- B. Conduit runs are diagrammatic. Verify and coordinate locations in field.
- C. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's data for each product specified.
 - 2. IBC Certificates of Compliance.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Electrical Components, Devices, and Accessories shall be listed and labeled in accordance with NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 2. Application and installation of conduits shall be in full compliance with requirements of applicable edition of NFPA 70 for each conduit type.
- B. Certifications:
 - 1. Conduit: Stamp each length with name or trade mark of manufacturer and affix UL label.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. As noted for each type listed below.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Rigid Metal Conduit (RMC):
 - 1. Manufacturers:
 - a. Base:
 - 1) Allied Tube and Conduit Corp.
 - b. Optional:
 - 1) Republic Conduit.
 - 2) Wheatland Tube.
 - 2. Materials
 - a. Hot dipped galvanized, or sherardized, including threads.
 - b. Standard pipe thread with coupling; deliver with thread protector and end caps.
 - c. Standards:
 - 1) NEMA/ANSI C80.1 – Electrical Rigid Steel Conduit – Zinc Coated (ERSC).
 - 2) UL 6 - Electrical Rigid Metal Conduit – Steel.

B. PVC-Coated Rigid Metal Conduit:

1. Manufacturers:
 - a. Base:
 - 1) Perma-cote.
 - b. Optional:
 - 1) Plasti-Bond.
 - 2) Robroy Industries.
2. Materials
 - a. Hot dipped galvanized or sherardized including threads; 40 mil PVC exterior coating, 2 mil urethane interior coating.
 - b. Standard pipe thread with coupling; deliver with thread protector and end caps.
 - c. Standards:
 - 1) NEMA/ANSI C80.1 – Electrical Rigid Steel Conduit – Zinc Coated (ERSC).
 - 2) UL 6 - Electrical Rigid Metal Conduit – Steel.

C. Intermediate Metal Conduit (IMC):

1. Manufacturers:
 - a. Base:
 - 1) Allied Tube and Conduit Corp.
 - b. Optional:
 - 1) Republic Conduit.
 - 2) Wheatland Tube.
2. Materials
 - a. Hot dipped galvanized steel of intermediate wall thickness including threads.
 - b. Standard pipe thread with coupling; deliver with thread protector and end caps.
 - c. Standards:
 - 1) NEMA/ANSI C80.6 –Electrical Intermediate Metal Conduit (EIMC).
 - 2) UL 1242 - Standard for Electrical Intermediate Metal Conduit – Steel.

D. Electrical Metal Tubing (EMT):

1. Manufacturers:
 - a. Base:
 - 1) Allied Tube and Conduit Corp.
 - b. Optional:
 - 1) Republic Conduit.
 - 2) Wheatland Tube.
2. Materials
 - a. Galvanized steel of thin wall thickness.
 - b. Provide factory colored EMT for conduits 25mm 1 inch and below. Follow Identification for Electrical Systems, Section 26 05 53.
 - c. Standards:
 - 1) NEMA/ANSI C80.3 – Steel Electrical Metal Tubing (EMT).
 - 2) UL 797 - Electrical Metallic Tubing – Steel.

E. Flexible Metal Conduit (FMC):

1. Manufacturers:
 - a. Base:
 - 1) Anamet Electrical.

- b. Optional:
 - 1) Electri-Flex.
 - 2) AFC.
 - 3) International Metal Hose.
 - 2. Materials
 - a. Steel, hot dipped galvanized.
 - b. Standards:
 - 1) UL 1 – Standard for Flexible Metal Conduit.
- F. Liquid-Tight Flexible Metal Conduit (LFMC):
 - 1. Manufacturers based on specification compliance:
 - a. Base:
 - 1) Anamet Electrical.
 - b. Optional:
 - 1) Electri-Flex.
 - 2) AFC.
 - 3) International Metal Hose.
 - 2. Materials
 - a. Steel, hot dipped galvanized with PVC jacket.
 - b. Standards:
 - 1) UL 360 – Standard for Liquid-Tight Steel Conduit.
- G. Rigid Polyvinyl Chloride Nonmetallic Conduit (PVC):
 - 1. Manufacturers:
 - a. Base:
 - 1) Carlon.
 - b. Optional:
 - 1) Allied.
 - 2) Cantex.
 - 2. Materials
 - a. Schedule 40 or 80, meeting minimum requirements of NEC.
 - b. Standards:
 - 1) UL 651 - Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
 - 2) NEMA TC-2 and TC-3 – Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
- H. Conduit Fittings:
 - 1. Manufacturers:
 - a. Base:
 - 1) Appleton Electric.
 - b. Optional:
 - 1) Cooper Crouse-Hinds.
 - 2) Killark.
 - 3) Thomas & Betts.
 - 4) O-Z/Gedney.
 - 2. Materials
 - a. Standards:
 - 1) ANSI/NEMA FB-1 – Fittings, Cast metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.

- 2) UL 514B - Conduit, Tubing, and Cable Fittings.
- b. RMC Fittings
 - 1) Threaded cast ferrous alloy with corrosion resistant finish. Cast body with gasketed corrosion resistant screw cover and threaded hubs.
 - 2) Not Approved: Zinc alloy and similar soft metal die castings.
- c. IMC Fittings:
 - 1) Threaded cast ferrous alloy with corrosion resistant finish. Cast body with gasketed screw cover and threaded hubs.
 - 2) Not Approved: Zinc alloy and similar soft metal die castings.
- d. EMT Fittings:
 - 1) Steel compression-ring type.
 - 2) Set screw type fitting with pressure-cast bodies for 19 mm 3/4 inches conduit and smaller and steel body and cup type screws for 25 mm 1 inch conduit and larger.
 - 3) Wet locations or embedded in concrete.
 - a) Compression screw type leakproof fitting steel tabular zinc electroplated fittings with internal parts captive in a single unit.
 - b) Coated screws to indicate that fitting has been tightened.
 - c) Self-locking and self-sealing.
 - d) Internal rain tight silicone-impregnated neoprene seal.
 - e) Connectors to have factory installed insulated plastic throats and rain tight gasket to seal out moisture between lockout and enclosure.
 - f) Couplings to have fully formed grooved center stop for EMT.
- e. FMC Fittings:
 - 1) Dry locations: Squeeze type, malleable iron, zinc-nickel plated, straight and angle connectors for all sizes except twist-in connectors for 19 mm 3/4 inches and below flexible metal conduit.
 - 2) Damp or wet locations: liquid-tight connectors.
- f. PVC Conduit Fittings:
 - 1) PVC plastic solvent weld type, with threaded adapters as required.
- g. Bushings:
 - 1) Threaded, galvanized, malleable iron.
 - 2) Bushings for conductors No. 4 AWG and larger: Separate insulated bushings.
 - a) Do not use insulated throat connectors.
 - 3) Grounding bushings: With screw termination for green grounding wire.
- I. Expansion Fittings:
 - 1. Manufacturers:
 - a. Base:
 - 1) Cooper Crouse – Hinds.
 - b. Optional:
 - 1) O-Z/Gedney.
 - 2) Appleton Electric.
 - 2. Materials
 - a. Description:
 - 1) Watertight deflection type cast slip joint fitting for conduit, with flexible bonding conductor for continuity of ground through metallic conduit.
 - b. Design Standards:
 - 1) O-Z/Gedney: Type DX.

2) Cooper Crouse-Hinds: Type XJG.

J. Inserts and Attachments:

1. Select inserts and attachments to suit loading conditions.
 - a. See Section 01 31 11 for load limitations where more than one trade may be applying loads to device.
2. Inserts For Placement in Concrete Formwork:
 - a. Malleable iron, wedge with nut, galvanized finish.
 - b. Size inserts to suit threaded hanger rods.
3. Attachments to Existing Construction:
 - a. Malleable iron, wedge, galvanized finish.
4. Use plastic toggles where securing directly to drywall.

K. Supports, Sleeves and Seals:

1. Conduit supports:
 - a. Standards:
 - 1) UL 2239 – Hardware for the Support of Conduit, Tubing, and Cable.
 - 2) Listed and in compliance with other applicable standards.
 - b. Designed specifically for electrical installations.
 - c. Hangers:
 - 1) Steel zinc-nickel plated threaded rods with straps or clamp conduit holder.
 - d. Straps:
 - 1) One-hole and two-hole malleable iron, hot-dipped galvanized or steel, zinc-nickel or zinc plated.
 - e. Beam Clamps:
 - 1) Malleable iron, hot-dipped galvanized or zinc-nickel plated.
 - f. Channels and Fittings:
 - 1) Channels: Hot-dipped galvanized.
 - 2) Fittings: Galvanized.
 - g. Trapeze assemblies:
 - 1) Constructed from channels and supported by at least two threaded rods attached to building structure.
2. Sleeves:
 - a. Black iron pipe, RMC, or IMC sized to accommodate work passing through.
3. Sealer for sleeves and openings around conduit:
 - a. UL listed for assembly.
 - b. See Section 07 84 00.
4. Sealer for use inside conduits:
 - a. Manufacturers:
 - 1) Base:
 - a) Arnco.
 - 2) Optional:
 - a) Polywater.
 - b. Materials
 - 1) Description:
 - a) Watertight / Air tight foam sealant for electrical conduit.
 - b) Listed for application with electrical wiring and conduit.
 - 2) Design Standards:

- a) Arnco: Hydra-Seal.
- b) Polywater: FST Duct Sealant.

PART 3 - EXECUTION

3.1 SCHEDULE OF CONDUIT UTILIZATION

- A. Use no conduit smaller than 19 mm 3/4 inches.
- B. Size conduit in accordance with NEC unless indicated larger.
- C. Rigid Steel Conduit (RMC) or Intermediate Metal Conduit (IMC) shall be used in following locations unless otherwise noted:
 - 1. Outdoors exposed.
 - 2. In exterior masonry walls.
 - 3. In wet locations.
 - 4. For exposed interior runs below 3 m 10 feet above finished floor and/or where subject to severe physical damage, unless otherwise indicated.
 - 5. For feeders over 1000 volts.
- D. Electrical Metallic Tubing (EMT) shall be used for dry interior applications 1000 V and below as follows:
 - 1. Concealed in walls or above finished ceilings.
 - 2. Exposed EMT may be used below 3050mm 10 feet above finished floor and where not subject to physical damage in the following locations:
 - a. From floor to ceiling in electrical equipment rooms.
 - b. Directly above motor control centers in locations other than electrical equipment rooms.
 - c. Directly above junction boxes or control panels associated with elevators or mechanical equipment with conduit termination point of 1830 mm 6 feet or more above floor.
- E. Flexible metal conduit (FMC) shall be used for dry interior applications limited to:
 - 1. For connection to luminaires above suspended ceilings.
 - 2. In listed office furnishings.
 - 3. In architectural millwork and casework.
 - 4. Where fished into existing walls or ceilings, not otherwise accessible and not subject to physical damage.
- F. Liquid-tight flexible metal conduit (LFMC) shall be used for applications including, but not limited to:
 - 1. All damp and wet locations.
 - 2. For connection to equipment subject to vibration.
 - 3. Mechanical equipment connections, not exceeding 915 mm 36 inches in length.
- G. Rigid polyvinyl chloride non-metallic conduit (PVC) may be used subject to following:
 - 1. Do not use exposed PVC conduit unless otherwise noted.
 - 2. Provide a 1000 V, insulated, green grounding conductor in each PVC conduit.
 - a. Power circuits: Proper ampacity per NEC.
 - b. Communications circuits: No. 12 AWG minimum.
 - 3. 45 degrees and greater bends in PVC conduit runs larger than 38 mm 1-1/2 inches shall be made with rigid steel conduit.
 - 4. Schedule 80 PVC conduit may be used as follows:
 - a. Routing of grounding electrode system conductors and telecommunications ground backbone runs below and above grade and stubs through concrete slabs on grade.
 - 5. Direct-burial Schedule 40 PVC or concrete-encased Type EB may be used as follows:

- a. Exterior Lighting: See Section 26 56 00.
- b. Underground Ducts and Raceways for Electrical Systems: See Section 26 05 43.
- c. Voice and data systems where underground and in or under concrete slabs on grade.
- d. Underground and concrete encased conduits over 1000 V.
- e. For 1000 V and below:
 - 1) Underground and concrete encased conduits 1000 V and below for feeders and branch circuits.

3.2 INSTALLATION - GENERAL

- A. Provide separate conduit systems for all lighting, power, and communications systems, unless otherwise indicated.
 - 1. Separate systems of different branches of power.
 - 2. Separate systems of different voltage classes into different conduit systems unless otherwise noted.
 - a. Do not combine wiring for 208/120 V and 480/277 V circuits in common wireways or pull boxes.
 - 3. Provide dedicated junction boxes and pull boxes to separate wiring systems.
- B. Where practical, group home runs to same panelboard.
 - 1. Do not enclose more than three single phase circuits or one three phase circuit in one raceway unless noted otherwise.
- C. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.
- D. Moisture and debris protection:
 - 1. Clean interior of conduits to remove moisture and foreign matter.
 - 2. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.
 - 3. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors (above and below grade) into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- E. Make conduit field cuts square and ream to full size.
 - 1. Shoulder conduit in couplings.
- F. Do not install conduit under pads for fans, pumps, boilers, or other machinery.
- G. Seal and waterproof penetrations of floor slab at mechanical rooms above grade.
 - 1. Where required to preserve fire resistance rating of partitions and other elements, use materials and methods specified in Section 07 84 00.
 - 2. Where conduits penetrate a waterproof membrane, seal as required to maintain integrity of membrane.
- H. Provide sealing fittings on rigid galvanized conduit in hazardous areas and install in accordance with NEC.
- I. Conduit bends:
 - 1. Make field bends with tools designed for conduit bending.
 - a. Heating of metallic conduit to facilitate bending is not permitted.

2. Hand conduit bender may be used on 19 mm 3/4 inches RMC, IMC or EMT conduit and 25 mm 1 inch EMT conduit.
 - a. Use conduit bending machine for larger sizes.
 3. Make no bends with radius less than 12 times diameter of associated cable.
 4. Make no bends with radius less than 6 times the diameter of telecommunications conduits up to 50 mm 2 inches, or less than 10 times the diameter of telecommunications conduits greater than 50 mm 2 inches.
 5. No conduit bends shall exceed 90 degrees.
- J. Angles:
1. Sum of angles in any power conduit run shall not exceed 360 degrees.
 2. Sum of angles in any telecommunications conduit run shall not exceed 180 degrees.
 - a. Provide pull boxes every 30 m 100 feet in telecommunications conduit runs.
- K. Provide conduit bodies, junction boxes, or pull boxes when the maximum number of bends have been exceeded.
1. Covers shall be accessible.
 2. Conduit bodies for power circuits may be used as follows:
 - a. On exposed runs at junctions, bends, or offsets where splices are not required.
 - b. Around outside corners of walls and equipment or around beams.
 - c. Conduit bodies are not allowed for use with conduits containing telecommunication cables.
- L. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 5. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 6. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- M. Provide grounding and bonding in accordance with Section 26 05 26.
- N. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
- O. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction, and splicing points.
- P. Trade Coordination:
1. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts installed under other sections or by others.
 2. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 3. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
- Q. Empty conduits:

1. Install 5 mm 3/16 inches minimum diameter polypropylene or nylon pull-line from end to end with tag at each end designating opposite terminus.
- R. Make joints in threaded conduit watertight with white nonlead compound applied to male threads only.
 1. Cut square, ream smooth, and properly thread field joints to receive couplings.
 2. Do not use running threads.
- S. Electrical conduit installation shall maximize the ability to install additional conduit in the future. Contractor to submit coordination drawings per section 26 00 10 indicating final routing of conduit systems.

3.3 INSTALLATION OF CONDUIT ABOVE GRADE

- A. Unless otherwise noted, install conduits concealed within walls and above finished ceilings.
- B. Do not run horizontally in CMU.
- C. Run conduit in straight lines at right angles to or parallel with walls, beams, or columns.
- D. Keep conduit away from uninsulated hot water and steam pipes.
 1. Where crossings are unavoidable, leave minimum 150 mm 6 inches clearance.
- E. Avoid running conduits underneath water lines except for crossings.
- F. Do not cross conduit in front of access door in HVAC duct.
- G. Provide conduit support designed for building structural conditions to carry load imposed.
- H. Provide inserts or fasteners to attach hangers to structure.
 1. Attachment to metal roof deck may be by means of pre-punched tabs, pre-punched holes, or with screws in sides of ribs or toggle bolts in bottom of ribs.
 2. Space hangers in joints between precast units at minimum 100 mm 4 inches from walls.
- I. Use trapeze assemblies to support multiple conduits.
 1. Coordinate layout to provide adequate access to cable tray assemblies if applicable.
- J. Installation of conduit or rack of conduits shall not interfere with placement of specified luminaires.
- K. Hangers in roof deck:
 1. Do not extend above tops of ribs, or otherwise interfere with vapor retarder, insulation, or roofing.
- L. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
- M. Independently support conduit systems from building structure or walls with approved hangers.
 1. Do not use following to support conduit:
 - a. Wire including ceiling support wires.
 - b. Perforated strap hangers.
 - c. Plastic or nylon tie wraps.
 2. Do not support from piping, ducts or support systems for piping or ducts.
 3. Do not support from ceiling or ceiling support systems.
 4. Do not install to prevent ready removal of equipment, piping, ducts, or ceiling tiles.
 5. Do not support from drywall.
- N. Support suspended conduits within 300 mm 12 inches of any change of direction of 45 degrees or greater.

- O. Neatly seal openings around conduits, etc., where they pass through fire rated construction or exterior walls or roof. Provide proper rated seal for fire-rated penetrations.
- P. No exterior horizontal roof supported conduit runs are permitted in lengths exceeding 6 feet unless indicated otherwise.
- Q. Conduit stub-outs:
 - 1. Extend conduit stub-out to cable tray system and attach to edge of tray with cable tray manufacturer recommended coupling.
 - 2. Terminate conduit with insulating bushing.
- R. Install rigid conduits squarely into boxes.
 - 1. Rigidly clamp to box with locknut on outside and inside and provide bushing on inside.
- S. Fit all conduit ends at switch and outlet boxes with approved lock nuts and bushing forming approved tight bond with box when screwed tightly in place.
- T. Above lay-in tile ceilings, make connections to lay-in type luminaires with flexible steel conduit no longer than 1830 mm 6 feet.
 - 1. Conduit shall be supported to structure or support wires above ceiling. Do not install on ceiling or ceiling tiles.
 - a. Zip ties shall not be used as a means of attachment.
 - 2. Arrange conduit and box systems for easy removal of lay-in ceiling.
- U. Provide connections to door security devices in hollow metal jamb posts using 13 mm 1/2 inches flexible steel conduit.
- V. Provide expansion joint fittings as follows:
 - 1. On conduit at all building expansion or control joints where conduit is rigidly attached to structure.
 - 2. Where necessary to compensate for thermal expansion and contraction.
 - 3. Flexible metal conduit may be used for expansion fittings on runs smaller than 25 mm 1 inch where exposed or concealed above suspended ceilings.
 - a. Leave slack in conduit for movement.
 - b. Fasten on each side of joint.
- W. Provide junction box with duct-seal on raceways subject to different temperatures including but not limited to:
 - 1. Conduits passing from interior to exterior of structure.
 - 2. Conduits serving cold storage rooms, freezers, and refrigeration equipment.
- X. When roof exhaust fans are equipped with housing conduit entries and integral disconnects, install conduit to roof exhaust fans through fan housing with no conduit exposed.

3.4 INSTALLATION OF CONDUIT WITHIN OR THROUGH STRUCTURAL ELEMENTS

- A. Conduit shall not be installed within structural elements, i.e., concrete columns, beams, decks, or slabs unless otherwise noted.
 - 1. Conduit in concrete columns:
 - a. Install no conduit larger than 19 mm 3/4 inches in concrete columns.
 - b. Do not install multiple conduits in a single concrete column without the Structural Engineers approval.
 - 2. Conduit in slab on grade:
 - a. The outside diameter of a single conduit or vertical dimension of two or more stacked conduits (including crossovers) shall not exceed 1/3 the thickness of the slab.

- b. The outside horizontal dimension of two or more adjacent conduits shall not exceed twice the depth of the slab and the separation between groups of conduits shall not be less than the thickness of the slab.
- 3. Conduit in elevated slabs on metal deck:
 - a. Do not install conduit in concrete slabs on metal deck without the Structural Engineer's approval except as follows:
 - 1) The outside diameter of a single conduit or vertical dimension of two or more stacked conduits (including crossovers) shall not exceed 1/5 the total thickness of the slab.
 - 2) The outside horizontal dimension of two or more adjacent conduits shall not exceed the total thickness of the slab and the separation between groups of conduits shall not be less than the total thickness of the slab.
 - 3) The conduit shall have a minimum concrete cover of 19 mm 3/4 inches top and bottom.
- 4. Conduit in elevated slabs:
 - a. Do not install conduit in elevated concrete slabs without the Structural Engineer's approval except as follows:
 - 1) The outside diameter of a single conduit or vertical dimension of two or more stacked conduits (including crossovers) shall not exceed 1/5 the thickness of the slab.
 - 2) The outside horizontal dimension of two or more adjacent conduits shall not exceed the thickness of the slab and the separation between groups of conduits shall not be less than the thickness of the slab.
 - 3) The conduit shall have a minimum concrete cover of 3/4 inches top and bottom.
- B. Conduit penetrations passing through concrete walls, decks, or slabs:
 - 1. All core drilling, sleeves, block-outs, and other penetrations must be approved by Structural Engineer prior to installation.
 - 2. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 - a. Space sleeves and core drills to ensure minimum of three (3) times nominal trade diameter of largest adjacent conduit between sleeves or core drills.
 - 3. Use block-outs for concentrations of conduits in confined area.

END OF SECTION

SECTION 26 05 34

BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Boxes, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. National Electrical Manufacturers Association (NEMA):
 - 1. FB-1, Fittings, Cast metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- B. Society of Cable Telecommunications Engineers (SCTE).
 - 1. 77, Specification for Underground Enclosure Integrity.
- C. Underwriters Laboratories, Inc. (UL):
 - 1. 514A, Metallic Outlet Boxes.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Dimensioned drawings indicating locations of all floor boxes.
 - 2. Dimensioned drawings indicating locations of all poke-thru assemblies.
- B. Product Data:
 - 1. Describe configurations, finishes, colors, and dimensions for the following:
 - a. Ingrade splice boxes.
 - b. Special mounting boxes and covers.
 - c. Floor boxes.
 - d. Poke-thru assemblies.
 - e. Provide IBC Certificates of Compliance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Galvanized Outlet Boxes and Fittings:
 - 1. Base:
 - a. Hubbell/RACO.
 - 2. Optional:
 - a. Emerson Industrial – Appleton Electric.
 - b. Thomas & Betts –Steel City.
- B. Corrosion Resistant Boxes:
 - 1. Crouse Hinds.
 - 2. Robroy.
- C. Wet Location Boxes/Covers:

1. Base:
 - a. Hubbell.
 2. Optional:
 - a. Thomas & Betts.
 - b. Robroy.
- D. Box Supporting Brackets:
1. Base:
 - a. Hubbell/RACO.
 - b. Erico/Caddy.
- E. Ingrade Splice and Pull Boxes:
1. Base:
 - a. Hubbell/Quazite.
- F. Flush Floor Boxes:
1. Base:
 - a. Hubbell.
 - b. Wiremold.
 2. Optional:
 - a. FSR, Inc.
- G. Flush Poke-Thru Devices:
1. Base:
 - a. Wiremold.
 - b. Hubbell.
- H. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 WALL OUTLET BOXES

- A. General:
1. Minimum Size.
 - a. 100 mm 4 inches square or octagon.
 - b. Depth as required.
 2. Lighting outlet boxes.
 - a. Galvanized.
 - b. Use extension and plaster rings as required.
 - c. Verify proper depth with partition thickness.
 - d. Provide with proper fittings to support and attach luminaires.
 - e. Support outlet boxes for luminaires and other ceiling mounting devices in lay-in acoustic tile ceilings by bar hangers anchored to ceiling construction members which do not interfere with tile removal.
 3. Switch and receptacle boxes for concealed wiring.
 - a. Galvanized.
 4. Pull and junction boxes.
 - a. Galvanized steel, code gauge.
 - b. Cover:
 - 1) Same material as box, screw-on type.
 5. Masonry boxes for CMU installation.

- a. 3-1/2 inches deep, non-gangable with integral brackets to hold box to concrete block from front and back. Includes break-off front tabs.
 - b. Hubbell RACO Block-Loc series.
 - 6. Boxes for 277 volt switches on opposite phases.
 - a. Where multi-ganging boxes occur, provide barriers per NEC.
 - 7. Extension Rings.
 - a. To suit conditions.
 - 8. Hardware.
 - a. Grounding screw and connectors as required by wiring method.
 - 9. Supports.
 - a. Box supporting brackets.
 - 1) Caddy MEB1 and SGB Series.
 - b. Far side box support.
 - 1) Hubbell/RACO Model No. 978.
 - 2) Erico Model No. 766.
 - 3) Caddy Model No. J1A35.
 - 10. PVC coated steel boxes.
 - a. Provide NEMA RN-1 compliant coating of PVC.
- B. Narrow switch boxes (for hollow metal jambs):
 - 1. Base Product: Hubbell/RACO 426.
- C. Weatherproof box and cover (mounted to building):
 - 1. Box:
 - a. Corrosion resistant cast malleable iron type, with threaded hubs and neoprene gasket.
 - b. Design basis: Crouse-Hinds Type FS.
 - 2. Cover for damp locations:
 - a. Suitable for damp location when receptacle is in use.
 - b. Gasketed and self-closing, zinc die cast, gray, lift cover.
 - 1) Single outlets: Hubbell RW51550.
 - 2) Duplex outlets: Hubbell RW51470.
 - 3) Duplex GFCI and USB receptacles: Hubbell RW51040.
 - 3. Cover for wet locations:
 - a. Suitable for wet location when receptacle is in use.
 - b. Die-cast aluminum construction; meets extra-duty rating in UL 514D.
 - c. Padlockable, gasketed NEMA 3R cover.
 - 1) Single outlets: Hubbell WP700E.
 - 2) Duplex outlets: Hubbell WP26E with duplex adapter.
 - 3) Duplex GFCI receptacles: Hubbell WP26E.
- D. Television/Monitor Multi-Service Wall Box:
 - 1. Provide interface between power and audio/video cabling by providing a common recessed wall box for all device outlets.
 - 2. 18 GA cold-rolled steel housing with a white powder coat finish. Includes a high impact ABS trim ring.
 - 3. 2-gang enclosure shall be 8-1/8 inches H x 8 inches W x 3-3/8 inches D.
 - 4. Refer to Drawings for devices specified within box.
 - 5. Multi-service wall box: Hubbell NSAV62M.

E. Television/Monitor Multi-Service Wall Box:

1. Provide interface between power, communication, and audio/video cabling by providing a common recessed wall box for all device outlets.
2. Stamped steel with a polyester baked white enamel interior finish.
3. Independent wiring compartments that accommodate standard size wall plates and shall have removable and relocatable dividers.
4. Device and storage compartments removable from the top of the box.
5. Mounting brackets allowing box to be secured to wall studs.
6. 8-3/4 inches H by 13 inches L trim ring flange and decorative cover with white finish.
7. Dimensions: 11-1/4 inches L by 4 inches W by 11-5/8 inches H.
8. Refer to Drawings for devices specified within box.
9. Multi-service wall box: Wiremold EFSB2.

F. Interior Countertop Mounted Box for Duplex Receptacles:

1. Pop-up countertop receptacle:
 - a. Die-cast aluminum cover, flange, and wiring chamber.
 - b. Thermoplastic main body.
 - c. Elastomer and silicon water seals.
 - d. 4 inches diameter flush installation top flange without chamfer.
 - 1) Polished chrome finish.
 - e. 4.70 inches depth.
 - f. 15 A, 125 V tamper resistant receptacle.
 - g. Push-down to pop-up function.
 - h. Aluminum finish.
 - 1) Hubbell Model No. RCT201ALU.

2.3 INGRADE SPLICE AND PULL BOXES

- A. Polymer concrete, PC Style gasketed boxes, black color; with open base.
- B. Size: unless indicated otherwise on drawings;
1. 8 inches width x 18 inches length x 8 inches depth.
- C. ANSI/SCTE 77 Tier Load Rating.
1. Tier 15.
- D. Cover Text.
1. Power.
 2. Comm.
 3. Fiber Optics.

2.4 FLUSH FLOOR BOXES

- A. General:
1. See Section 26 07 26 and electrical symbol legend for receptacle requirements.
 2. Provide single service or combination power and communication boxes as indicated.
 3. Floor boxes do not provide any fire separation or fire rating.
 - a. Floor boxes shall rely upon floor assembly components, physical dimensions, structural materials, etc., to provide fire separation and rating.
 - b. Coordinate all floor box installations with other trades to ensure that installation will provide required floor rating.

4. For floor boxes in laboratory and lab support areas, comply with UL 514 A and C scrub water requirements to prohibit entrance of water into box when covers are closed.
- B. Flush Surface-Activation Single-Service Floor Boxes:
1. Metallic Box.
 - a. Flush in-floor box for duplex receptacle:
 - 1) Dual level 100 mm 4 inches round fully adjustable cast iron box with aluminum ring.
 - a) Floors over 75 mm 3 inches deep: Hubbell BA-2536.
 - b) Floors 75mm 3 inches deep or less: Hubbell BA-2537.
 - 2) Dual level 100 mm 4 inches round fully adjustable stamped steel box with aluminum ring.
 - a) Floors over 75 mm 3 inches deep: Hubbell BA-2527.
 - b) Floors 75mm 3 inches deep or less: Hubbell BA-2529.
 - 3) Covers:
 - a) Round aluminum fitting cover, duplex flap: Hubbell SA-3925.
 - b) Round aluminum carpet flange: Hubbell SA-3182. Provide as required.
 - c) Pedestal service fitting: Hubbell SC3098/ SS309B/ SS309D.
 2. Non-metallic Box.
 - a. Flush Nonmetallic in-floor boxes for power and communications:
 - 1) Injection-molded flush rectangular nonmetallic in-floor box with metallic cover.
 - a) Rectangular shape designed for ganging of boxes together through dovetail, interlocking mechanism.
 - 2) Dimensions:
 - a) Length: 140 mm 5.5 inches.
 - b) Width: 105 mm 4.13 inches.
 - c) Height: 152 mm 6 inches.
 - d) Wiring volume: Minimum of 820 cubic centimeter 50 cubic inches to maximum of 1639 cubic centimeter 100 cubic inches.
 - 3) Knockouts shall be provided on sidewalls of each box to provide for pass-through capability between each gang.
 - 4) Box shall have concrete depth markings on exterior of box to indicate box depth at time of pour.
 - a) Provide graduated cubic inch markings on interior of box to indicate volume capacity at appropriate box depth.
 - b) Box shall accommodate concrete depths from 90 mm 3.5 inches minimum to 150 mm 6 inches maximum.
 - 5) Floor box shall provide two 35 mm 1.25 inches trade size conduit openings to feed cabling to box. Each box shall also provide means to reduce this opening down to fit 25 mm 1 inch, 19 mm 3/4 inches and 13 mm 1/2 inches trade size conduit.
 - 6) Box shall provide means to plug off unused conduit openings.
 - 7) Provide nonmetallic, reusable mud-cap to prevent concrete entry during pour and debris entry after pour.
 - 8) Provide ratchet teeth along interior box walls to attach cover options.
 - 9) Adjusting Ring:
 - a) Provide to attach flanges and covers to floor box body.
 - b) Provide ratchet teeth to align with teeth on box wall to connect to box body without use of glue or mechanical fasteners.
 - c) Provide 10 degrees of adjustment after concrete pour to adjust to various concrete conditions and floor finishes.

- 10) Provide brass inserts to mount finish flanges to box body.
- 11) Provide for grounding locations through use of brass inserts.
- 12) Covers and Flanges:
 - a) Floor boxes shall accept brushed aluminum cover plates and flanges available for one-, two-, or three-gang applications.
 - b) Provide 13 mm 1/2 inches of adjustment in flange to accommodate various floor covering and concrete pour depths.
 - c) Brushed aluminum flanges shall be approved for use on carpet, tile, or wood covered floor applications. Flanges and cover plates shall have a buffed appearance protected with lacquer finish.
 - d) Brushed aluminum cover plate options shall seat inside the aluminum flanges and be flush with finished floor. Brushed aluminum cover plate dimensions shall be 84 mm 3.29 inches wide by 109 mm 4.31 inches long.
- 13) Wiremold 880MP boxes with 818TCAL single-gang flange and cover plate, and/or 827 TCAL two-gang flange and cover-plate.

C. Flush Recessed-Activation Multi-Service Floor Boxes:

1. Capable of supplying power, data, and voice services.
2. Floor box material:
 - a. 16 GA galvanized sheet metal and cast iron construction.
3. Gangs, see Drawings:
 - a. 2 gang:
 - 1) 3 inches deep x 6-5/8 inches wide x 16-1/4 inches long.
 - 2) 113 cubic inches capacity.
 - 3) Hubbell System One CFB2G30E.
 - b. 4 gang:
 - 1) 3 inches deep x 11-3/8 inches wide x 14-1/2 inches long.
 - 2) 204 cubic inches capacity.
 - 3) Hubbell System One CFB4G30E.
 - c. 6 gang:
 - 1) 3 inches deep x 11-1/2 inches wide x 19-5/8 inches long.
 - 2) 283 cubic inches capacity.
 - 3) Hubbell System One CFB6G30E.
 - d. 10 gang:
 - 1) 5-1/2 inches deep x 11 inches wide x 14-1/8 inches long.
 - 2) 407 cubic inches capacity.
 - 3) Hubbell System One CFB10G55E.
4. Cover:
 - a. Provide device plates and dividers within boxes as required by application.
 - b. Meet requirements of UL514A (scrub water compliant).
 - c. Die cast aluminum construction.
 - d. Style (see Interiors Series of Drawings for floor finish):
 - 1) For carpet or vinyl composite tile applications with surface cover. 11-11/16 inches long x 7-3/16 inches wide for 2-gang and 4-gang applications.
 - a) Hinged door.
 - (1) Include two large cable egress doors and 180 degree access opening.
 - (2) Hubbell 24GCCVRALU (aluminum powder coat).
 - b) Furniture feed.

- (1) Include one 1 inch and one 2 inch plugs.
 - (2) Hubbell 24GCFFCVRALU (aluminum powder coat).
- 2) For finished concrete or terrazzo applications with flush cover. 10-11/16 inches long x 6-3/16 inches wide for 2-gang and 4-gang applications.
 - a) Hinged door.
 - (1) Include two large cable egress doors and 180 degree access opening.
 - (2) Hubbell 24GTCVRLU (aluminum powder coat).
 - b) Furniture feed.
 - (1) Include one 1 inch and one 2 inch plugs.
 - (2) Hubbell 24GTFFCVRALU (aluminum powder coat).

D. Flush Recessed-Activation Extra Capacity Multi-Service Floor Boxes:

- a. Capable of supplying power, voice, data and audio-visual services.
- b. Concrete-tight stamped steel construction with 14 gauge sides and bottom and 10 GA steel top.
- c. Painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and be approved for use on grade and above-grade floors.
- d. Eleven (11) gang.
 - 1) One 3-gang, two 1-gang, and one 6-gang compartments.
- e. Nominal box dimensions:
 - 1) Length: 375 mm 14.75 inches.
 - 2) Width: 320 mm 12.63 inches
 - 3) Height: 155 mm 6.13 inches.
 - 4) Wiring volume: 5114 cm 3 279 cubic inches.
- f. Conduit knockouts.
 - 1) Four combination 1 inch and 1-1/4 inches concentric trade size, four combination 3/4 inches and 1 inch concentric trade size, and ten combination 1-1/4 inches and 2 inches concentric trade size.
- g. External pre-pour adjustment shall be provided by at least 50 mm 2 inches leveling screws.
- h. Cover:
 - 1) Cast aluminum.
 - 2) Lid to be offered with solid, flush surface for tile, wood or terrazzo and an insert option for carpet inlay.
 - 3) Egress to be provided by two 24 mm 15/16 inches by 156 mm 6-3/8 inches access doors.
 - 4) Access door to fold under lid during cable exit for unobtrusive appearance and mechanical protection.
- i. Wiremold Model No. RFB11.

2.5 THROUGH-FLOOR POKE-THRU DEVICES

A. Recessed Outlet Poke-Thru Devices:

- 1. Poke-thru devices provide an interface between power, communication and audio/visual (A/V) cabling in an above grade concrete floor and the workstation or activation location where power, communication and/or A/V device outlets are required. These devices provide recessed device outlets that will not obstruct the floor area. Refer to the Drawings for types.
- 2. Poke-thru devices shall be compatible with workstation connectivity outlets and modular inserts, system adapters, and/or a variety of audio/video devices.

- B. Classification and Use: Poke-thru device shall have been examined and tested by Underwriters Laboratories Inc. to comply with UL514A and/or UL514C and bear the UL Listing Mark. Poke-thru device shall also have been tested by UL and classified for fire resistance and bear the UL Classification Mark. The poke-thru device shall conform to the standards set in the National Electrical Code, Section 300-21.
1. Poke-thru devices shall be classified for use in 1, 1-1/2, or 2-hour rated floors and 1, 1-1/2, or 2 hour rated floors employing unprotected steel floor units and concrete toppings, or concrete floors with suspended ceilings. Fire resistive designs with suspended ceilings shall have provisions for accessibility in the ceiling below the poke-thru device fittings.
 2. Poke-thru device shall have been evaluated by UL to meet the applicable safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
 3. These devices are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens.
 4. Poke-thru device shall be suitable for use in air handling spaces in accordance with Section 300-22C of the National Electrical Code.
- C. Poke-Thru Assembly:
1. Poke-thru device assemblies shall consist of an insert and an activation cover. Assembly length: 16-3/4 inches 425mm.
 2. Body consists of an intumescent firestop material to maintain fire rating of the floor slab. Hold intumescent material securely in place in insert body. Intumescent material will not have to be adjusted to maintain fire rating of the unit and the floor slab. Provide insert with a retaining feature to hold the poke-thru device in the floor slab without additional fasteners. Poke-thru insert shall also consist of a 3/4-inch trade size conduit stub that is connected to the insert body and a 24.5 cu in 402 ml stamped steel junction box for wire splicing and connections. Stamped steel junction box shall also contain the means necessary to electrically ground the poke-thru device to the system ground.
 3. 6 inches Diameter with recessed activation devices.
 - a. Insert.
 - 1) Insert body shall recess the devices a minimum of 2-3/4 inches 69 mm and have a polyester based backing enamel finished interior; ivory color. Furnish with necessary channels to provide complete separation of power and communication services. Provide three (3) compartments that allow for up to three (3) duplex receptacles that can be wired as a standard receptacle or isolated ground and/or 12 communication ports.
 - b. Activation Cover.
 - 1) Manufactured of die-cast aluminum alloy. Provide with two (2) gaskets (one (1) for surface and one (1) for flush) to go under the trim flange to maintain scrub water tightness. Activation cover is 7-1/4 inches 184 mm in diameter. Provide cover with spring-loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible.
 - 2) Finishes.
 - a) Brushed Aluminum.
 - c. Communication Modules Mounting Accessories.
 - 1) Provide activation unit with three locations to mount communication connectors. Mount connectors using a mounting bracket capable of accepting insert modules or discrete keystone connectors. Also provide unit with mechanism to permit protection of communication cabling. Fabricate mechanism from stamped steel construction. Mechanism shall accept both flexible and rigid 3/4-inch, 1-1/4-inch or two-inch trade size conduit.
 4. The design basis for recessed outlet poke-thru devices is Evolution Series Poke-Thru Devices manufactured by Legrand/Wiremold.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate the work with other trades and architect to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
- B. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
- C. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
- D. Coordinate the work with other trades and architect to provide walls suitable for installation of flush-mounted boxes where indicated.
- E. Coordinate with Architect final box cover material and color requirements.
- F. Coordinate with Architect and Structural Engineer the final types and locations of floor boxes and/or poke-through devices.
- G. Coordinate with low voltage system engineer(s) the requirements for common floor boxes/poke-through devices provided for power and low voltage system outlets.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide separate boxes for emergency, legally required, optional standby, and normal power systems.
- C. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- D. Where floor mounted power receptacle outlet and low voltage system outlet (IT, audio, video, etc.) occur at the same location, power and low voltage system devices shall be provided with a multiple gang box under a single cover plate as required.
- E. Mounting Outlet Boxes for Concealed Wiring:
 - 1. Boxes mounted adjacent to studs shall be attached directly to stud with a minimum of 4 metal screws.
 - a. Provide far-side box support on all boxes.
 - b. Box side support shall be secured to box with drywall screws.
 - 2. Boxes that are not attached directly to studs shall be attached to box support bracket spanning studs.
 - a. Bracket shall be attached to studs with 2 screws at each end.
 - b. Attach box to bracket with 2 screws minimum.
 - 3. For outlets mounted above, below or within counters, benches, or furniture, coordinate location and mounting heights with casework, millwork, and furniture.
 - a. Adjust outlet mounting height to agree with required location for equipment served.
 - 4. Position outlet boxes to locate luminaires as shown on reflected ceiling plans.
- F. Mounting of junction boxes in existing walls:
 - 1. Where junction boxes or device boxes are to be mounted in existing walls, sufficient drywall shall be removed to allow proper support of box by attaching directly to stud or bracket spanning 2 studs.
 - a. Patch drywall and seal as required to return wall to original finish.
- G. When a metallic junction box for electrical receptacles or switches is contained within a 1 or 2-hour rated fire or smoke wall of gypsum wall board construction and an opening is provided for box in surface of wall, area of opening shall not exceed 16 square inches, unless junction box is protected by approved UL listed firestop.

1. Aggregate area of such junction boxes in a rated wall not protected by an approved firestop shall not exceed 100 square inches in 100 square feet of wall area as measured from floor to structural deck or rated membrane.
 2. Junction boxes with openings on opposite faces of rated walls shall have a horizontal separation of 24 inches as a minimum, regardless of box size, unless protected by an approved method.
 3. Locations of studs do not have any bearing on the above requirements, nor does the use of mineral wool fire-safing alter these requirements.
- H. Back to back boxes shall not be installed within the same stud cavity.
1. Where installation within the same stud cavity is required based on device layout, unfaced glass or mineral fiber sound batting or putty pads with sound reduction characteristics shall be installed to prevent sound transfer between rooms. Where putty pads are used, they shall cover all openings on box.
- I. Locate junction and pull boxes as indicated and as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 25 05 33.
- J. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- K. Install all boxes plumb and level.
- L. Clean interior of boxes to remove dirt, debris, plaster, and other foreign material.
- M. Provide grounding and bonding in accordance with Section 26 05 26.
- N. Fill unused punched-out openings in boxes with closures.
- O. Use outlet boxes sized to accommodate quantity of conductors enclosed.
- P. Provide pull boxes or junction boxes in conduit runs where indicated or as required to facilitate pulling of wires or making of connections.
1. Make box covers accessible.
- Q. Paint inside of boxes and box cover per Section 26 05 53.
- R. Identify circuit numbers on inside of box and cover plate.
1. Identification shall be post painting of boxes.
- S. Coordinate floor boxes with slab depth to assure that concrete depth is adequate for specified box.
1. Set boxes level based on slab depth.
 2. Maintain fire rating.
- T. Poke-thru assemblies shall permit wiring to be completed at floor level.
1. Core drill holes to accommodate assemblies as required.
 - a. Coordinate requirements with manufacturer.
 2. Locate poke-thru devices a minimum of two (2) foot on center and so no more than one assembly is provided per 6 square meters 65 square feet of floor area in each span.
 3. Complete installation by pushing unit down into cored hole.
 - a. Prior to and during installation, refer to system layout and/or approval drawings.
 4. Installer shall comply with detailed manufacturer's instruction sheet included with each device.
 5. Each assembly shall contain retainer for securing device in slab, as well as necessary intumescent material to seal cored-hole under fire conditions.
- U. Identification and Labeling

1. As indicated in Section 26 05 53.

END OF SECTION

SECTION 26 05 35
SURFACE METAL RACEWAYS AND WIREWAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Surface Metal Raceways and Wireways, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SYSTEM DESCRIPTION

- A. Design Requirements / Performance Requirements
 - 1. Field-wired surface metal raceways for branch circuit wiring and voice, telecommunications, video, and other low-voltage wiring as indicated.
 - 2. Provide wireways to consolidate or splice conductors where indicated.

1.3 REFERENCES

- A. Reference Standards:
 - 1. UL 5 – Standard for Surface Metal Raceways and Fittings.
 - 2. UL 870 – Wireways, Auxiliary Gutters and Associated Fittings
 - 3. NEMA WD 6 – Wiring Device Configurations.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Provide manufacturer's standard literature describing components identified below as specified for this project.
 - a. Field-wired surface metal raceways.
 - b. Wireways.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Surface Metal Raceways:
 - 1. Base:
 - a. Legrand/Wiremold.
 - 2. Optional:
 - a. Hubbell.
- B. Wireways:
 - 1. Base:
 - a. Schneider Electric/Square D.
 - 2. Optional:
 - a. Eaton Electrical.
 - b. Siemens.
 - c. ABB / General Electric.
 - d. Hoffman.
 - e. Mono-Systems.

C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. Field-Wired Surface Metal Raceways:

1. Two piece steel raceway with base and snap-on cover for mounting power, communication devices, or both.
2. Wiremold 3000 Series:
 - a. Nominal dimensions:
 - 1) Base and cover sections: minimum of 1 mm 0.040 inches wall thickness.
 - 2) Assembled base and cover: 70 mm 2.75 inches wide by 40 mm 1.50 inches deep with a 2265 mm² 3.50 square inches cross sectional area.
3. Provide fittings and accessories for a complete installation including but not limited to:
 - a. Base fittings, flat internal and external elbows, entrance fittings, wire clips, cover clips, couplings, c-hangers, and end caps.
 - b. Colored fittings to match raceway.
 - c. Supply fittings with base where applicable to eliminate mitering.
 - d. Provide take-off fittings to adapt different size raceways.
4. Provide device brackets and associated faceplates for mounting devices in raceway including but not limited to following features:
 - a. Brackets for mounting standard single-gang devices within raceway.
 - b. Devices shall have capacity of mounting flush or in conjunction with standard faceplates.
 - c. Faceplates to conceal seam between raceway cover and installed faceplate.
 - d. Device brackets and plates color to match raceway.
 - e. Device brackets and plates available with any combination of multiple device opening options.
 - f. Circuit breaker housings shall be available to mount from one to three single-pole circuit breakers inline to raceway.
5. Two-gang device box shall be able to accommodate up to 60 A receptacle or for use as tee, cross, junction box or for branch circuit extensions.
6. Raceway shall be electrically continuous and listed as an equipment grounding conductor.
7. Base, cover, fitting and accessory finish shall be gray and suitable for field repainting.

B. Wireways:

1. NEMA I lay-in wire-way.
2. Provide fittings as required.
3. Provide solid cover where passing through partitions.
4. Design for continuous grounding.
5. Provide general purpose, oil-tight, rain-tight, and/or dust-tight type wireway as required.
6. Knockouts shall be manufacturer's standard or as required.
7. Size as indicated on the drawings. Where size is not indicated on drawings size per NEC.
8. Hinged cover.
9. Finish: Electro-coated gray epoxy paint over phosphate primer.
10. Schneider Electric/Square D Class 5100.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate the placement of raceways with millwork, furniture, equipment, etc., installed under other Sections or by others.

- B. Coordinate rough-in locations of outlet boxes provided under Section 26 05 34 and conduit provided under Section 26 05 33 as required for installation of raceways provided under this section.
- C. Verify minimum sizes and types of raceways with the actual conductors and components to be installed.
- D. Final raceway finishes shall be as determined by the Architect.

3.2 INSTALLATION

- A. Comply with system layout drawings, detailed manufacturer's instruction sheets and system instruction sheets.
- B. All raceway systems shall be mechanically continuous and connected to electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.
- C. Metal raceway shall be electrically continuous and bonded in accordance with National Electrical Code for proper grounding.
- D. Mount surface raceway and wireways on walls or support channels as indicated in manufacturer's instruction sheets.
 - 1. Support raceway at intervals not exceeding 1.5 M 5 feet.
- E. In unfinished spaces, feed raceway with flexible or liquid-tight conduit from surface mounted outlet box on wall.
- F. Where raceway is mounted on furniture, use cover plate on outlet box with conduit connector in face and extend flexible or liquid-tight conduit to raceway.
- G. Install raceway systems complete, including insulating bushings and inserts where required by manufacturer's installation sheets.
 - 1. Unused raceway openings shall be closed.
- H. Install wiring devices in raceway of type, quantity and location indicated on drawings.
- I. Observe following guidelines for conductor fill in raceways and wireways:
 - 1. Install no more than 30 current carrying conductors.
 - 2. Cross-sectional area of conductors shall not exceed 20% of raceway or wireway.
- J. If there is an instance where a channel, or multiple channels, of a raceway are not shown on the Drawings to contain any devices, conduit and boxes shall still be roughed in for each channel to allow those channels to be used in the future.
 - 1. A future channel to be used for power shall utilize a minimum 25 mm 1 inch conduit routed back to the panel serving the room, unless noted otherwise.
 - 2. A future channel to be used for communications shall utilize a minimum 32 mm 1-1/4 inches conduit routed to the nearest cable tray, unless noted otherwise.
- K. Install wireways with manufacturer's name or trademark visible after installation.
- L. Mount wireway with section in accessible location.
- M. Close ends of wireway and any unused conduit openings.
- N. Use 305 mm 12-inch section of wireway to pass through walls, to allow accessibility on each side.
 - 1. Install special escutcheon plate on each side of wall to finish opening neatly.
- O. Do not install raceways until final surface finishes and painting are complete.
- P. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction, and splicing points.

- Q. Install raceways plumb and level.
- R. Secure and support raceways at intervals complying with NFPA 70 and manufacturer's requirements.
- S. Provide grounding and bonding in accordance with Section 26 05 26.
- T. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 05 36

CABLE TRAY

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Cable Trays, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Cable tray runs are diagrammatic.
 - 1. Verify locations in field.
- B. Reference Standards:
 - 1. ASTM B633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - 2. ASTM A653 Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process.
 - 3. ASTM A123 Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel.
 - 4. ASTM A510 Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
 - 5. ASTM A1008 Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - 6. ASTM A1011 Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low Alloy with Improved Formability
 - 7. NEMA VE 1 Metal Cable Tray Systems.
 - 8. NEMA VE 2 Cable Tray Installation Guidelines.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Cable tray including cut sheets of required components.
 - 2. Test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS; THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Cable Tray:
 - 1. B-Line (Eaton).
 - 2. P W Industries (Legrand).
 - 3. Wiremold (Legrand).
 - 4. Chatsworth.
 - 5. Cope (Atkore International).
 - 6. Unistrut (Atkore International).
 - 7. Chalfant Cable Trays (Obo Bettermann Group).
 - 8. Hubbell.
 - 9. Husky Products.
 - 10. Mono-Systems.

B. J-Hooks:

1. B-Line (Eaton).
2. Erico.
3. Panduit.
4. Mono-Systems.

C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. Wire Mesh Cable Tray:

1. Provide wire basket cable tray of types and sizes indicated with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars.
2. Wire basket type made of high strength steel wires and formed into a standard 2 inches by 4 inches wire mesh pattern with intersecting wires welded together. Wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
 - a. Straight sections shall be made from steel meeting minimum mechanical properties of ASTM A510 and shall be electro-plated zinc in accordance with ASTM B633, Type III, SC-1.
 - 1) Straight sections shall be painted flat black over Electrodeposited Zinc.
 - 2) Wall brackets and other pre-galvanized accessories shall be coated with zinc in accordance with ASTM A653.
 - b. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.
 - c. Provide all required cable drop-outs, fittings and supports for a continuous system.
 - d. Wire basket shall have 4 inches usable loading depth by 12 inches wide.
 - e. Wire basket shall have usable loading depth and width as indicated on plans.
 - f. Install and ground in accordance with NEC.
 - g. Bond trays with common cabling that are not directly connected together with a minimum number 6 AWG green insulated conductor.
 - h. Bond trays directly to cabling source feed equipment or rack with minimum number 8 AWG green insulated conductor.
 - i. Where public address cabling and similar speaker level audio system cabling is installed in cable tray, provide barriers to separate from other cables.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Clearances:

1. Maintain clearance to at least one side of cable tray to permit future cable installation.
2. Maintain minimum of 230 mm 9 inches headroom above cable tray side rail on side with clearance.
3. Provide a minimum of 6 inches clear access directly above cable trays.
4. Ductwork and piping that obstruct clearances for limited distances are acceptable when routed at right angles to tray.
 - a. Direct other trades to maintain minimum of 610 mm 24 inches between piping or duct obstructions that pass over cable tray.

B. Use trapeze assemblies to support cable trays suspended from structure.

1. Trapeze assemblies shall be constructed from channels and supported by at least two (2) 1/2 inches (minimum) diameter threaded rods.

- C. Provide approved supports for cable tray supports attached to walls.
- D. Structural Considerations:
 - 1. Steel or concrete roof/floor system including slabs or roof deck shall be in place and complete before installation of cable tray.
 - 2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Cable tray loading" but not greater than 8 feet on-center.
 - 3. Do not attach hangers to steel roof deck.
 - 4. Do not attach hangers larger than 1/2 inches diameter to bottom of concrete filled floor or roof deck.
 - 5. Individual hanger loads exceeding 1000 pounds attached to the same deck span shall not be spaced closer than 5 feet on center.
 - 6. Sum of all hangers supported by a slab span in a 5 feet by 5 feet area shall not exceed 1000 pounds.
 - 7. Attach hangers to beams whenever possible.
- E. If a run of cable tray or J-hook system is installed above an inaccessible ceiling for a length exceeding 6 feet, provide access panels as follows:
 - 1. Locate access panels directly under tray or within 12 inches of the tray edge at 8 feet on-center or,
 - 2. If access panels are more than 1 foot from the edge of tray locate so that entire length of cable tray is within 3 feet of an access panel.
 - 3. Provide access panel within 1 foot of any 45 degree or greater bend in the tray.
- F. Cable tray loading:
 - 1. Maximum loading:
 - a. 12 inches wide x 4 inches deep tray: 18 pounds/FT.
 - b. 18 inches wide x 4 inches deep tray: 27 pounds/FT.
 - c. 24 inches wide x 4 inches deep tray: 35 pounds/FT.
- G. Accessories shall be furnished as required to protect, support, and install cable tray system and shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.
- H. Support all cable tray and J-hook systems from building structure or walls with approved hangers.
 - 1. Do not support from piping, ducts or support systems for piping or ducts.
 - 2. Do not install to prevent ready removal of equipment, piping, ducts, or ceiling tiles.
 - 3. Do not support from ceiling or ceiling support systems.
- I. Support cable trays within 1 foot of any change of direction of 45 degrees or greater.

3.2 PENETRATIONS OF BUILDING FIRE AND SMOKE SEPARATIONS

- A. Where cable tray penetrates rated occupancy or area fire separations, seal penetration with a UL listed fire-stopping assemblies.
- B. Sleeve fire and smoke penetrations with a built-in fire stop system that automatically adjusts to the number of cables installed and in compliance with NEC and local fire codes.
 - 1. Manufacturers
 - a. Specified Technologies Inc. EZ-Path. Acceptable for Horizontal or vertical penetrations.
 - b. Hilti Speed Sleeve. Acceptable for Horizontal penetrations only, not allowable for vertical penetrations between floors.
- C. Provide and install additional fire stop assemblies where necessary for cable routing if available pathway or conduit sleeves do not exist such as cable tray penetrations.

- D. Provide and install the proper amount of firestop assemblies with a fill ratio determined and recommended by the manufacturer plus an overall spare capacity of 25 percent.
- E. Any wall penetration will not decrease the original fire rating of the wall.
- F. Fire-stopping shall comply with Section 07 84 00.

3.3 GROUND CABLE

- A. Bond to tray once on each length or section of tray using clamps manufactured for this purpose.
- B. Equipment grounding conductor connections to the tray shall be made using a U.L. listed mechanical connection.
 - 1. Do not use sheet metal or TEK screws for grounding.

3.4 TESTING

- A. Test wire basket support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test methods.
- B. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the "worst case" loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Underground Ducts and Raceways for Electrical Systems, as indicated, in accordance with provisions of Contract Documents.
- B. Definitions:
 - 1. Unsuitable material: Debris and/or soil material judged unsuitable by Engineer for support of slabs or other site improvements.
 - 2. Engineer: Soils Engineer employed by Owner, empowered to conduct inspections and make approvals.
 - 3. Rock excavation:
- C. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. Manholes.
 - 2. Handholes.
- B. Product Data:
 - 1. Duct bank conduit separation.
- C. Project Information:
 - 1. Test reports.
 - a. Indicate compliance with ASTM C857 and ASTM C858.
 - 2. Record documents.
 - a. Indicate dimensioned locations of all underground ducts, handholes, and manholes.

1.3 QUALITY ASSURANCE

- A. Compaction density test:
 - 1. Standard Proctor, ASTM D698.
- B. Owner will hire an independent soils laboratory to conduct in place moisture and density tests.
 - 1. Contractor to pay for retests of materials failing initial tests.
 - 2. Notify Owner's representative at least 48 hours prior to anticipated date of testing.
 - 3. Contractor will pay additional cost if work is delayed due to Contractor's failure to notify Owner's agent as specified above.
- C. Comply with Safety Rules & Regulations for Excavation for local jurisdiction.

1.4 JOB CONDITIONS

- A. Protect existing utilities and structures as indicated in Section 26 00 10.
- B. Avoid overloading. Keep surcharge sufficient distance back from edge of excavation to prevent slides or caving. Maintain and trim excavated materials in such a manner to be as little inconvenience as possible to public and adjoining property owners.
- C. Provide full access to public and private premises, to fire hydrants, sidewalks, and other points to prevent serious interruption of travel.

1.5 EXTRA WORK

- A. Removal and replacement of unsuitable material below design elevations will be paid for as extra work.
 - 1. Notify Owner's agent in time to have Engineer measure and record quantity removed.
 - 2. Recorded quantity will be basis for payment.
 - 3. Include unit price on Bid Form.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Duct bank conduit separators.
 - 1. Base:
 - a. Carlon.
 - 2. Optional:
 - a. IPEX.
- B. Handholes:
 - 1. Base:
 - a. Hubbell Power Systems, Inc.
 - 2. Optional:
 - a. Armorcast Products Company.
 - b. Synertech.
- C. Manholes:
 - 1. Base:
 - a. Christy Concrete Products, Inc.
 - 2. Optional:
 - a. Elmhurst-Chicago Stone Co.
 - b. Utility Concrete Products, LLC.
- D. Utility Structure Accessories:
 - 1. Base:
 - a. Campbell Foundry Co.
 - 2. Optional:
 - a. Christy Concrete Products, Inc.
 - b. Elmhurst-Chicago Stone Co.
- E. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Duct System:
 - 1. Duct system: Single or multiple, round bore PVC conduits direct-buried or completely concrete-encased as indicated.
 - a. Rigid PVC conduit: As specified in Section 26 05 33.
 - b. Separators: Concrete, plastic, or other non-metallic, non-decaying material.
 - c. Concrete: 20 685 kPa 3000 psi. Conform to Division 03 requirements.
 - d. Reinforcing steel: ASTM A615 Grade 60. Conform to Division 03 requirements.
 - 2. Pull wire: Heavy nylon cord, free of kinks and splices.

3. Marker tape: 75 mm 3 inches wide, 0.127 mm.005 inches thick brightly colored plastic tape with continuous metallic backing and a 0.0254 mm.001 inches corrosion resistant metallic foil core. Tape shall be labeled ELECTRIC, TELEPHONE or SIGNAL at intervals not exceeding 3000 mm 10 feet.
- B. Duct separation:
1. Spacers constructed of thermoplastic material that features a horizontal and vertical locking system that can be used as a base or immediate spacer.
 - a. Applicable for both direct-buried and concrete-encased installations.
 2. Available in duct sizes of 50 mm 2 inches, 75 mm 3 inches, 100 mm 4 inches, 125 mm 5 inches and 150 mm 6 inches.
 - a. Reducer to accommodate smaller duct sizes.
 3. Molded-in rebar holder.
- C. Manholes:
1. Electric and telephone manholes: Types as indicated.
 - a. Concrete: 27 580 kPa 4,000 psi. Conform to Division 03 requirements.
 - b. Precast or poured-in-place manholes acceptable.
 - c. Cover and frame: 915 mm 36 inches diameter, gray cast iron, with machine finished seat for perfect joint between cover and frame.
 - d. Embossed identification on cover: ELECTRIC, COMMUNICATIONS, or TELEPHONE
 - e. Provide floor drain with grate.
 - f. Provide cable racks, ladder rungs, 2 ground rods, cable pulling iron.
 2. Cable racks: Non-metallic, mounted on wall.
 - a. Equip with minimum of 8 adjustable hooks, minimum 2 spare hooks on each rack.
 - b. Insulators: Best quality, high-glazed porcelain; provide for each hook.
 - c. Space racks so each end of splices is supported horizontally.
 3. Ladder rungs: Galvanized, 305 x 305 x 19 mm 12 x 12 inches x 3/4 inches diameter.
 - a. Set with 180 mm 7 inches clearance from rung to wall.
 4. Ground rods: 19 x 3050 mm 3/4 inches x 10 feet long, copper weld.
- D. Handholes:
1. Construction: Polymer concrete.
 2. Suitable for light vehicular traffic (2267 kg 5000 pound over 250 x 250 mm 10 x 10 inches area).
 3. Designed and tested to temperatures of -45 deg C -50 deg F.
 4. Meet the requirements ANSI/SCTE 77 Specification for Underground Enclosure Integrity
 5. Secure cover with minimum 2 hex head fastener nuts.
 6. Open bottom.
 7. Embossed identification on cover: ELECTRIC
 8. Dimensions: Nominal 460 mm 18 inches long x 280 mm 11 inches wide x 305 mm 12 inches deep.
- E. Provide 50 mm 2 inches cover.
- F. Backfill material:
1. As approved by Engineer.
 2. Free of rock, cobbles, roots, sod, organic matter, and frozen material.
 3. Moisture content at time of placement:
 - a. 3 percent plus/minus of optimum moisture content.

- b. Add water to dry material, or dry wet material as required, or furnish off site material at no additional cost to Owner.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove and dispose of materials determined by Engineer to be unsuitable.
- B. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with other utilities, site grading, and surface features as determined in the field. Notify Engineer if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- C. Coordinate elevations of duct and duct bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features.
 - 1. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Engineer.
 - 2. Lay duct lines to minimum grade of 100 mm 4 inches in 100 feet.
 - 3. Grade may be from one manhole to next, or both ways from high point between manholes, depending on contour of finished grade.
 - 4. Install duct lines so that top of concrete is not more than 760 mm 30 inches below finished grade or finished paving at any point and not less than required by NFPA 70, Table 300.5(A).

3.2 INSTALLATION

- A. Excavate trenches by open cut method to depth indicated and necessary to accommodate the work.
 - 1. Do not excavate below indicated grades unless required to remove unsuitable material.
 - 2. Backfill over-excavations in firmly compacted 150 mm 6 inches lifts.
 - 3. Keep trenches free of water.
 - 4. Brace and sheet trenches as soil conditions dictate. Do not remove until backfilling has progressed to a stage where no damage to conduit will result from removal.
 - 5. Permission may be granted for tunnel work for crossing under crosswalks, driveways, or existing utility lines.
 - 6. Such tunnels are limited to 3050 mm 10 feet in length.
- B. Open no more than 90 m 300 linear foot of trench at one time, or less, as required by Engineer.
- C. Clean conduit before using or laying.
- D. Lay no conduit in water or in unsuitable weather or trench conditions.
- E. Accomplish changes in direction of runs exceeding total of 15 degrees, either vertical or horizontal, by long sweep bends with minimum radius of 7620 mm 25 feet.
 - 1. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
- F. Furnish manufactured bends at end of runs.
 - 1. Minimum radius of 457 mm 18 inches for conduits less than 75 mm 3 inches trade size and 915 mm 36 inches for ducts of 75 mm 3 inches trade size and larger.
- G. During construction and after duct line is completed, plug ends of conduits to prevent water washing into conduit or manholes.
 - 1. Keep conduits clear of concrete, dirt, and any other substance during course of construction.

- H. Where it is necessary to cut tapered end on a piece of conduit at site, make cut with tool or lathe designed to cut taper to match taper of particular conduit being used.
- I. Terminate conduits in end bells where duct lines enter pull boxes or manholes.
- J. After duct line has been completed, pull standard flexible mandrel not less than 305 mm 12 inches long, with diameter approximately 6 mm 1/4 inches less than inside diameter of conduit, through each conduit. Then pull brush with stiff bristles through each conduit to make certain that no particles of earth, sand, or gravel have been left in line.
- K. Pneumatic rodding may be used.
- L. Install pull wire in unused new ducts.
 - 1. Extend minimum of 915 mm 3 feet into each manhole or above pads beyond ends of ducts.
- M. Encase each conduit in concrete not less than 75 mm 3 inches beyond any surface of conduit.
 - 1. Stagger conduit joints a minimum of 300 mm 12 inches in concrete encased duct banks.
 - 2. Mix, place and cure concrete in accordance with Division 03 requirements.
- N. Provide uniform spacing between conduits: Not less than 50 mm 2 inches.
 - 1. Place separators on maximum 1220 mm 4 feet centers.
 - 2. Anchor ducts to prevent movement during placement of concrete.
- O. Make conduit joints in accordance with manufacturer's recommendations for conduit and coupling selected.
 - 1. Make conduit joints watertight.
 - 2. Brush plastic solvent cement on inside of plastic coupling fitting and outside of conduit ends.
- P. Place marker tape above service lines, electrical feeders, and communication ducts outside building footprint. Locate tape 300 mm 12 inches below finished grade.

3.3 INSTALLATION OF CONDUITS IN BELOW GRADE, NON-CONCRETE ENCASED DUCTBANKS

- A. Minimum size of underground conduit shall be 20 mm 3/4 inches.
- B. Maintain depth of conduit at least 762 mm 30 inches below finished grade.
 - 1. Remove materials from trench that could damage conduit.
 - 2. Use sand or selected material for bedding and first layer of backfill.
- C. Provide minimum separation of 300 mm 12 inches of concrete or compacted dirt between communications systems conduits and power systems conduits operating at 100 V or greater when conduits follow parallel path.
- D. For steel conduits in contact with earth or a vapor retarder, coat with 2 coats asphalt emulsion before installation, or use PVC coated steel conduit.
- E. Use long radius bends and deflection couplings for changes in direction.
 - 1. Maintain a minimum radius of 914 mm 36 inches.
- F. Tighten taper-fit joints with light blows of a sledgehammer.
 - 1. Dope threaded joints and tighten with tool.
 - 2. Seal plastic joints around entire perimeter with chemical bonding agent.
- G. Cap empty conduit.
 - 1. Seal ends with approved waterproofing compound after conductors have been installed.
- H. Provide rigid steel conduit elbows where non-metallic conduit emerges from underground, with threaded adapters for change of material.

1. Provide 914 mm 36 inches minimum radius or larger elbows as required by local utility company.
- I. Building Entrances:
 1. For direct-buried conduits penetrating a non-waterproofed wall, provide a galvanized-steel pipe sleeve for each conduit. Caulk space between conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.
 2. For direct-buried conduits penetrating a waterproofed wall, provide a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.
- J. Conduits stubbed into manholes:
 1. Terminate metal conduit with insulating bushing.
 2. Terminate non-metallic conduit with bell ends.
- K. Do not place backfill until work is inspected and approved.
- L. Provide identification for underground conduits.
 1. Use warning tape for direct-buried conduits.
 2. For warning tape, backfill trench to within 305 mm 12 inches of finished grade.
 3. Install tape continuously along entire length of trench, and complete backfill operation.
- M. All conduit stub-outs on site shall be identified in one of following ways and noted on as-built drawings provided to Owner:
 1. Cap conduits indicated to be stubbed out underground with glued-on PVC caps.
 2. Permanently marked.
 3. Dimension from landmark on site or building.
 4. Using a Global Positioning System (GPS) device accurate to within 6 inches.

3.4 INSTALLATION OF CONDUITS IN BELOW-GRADE, CONCRETE-ENCASED DUCTBANKS

- A. Minimum size of underground conduit shall be 20 mm 3/4 inches.
- B. Conduit design is based upon field assembly of raceways and spacers with concrete cast in place.
- C. Provide minimum separation of 300 mm 12 inches of concrete or compacted dirt between communications systems conduits and power systems conduits operating at 100 volts or greater when conduits follow parallel path.
- D. Unless shown otherwise, use Schedule 40 rigid polyvinyl chloride nonmetallic conduit in concrete encasement.
 1. Keep top of concrete envelope a minimum of 762 mm 30 inches below finished grade.
 2. Route conduit lines to clear interferences but make linear wherever possible.
 3. Use long radius bends and deflection couplings for changes in direction, maintaining a minimum radius of 914 mm 36 inches.
 4. Pitch conduit at 3 inches per 100 feet 1:400 away from buildings and toward manholes for drainage.
- E. Anchor conduit in place with plastic interlocking spacers 1219 mm 48 inches on-center to prevent dislocation during concrete placement.
 1. Stagger joints horizontally and vertically.
 2. Tighten taper fit joints with light blows of sledgehammer.
 3. Dope threaded joints and tool tighten.
 4. Seal joints with a chemical bonding agent.

- F. Use rigid steel conduit elbows where conduit emerges from underground.
 - 1. Provide threaded adapters for change of material.
 - 2. Provide 914 mm 36 inches minimum radius elbows or as required by local utility company.
- G. Provide concrete encasement for duct lines in areas of heavy loading such as under footings, foundations, walls, driveways, streets, parking areas, and railroads, and in locations where such areas might be extended, such as future roadways.
 - 1. In addition, provide encasement for conduit where soil has inadequate bearing capacity, and in other locations indicated.
 - 2. Extend protection 1524 mm 60 inches on each side of such areas.
 - 3. For protection of concrete-encased conduit, provide reinforcing steel in concrete envelope unless shown otherwise.
 - 4. Use No. 4 steel reinforcing bars unless indicated otherwise.
- H. Building entrances:
 - 1. For concrete-encased ducts, install reinforcing in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
- I. Provide identification for underground conduits.
 - 1. Use concrete colorant for concrete-encased conduit.

3.5 INSTALLATION OF MANHOLES AND HANDHOLES

- A. Determine exact location of each manhole and handhole after careful consideration has been given to location of other utilities, grading, and paving.
 - 1. Do not begin construction until location of each manhole and handhole has been approved by Engineer.
- B. Construct manholes of type indicated in accordance with applicable details.
 - 1. Mix, place and cure concrete in accordance with Division 03 requirements.
- C. Set manhole frames and covers.
 - 1. Paint with 2 coats asphaltic paint after inspection and approval and before setting.
 - 2. In paved areas, set top of manhole covers flush with finished surface of paving.
 - 3. In unpaved areas, set top of manhole covers approximately 13 mm 1/2 inches above finished grade.
 - 4. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of manhole and manhole frame to temporarily elevate manhole cover to existing grade level.
- D. Install cable racks, ladder rungs and cable pulling iron.
- E. Drive 2 ground rods into earth not less than 2745 mm 9 feet before manhole floor is placed.
 - 1. Extend ground rods approximately 100 mm 4 inches above manhole floor.
- F. Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days.

3.6 BACKFILLING

- A. Perform field tests and verify electrical system complies with specified requirements before backfilling.
- B. Hand or pneumatic tamp backfill around and over pipe in lifts not exceeding 200 mm 8 inches loose thickness.
- C. Backfill carefully to avoid displacing pipe joints either horizontally or vertically and to avoid breaking pipe.

D. Do not water flush for consolidation.

3.7 COMPACTION

- A. Compact trench backfill in areas under paved roads, parking areas, sidewalks, and other structures as directed by Engineer to at least 95% of maximum dry density.
- B. In locations where trench will not be under paved areas, compact backfill to minimum 90% of maximum dry density.
- C. Remove materials which cannot be compacted as specified.
- D. Replace with suitable material and compact.

3.8 FIELD QUALITY CONTROL

- A. Perform backfill density tests as directed by Engineer.
 - 1. Allow for one test per 30 m 100 feet of trench.

3.9 CLEANING

- A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2 inch 12 mm greater than internal diameter of duct.
- B. Scrub internal surfaces of manholes and handholes. Remove foreign material.

END OF SECTION

SECTION 26 05 48

VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope of Vibration and Seismic Controls:
 - 1. Vibration isolation and seismic bracing shall be required for electrical systems within new and renovated areas of construction.
- B. Furnish labor, materials, tools, equipment, and services for Vibration and Seismic Controls for Electrical Systems, as indicated, in accordance with provisions of Contract Documents.
- C. Completely coordinate with work of other trades.

1.2 SYSTEM DESCRIPTION

- A. Transverse and longitudinal bracing for seismic forces on suspended electrical systems including conduit, cable tray, bus duct, and equipment.
- B. Anchorage of floor and roof mounted electrical equipment.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Layout and mounting detail drawings showing system and proposed vibration isolation and/or seismic brace locations for systems including pre-engineered systems.
 - 2. Reference specific detail for each type of brace or anchor identifying required locations.
- B. Product Data:
 - 1. Technical data on seismic control devices.
 - 2. Structural calculations for required lateral force level for each component.
 - 3. Detailed selection data for each vibration isolator supporting equipment, including:
 - a. The equipment identification mark.
 - b. The isolator type.
 - c. The actual load.
- C. Samples:
 - 1. Sample of each type of vibration isolation device.
- D. Project Information:
 - 1. Engineering calculations indicating design moments, shears, lateral forces, and other forces signed and sealed by Specialty Structural Engineer.

1.4 QUALITY ASSURANCE

- A. Contractor is responsible for design, labor, materials and installation of seismic bracing and anchorage systems.
- B. Provide Vibration and Seismic Controls for Electrical Systems engineered to support dead, live, and lateral wind or seismic loads indicated.
 - 1. Comply with Section 01 71 21, Specialty Engineering Requirements.
 - 2. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Seismic Controls for Electrical Systems:

1. Base:
 - a. International Seismic Application Technology (ISAT).
2. Optional:
 - a. Unistrut.
 - b. Tolco.
 - c. B-Line.

B. Vibration Controls for Electrical Systems:

1. Double neoprene pads and hanger neoprene:
 - a. Base:
 - 1) Amber/Booth.
 - 2) Korfund Dynamics.
 - 3) Mason Industries.
 - 4) Kinetics Noise Control.
 - 5) Vibration Mountings & Controls.
2. Flexible electrical connections:
 - a. Base:
 - 1) Crouse-Hinds.
 - 2) Spring City Electrical Mfg. Co.

C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 SEISMIC DESIGN CRITERIA

A. Provide bracing and anchoring for equipment, conduit, cable tray, bus duct, designed, constructed, and installed to resist stresses produced by lateral forces specified under authority below:

1. International Building Code (IBC) for Seismic Design Category C.
2. ASCE/SEI 7 Chapter 13.

B. Utilize following seismic coefficients in calculating required lateral force:

1. $S_{DS} = 0.116$ International Building Code (IBC).
2. $I_p = 1.5$ For Normal Electrical Systems.
3. $I_p = 1.5$ For Essential Electrical Systems.

C. Seismic forces shall be presumed to act through center of mass of equipment in direction that will produce largest single anchor force.

2.3 SEISMIC MATERIALS

A. Suspended Bracing Systems:

1. Custom engineered systems designed using specified criteria and common building materials.
2. Provide on-site technical support and installer training by factory trained technical representative or structural engineer providing design.

B. Equipment Anchors and Supports:

1. Drilled-in-place concrete anchors: Approved ICC Evaluation Services Report.

2. Cast-in-place anchors: Comply with ASTM A36, ASTM A307, or ASTM F1554-36.
3. Anchors permanently exposed to weather or corrosive environments shall be stainless steel or hot-dipped galvanized.
4. Structural steel for supports: ASTM A36
5. Cold formed metal and connection material: Unistrut or equal.

2.4 VIBRATION ISOLATION MOUNT TYPES

A. Type DNP (Double Neoprene Pad) :

1. Neoprene pad isolators shall be formed by two layers of 1/4 inches thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate. These layers shall be permanently adhered together. Neoprene shall be 40 to 50 durometers. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Type DNP isolators shall be formed from one of the following products or approved equal:
 - a. Type NR: Amber/Booth.
 - b. Type Korpad: Korfund Dynamics.
 - c. Type WSW: Mason Industries.
 - d. Type NPS: Kinetics Noise Control.
 - e. Multi Layers of Series Shear-Flex or Maxi-Flex: Vibration Mountings & Control.

B. Type HN (Hanger Neoprene):

1. Vibration isolation hangers shall consist of a neoprene-in-shear or glass fiber element contained in a steel housing. A neoprene neck bushing (or other element) shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30 degree arc before contacting the hanger housing.
2. Type HN isolators shall be one of the following products or approved equal:
 - a. Type BRD-A: Amber/Booth.
 - b. Type H: Korfund Dynamics.
 - c. Type HD: Mason Industries.
 - d. Type RH or FH: Kinetics Noise Control.
 - e. Type RHD or RFD: Vibration Mountings & Control.

2.5 VIBRATION ISOLATION FLEXIBLE ELECTRICAL CONNECTIONS

A. Type A:

1. Flexible electrical connection Type A shall be a prefabricated unit incorporating a flexible and watertight outer jacket, grounding strap, plastic inner sleeve to maintain a smooth wireway, and end hubs with tapered electrical threads to fit standard threaded rigid metal conduit.
2. Flexible electrical connection Type A shall be a Crouse-Hinds 'XD Expansion/Deflection Coupling', or Spring City Electrical Mfg. Co. 'DF Expansion and Deflection Fitting'.

B. Type B:

1. Flexible Electrical Connection Type B shall be field fabricated using a minimum 24 inches length of flexible conduit or cable.

C. Type C:

1. Flexible Electrical Connection Type C shall be field fabricated using a minimum 48 inches length of flexible conduit or cable.

PART 3 - EXECUTION

3.1 SEISMIC GENERAL REQUIREMENTS

- A. Design and install bracing and anchoring for equipment, conduit, cable tray, and bus ducts in accordance with requirements of this section.
- B. A run is defined as suspended pipe, conduit, cable tray, bus duct or trapeze rack having minimum 5 feet straight run length.
- C. Runs requiring bracing shall have a minimum of two transverse braces and one longitudinal brace.
- D. Brace spacing shall not exceed maximum allowable brace spacing as engineered by manufacturer or custom bracing designer.
- E. Bracing may be omitted from conduit, cable tray, and bus duct runs less than 5 feet in length.
- F. Bracing may be omitted from conduit, cable tray, and bus duct runs where rod hung supports of less than 12 inches in length are required.
 - 1. Unbraced suspended utility systems having 2 inches conduit and larger or systems weighing more than 5 pound/FT shall be installed with minimum 6 inches clearance to suspended ceiling vertical hanger wires.
 - 2. Conduit, cable tray, or bus duct shall be installed such that lateral motion of members will not cause damaging impact with other systems or structural members or loss of vertical support.
- G. Longitudinal brace with 90-degree change in direction may act as Transverse Brace if located within 2 feet of change in direction.
- H. Transverse brace may act as longitudinal brace if it is located within 2 feet of change in direction and if brace arm and anchorage have been sized to meet or exceed requirements of Longitudinal Brace.
- I. When bracing equipment or utility system suspended from overhead deck, brace back to overhead deck or to structure supporting deck.
 - 1. Do not brace to another element of structure which may respond differently during seismic event.
- J. Obtain approval from Structural Engineer prior to attaching any brace elements to structural steel or wood framing.
- K. Tension cable to remove slack from cable bracing without inducing uplift of suspended element.
 - 1. Tension seismic bracing system prior to equipment start-up and adjust after start-up.
- L. Do not mix rigid bracing with cable bracing in same run unless approved by Structural Engineer.
- M. Install brace members at angle of 45 degrees from horizontal within tolerance of plus 2-1/2 degrees or minus 45 degrees provided brace length is accounted for in design. Brace angle may be increased to 60 degrees provided brace spacing is reduced to 1/2 that required for 45-degree brace.
- N. Seismic bracing may not pass through building separation joint.
 - 1. Utility systems that pass through separation joint must be seismically restrained no greater than 5 feet from point of connection.
 - 2. Install hardware designed to accommodate seismic movement across span of separation joint per manufactures installation and listing instructions.
- O. With approval of Structural Engineer, utility systems that are suspended from overhead deck may be braced to load bearing concrete or CMU (concrete masonry) walls provided that walls and overhead decks will respond similarly during seismic event.
- P. Brace each layer of multiple layer trapeze rack individually based on weight of individual layer.

- Q. Conduit, cable tray, or bus duct constructed of non-ductile material (plastic, or fiberglass), shall have brace spacing reduced to 1/2 of spacing allowed for ductile materials.
- R. Where brace elements are through-bolted, mounting hole in element is to be no more than 1/16 inches in diameter larger than bolt or threaded rod.
- S. Seismic braces shall directly brace system and not hanger.

3.2 SEISMIC INSTALLATION OF SUSPENDED ELECTRICAL SYSTEMS

- A. Install seismic bracing for conduit 2 1/2 inches trade size or greater.
- B. Trapeze assemblies supporting conduits, cable trays or bus ducts shall be braced considering total weight of elements on trapeze.
 - 1. For purposes of calculating weight, all conduits are to be treated as full.
- C. Brace trapeze racks which support conduit 2 1/2 inches trade size or larger.
 - 1. Brace other conduit rack, cable tray or bus duct trapezes having minimum weight in excess of 10 pounds, per lineal foot.
 - 2. Include minimum 10 percent additional capacity for future additions.
- D. Seismic bracing may be omitted from cable trays, conduit and bus ducts suspended by rod hung supports 12 inches or less in length from top of element to bottom of structural attachment of hanger provided lateral motion will not cause damaging impacts to other systems or loss of system vertical support.
- E. Vertical risers involving conduit 2-1/2 inches in diameter or larger shall include lateral restraint at maximum 30 feet intervals and at the top and bottom of the riser.

3.3 SEISMIC INSTALLATION OF FLOOR OR ROOF MOUNTED EQUIPMENT

- A. Provide one mounting device on each leg or support with minimum three 3/8 inches diameter anchors.
 - 1. Do not include friction when designing anchors for shear.
- B. Presume seismic forces to act through center of mass of equipment in direction producing largest single anchor force.
- C. Presume vertical seismic forces to act concurrently with horizontal seismic forces.

3.4 VIBRATION ISOLATION APPLICATIONS

- A. Transformers (480-208/120V):
 - 1. All transformers indicated as "trapeze-mounted" shall either be suspended with Type HN isolators or mounted on Type DNP isolators between the trapeze assembly and the transformer.
 - 2. All transformers indicated as "floor-mounted" shall be mounted on Type DNP isolators.
 - 3. Electrical connections to all transformers shall be made using flexible connections Type A or Type B.
- B. Mechanical equipment:
 - 1. Electrical connections to all mechanical equipment shall be made using flexible electrical connections Type A or Type B.

3.5 VIBRATION ISOLATION INSTALLATION

- A. General:
 - 1. In all cases, isolated electrical equipment shall be positioned so that it is free-standing and does not come in rigid contact with the building structure or other systems.
 - 2. Coordinate the size, location and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.

3. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified requirements.
 4. Provide any incidental materials needed to meet the requirements stated herein, even if not expressly specified or indicated on drawings, without claim for additional payment.
 5. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
 6. Should any electrical equipment cause excessive noise or vibration, provide remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
 7. Upon completion of the work, Contractor shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the Contractor that result from the final inspection. This work shall be done before vibration isolation systems are accepted.
- B. Isolation Mounts:
1. All mounts shall be aligned squarely above or below mounting points for the supported equipment.
 2. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
 3. Hanger rods for vibration isolated support shall be connected to structural beams or joists, not to the floor slab between beams and joists. Provide suitable intermediate support members, as necessary.
 4. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
- C. Flexible electrical connections:
1. Rigid conduit on the isolated-equipment side of the flexible connections, and the flexible connection itself, shall not be tied to the building construction or other rigid structures.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Identification for Electrical Systems, as indicated, in accordance with provisions of Contract Documents.
- B. Provide the following:
 - 1. Identification for raceways.
 - 2. Identification for conductors.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Equipment identification labels.
 - 6. Miscellaneous identification products.
- C. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. A13.1, Standard for the Identification of Pipes.
 - 2. Z535.4, Safety Labels.
- B. ASTM International (ASTM):
 - 1. D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
- C. National Fire Protection Association (NFPA):
 - 1. 70, National Electrical Code (NEC) as amended by local Authority Having Jurisdiction.
- D. Occupational Safety and Health Administration (OSHA):
 - 1. 29 CFR 1910.144, Safety Color Code for Marking Physical Hazards.
 - 2. 29 CFR 1910.145, Specifications for Accident Prevention Signs and Tags.
- E. Underwriter's Laboratories (UL):
 - 1. 969, Compliance Guidelines for Marking and Labeling Systems.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer literature for each electrical identification product indicated.
- B. Project Information:
 - 1. Identification Schedule:
 - a. Index of all electrical equipment and system components on project of identification signs and labels. Include appropriate colors of both lettering and label background.

1.4 COORDINATION

- A. Identification required in this section applies to equipment furnished in other Divisions.
- B. Coordinate identification names and abbreviations with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, operation manuals, maintenance manuals, code requirements, standards, and 29 CFR 1910.145.
 - 1. Use consistent designations throughout Project.

2. Equipment identification shall be same as designation indicated on plans.
- C. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- D. Coordinate installation of identifying devices with location of access panels and doors.
- E. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer of materials meeting required standards.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Power and Control Raceway Identification Materials:
 1. Colors for Raceways Carrying Circuits at 600 V or Less:
 - a. As scheduled below.
- B. Conductor Identification Materials:
 1. Conductor jacketing shall be color-coded as scheduled below.
- C. Underground-Line Warning Tape:
 1. Tape:
 - a. Suitable to permanently identify and locate underground electrical and communications utility lines.
 - b. Tape and ink:
 - 1) Chemically inert.
 - 2) Unaffected when exposed to acids, alkalis, and other destructive substances found in soil.
 2. Color and Printing:
 - a. Comply with applicable referenced standards.
 - b. Inscriptions for Red-Colored Tapes with Black Lettering: ELECTRIC LINE, HIGH VOLTAGE.
 - c. Inscriptions for Orange-Colored Tapes with Black Lettering: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.
 3. Construction:
 - a. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Non-detectable tape:
 - 1) Thickness: 4 mils 0.1 mm.
 - 2) Weight: 18.5 pound/1000 SQ FT. 9.0 kg/100 sq. m.
 - 3) Width: 3 inches 75 mm.
- D. Concrete Colorant:
 1. Color Pigment:
 - a. Add red color pigment to concrete mixture according to manufacturer's written instructions.
- E. Warning Labels and Signs:
 1. Comply with applicable referenced standards.

2. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
 3. Warning label and sign shall include, but are not limited to, the following legends:
 - a. Arc Flash Warning: "WARNING – ARC FLASH HAZARD."
 - b. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
- F. Equipment Identification Labels:
1. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting.
 - a. Colors as indicated in Identification Schedule below.
 - b. Letters:
 - 1) 7 mm 1/4 inches high for equipment with cover plate less than 305 mm 12 inches wide.
 - 2) 13 mm 1/2 inches high for equipment with cover plate over 305 mm 12 inches wide:
- G. Miscellaneous Identification Products:
1. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
 2. Fasteners for Labels and Signs: Self-tapping stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.
- H. Floor Marking Tape:
1. 2 inches 50 mm wide, 5-mil 0.125 mm pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
1. Coordinate all signage with Owner's facility-wide standard nomenclature, if applicable.
- B. Location:
1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Surface Preparation:
1. Apply identification devices to surfaces that require finish after completing finish work.
 2. Painted Identification:
 - a. Comply with requirements in painting Sections for surface preparation and paint application.
 3. Self-Adhesive Identification Products:
 - a. Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
 4. Non Self-Adhesive Identification Products:
 - a. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - b. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.
- D. Conductors/cables:
1. Power-circuit conductor identification, 600 V or less:

- a. Color shall be factory-applied or field-applied for sizes larger than No. 8 AWG, if authority having jurisdiction permits.
 - b. For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coded conductor tape to identify the phase(s).
 - 1) Field-Applied, Color-Coded Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches 150 mm from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
 - 2. Power-circuit conductor identification, greater than 600 V:
 - a. For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.
- E. Conduits:
- 1. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits:
 - a. Provide conduit color as indicated in Tables below per the following types of conduit-routing conditions:
 - 1) In unexposed, concealed areas:
 - a) All fire alarm system conduit shall be fully factory-painted and colored red. Tape or field painting is not acceptable.
 - b) For all other systems/branches, minimum of 1 inch 25 mm diameter and smaller shall be fully factory-painted.
 - c) Larger than 1 inch 25 mm diameter shall be fully factory-painted or painted with a 2 inches 50 mm wide band every 10 feet 3 m on center or provided with a 2 inches 50 mm wide pressure-sensitive, color-impregnated tape every 10 feet 3 m on center.
 - 2) In exposed, public-facing "architectural" non-concealed areas:
 - a) No coloring of conduit.
 - 2. Underground raceways:
 - a. Identify with underground-line warning tape for power, lighting, communication, control wiring, and optical fiber cable conduits.
 - b. Install warning tape for both direct-buried conduit and conduits in ductbank.
 - c. During backfilling of trenches, install continuous underground-line warning tape directly above conduit(s) or ductbank(s) at 12 inches 300 mm below finished grade. Use multiple tapes where width of multiple conduit(s) or ductbank(s) installed in a common trench exceeds 16 inches 400 mm overall.
 - 3. Concealed raceways, duct banks, greater than 600 V, within buildings:
 - a. Tape and stencil 4-inch 100-mm wide black stripes on 10-inch 250 mm centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil text "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch 75 mm high black letters on 20-inch 500-mm centers. Stop stripes at text. Apply to the following finished surfaces:
 - 1) Floor surface directly above conduits running beneath and within 12 inches 300 mm of a floor that is in contact with earth or is framed above unexcavated space.
 - 2) Wall surfaces directly external to raceways concealed within wall.
 - 3) Accessible surfaces of concrete ductbank envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- F. Boxes & Enclosures:
- 1. Paint outlet boxes, junction boxes, and enclosures, except switchboard and panelboard enclosures, as scheduled in Tables below.

2. Paint inside and outside of boxes and box cover plates when boxes are above an accessible ceiling or access panel or when exposed in mechanical and electrical spaces.
3. Paint inside of boxes and box cover plates when box is recessed in wall or ceiling, or when fully exposed in a public-facing 'architectural' space.
4. Identify circuit numbers on inside of box and cover plate. Identification shall be applied after painting of boxes.
5. Warning labels for boxes and enclosures:
 - a. Comply with 29 CFR 1910.145.
 - b. Identify system voltage with black letters on an orange background.
 - c. Apply to exterior of door, cover, or other access.
 - d. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - 1) Power transfer switches.
 - 2) Controls with external control power connections.

G. Workspace Indication:

1. Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

H. Equipment Nameplates:

1. Provide engraved laminated nameplates for electrical equipment.
 - a. Switchgear, switchboard, distribution panel, and motor control center nameplates:
 - 1) Center nameplate near top of first section. Label text to include:
 - a) Equipment name and branch, e.g., "Switchboard XXXX - Normal Branch".
 - b) Source, e.g., "Source – Utility Transformer".
 - 2) Provide similar nameplates for each main and feeder device. Mount label adjacent to or on cover of device. Label text to include:
 - a) Description of load, e.g., "Load - Panelboard XXXX".
 - b. Panelboard nameplates:
 - 1) Center nameplate near top of each section (including sections of multi-section panels). Label text to include:
 - a) Equipment name and branch, e.g., "Panel XXXX - Normal Branch".
 - b) Source, e.g., "Source - Switchboard XXXX", or "Source – Panel XXXX via Transformer XXXX" as appropriate.
 - c. Transformer nameplates:
 - 1) Center nameplate near top of face plate or cover. Label text to include:
 - a) Equipment name and branch, e.g., "Transformer XXXX - Normal Branch".
 - b) Description of load, e.g., "Load – Panelboard XXXX".
 - c) Source, e.g., "Source – Busduct XXXX".
 - d. Disconnect switches, contactors, thermal element switches, starters, capacitors, etc., nameplates:
 - 1) Center nameplate near top of face plate or cover. Label text to include:
 - a) Description of load, e.g., "Load - AHU-XXX".
 - b) Source, e.g., "Source - MCC-XXXX".
 - e. Transfer switches nameplates:
 - 1) Center nameplate near top of cover. Label text to include:
 - a) Equipment name, e.g., "Automatic Transfer Switch ATS/E."
 - b) Description of load, e.g., "Load - Distribution Board XXXX - Life Safety Branch".

- c) Normal source, e.g., "Normal Source - Switchboard XXXX".
- d) Emergency source, e.g., "Emergency Source - Switchboard XXXX".
- f. Fire alarm, public address, and other system control cabinet nameplates:
 - 1) Center nameplate near top of cover. Label text to include:
 - a) Description of system, e.g., "Fire Alarm System Control Panel".
- g. Relays and relay cabinet nameplates:
 - 1) Center nameplate near top of cover. Label text to include:
 - a) Description of item controlled, applicable system or function and type of device, e.g., "AHU-XXX FA Shutdown Relay" or "Exterior Lighting Circuit XXXX-## Control Relay".
- h. Lighting Control Panel nameplates:
 - 1) Center nameplate near top of cover. Label text to include:
 - a) Equipment name and branch, e.g., "Lighting Control Panel XXXX - Normal Branch".
 - b) Control Power Source, e.g., "Control Power – Panel XXXX".
- I. Flash Hazard Warning Signs:
 - 1. Provide for switchboards, panelboards, and motor control centers per NEC Article 110.
- J. Device Plates:
 - 1. Color as scheduled in Tables below and label text as required under Section 26 27 26.

3.2 IDENTIFICATION SCHEDULE

- A. Provide color-coding of conductors, conduits, devices, boxes, equipment, and nameplates as indicated in Tables below.

- 1. Table 1.

Electrical Boxes, Conduit, Devices, Labels and Covers	Normal	Life Safety	Optional Standby		
Boxes (Outlet, Junction)	Silver (un-tinted)	Yellow	Green		
Conduit/Paint/Taping	Silver (un-tinted)	Yellow	Green		
Device Plates	White	SS 304	Brown		
Labeling - Nameplate and Device Plate Background	White	Yellow	Green		
Labeling - Nameplate and Device Plate Lettering	Black	Black	White		
LV Lighting Control Switch	White	N/A	N/A		
Receptacle	White	Yellow	Brown		
Toggle-type Switch	White	Red	Brown		
Wall-box Dimmer	White	N/A	N/A		
Wall-box Occupancy Sensor	White	N/A	N/A		

- 2. Table 2.

Electrical Boxes, Conduit, Labels and Covers	Generator (Upstream of ATS)	Fire Alarm	BMS	Low Voltage Voice/Data
Boxes (Outlet, Junction)	Black	Red	Purple	White
Conduit/Paint/Taping	Black	Red	Purple	White
Labeling - Nameplate and Device Plate Background	Black	Red	Purple	Refer to Section 27 05 32

Electrical Boxes, Conduit, Labels and Covers	Generator (Upstream of ATS)	Fire Alarm	BMS	Low Voltage Voice/Data
Labeling - Nameplate and Device Plate Lettering	White	White	White	

3. Table 3.

Electrical Wiring and Cabling	120/208 Volt	277/480 Volt	Fire Alarm	BMS	Low Voltage Voice/Data	Low Voltage Control
Wire - Ground	Green	Green	Refer to Section 28 31 00 for Wiring Color	Refer to Section 25 50 00 for Wiring Color	Refer to Section 27 05 32 for Cable Color	
Wire - Isolated Ground	Green w/ Yellow Stripes	Green w/ Yellow Stripes				
Wire – Hospital Isolated Power System No. 1	Orange with at least one distinctive colored stripe other than white, green, or gray along entire length of conductor	N/A				
Wire – Hospital Isolated Power System No. 2	Orange with at least one distinctive colored stripe other than white, green, or gray along entire length of conductor	N/A				
Wire - Neutral	White	Gray				
Wire - Phase 1	Black	Brown				
Wire - Phase 2	Red	Orange				
Wire - Phase 3	Blue	Yellow				
0-10V Control Wire	N/A	N/A	N/A	N/A	N/A	Pink and Purple

END OF SECTION

SECTION 26 05 73

POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish power system study modeling, analysis, and device settings to ensure:
 - 1. Compliance with project requirements for selective coordination.
 - 2. Equipment ratings are sufficient to withstand the fault currents experienced.
 - 3. Minimum arc flash hazard exposure to personnel, including development of arc-reduction maintenance settings, while maintaining device selective coordination.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. C37.5, Guide for Calculation of Fault Currents for Application of AC High-Voltage Circuit Breakers Rated on a Total Current Basis.
 - 2. C37.010, Guide for AC High-Voltage Circuit Breakers >1000 VAC Rated on a Symmetrical Current Basis.
 - 3. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
 - 4. C37.40, Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.
 - 5. C37.46, Specifications for High-Voltage (>1000 V) Expulsion and Current-Limiting Power Class Fuses and Fuse Disconnecting Switches.
 - 6. 141, Recommended Practice for Electric Power Distribution for Industrial Plants.
 - 7. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
 - 8. 1015, Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
 - 9. 1584, Guide for Performing Arc-Flash Hazard Calculations.
 - 10. 3002.3, Recommended Practice for Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems.
 - 11. 3004.5, Recommended Practice for the Application of Low-Voltage Circuit Breakers in Industrial and Commercial Power Systems.
- B. National Fire Protection Association (NFPA):
 - 1. 70, National Electrical Code (NEC) as amended by Authority Having Jurisdiction.
 - 2. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.
 - 3. 99, Health Care Facilities Code.
 - 4. 110, Standard for Emergency and Standby Power Systems.
- C. Occupational Safety and Health Administration (OSHA):
 - 1. 29 CFR 1910, Occupational Safety and Health Standards – General Industry.

1.3 SUBMITTALS

- A. Engineering Staff Qualifications:
 - 1. Professional engineering certification of engineer performing the study.
 - a. Engineer performing the study shall carry professional engineering licensure within state where project is occurring.
 - 2. Project resume of professional engineer performing the study, indicating 5 years of direct experience with the modeling, analysis, and overcurrent device setting selections associated with power system study efforts.

B. Shop drawings:

1. Power system study:

a. Submittal 1:

- 1) Prior to or at same time as distribution equipment shop drawings and prior to release of equipment for manufacturing. No distribution equipment (including, but not limited to switchgear, switchboards, panelboards, transfer switches, transformers) shall be released for production until design Engineer of Record has reviewed and approved power system study submittal 1.
- 2) Submittal 1 to include preliminary:
 - a) Short circuit study.
 - b) Coordination study.
 - c) Arc flash study.
- 3) Use specified conductor sizes and estimated conductor lengths for shop drawing.
- 4) Provide calculation methods and assumptions, base per unit quantities selected, one-line diagrams, source impedance data including utility company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations.
- 5) Submittal shall be provided with seal of Engineer licensed within the jurisdiction where the project is located.

b. Submittal 2:

- 1) Field-verify installed circuit breakers and conductor lengths after installation.
- 2) Update power system study with actual installed equipment, conductor lengths and any changes in conductor sizes or equipment.
- 3) Submittal 2 to include final:
 - a) Short circuit study.
 - b) Coordination study.
 - c) Arc flash study.
- 4) Submit updated study at least 3 months prior to applying final settings for testing and 6 months prior to substantial completion of project. Include any recommended changes in Submittal 2.
- 5) Submittal shall clearly indicate changes made between Submittal #1 and Submittal #2 documents.

C. Contract Closeout Information:

1. Final power system study, with seal of electrical engineer. Final submittal shall incorporate all as-built conditions including installed equipment, field measured conductor lengths, and any applicable modifications to construction documents.
2. As-left settings for overcurrent protective devices, per paragraph 1.4.E below.
3. Electronic copy of native power system study files, including relevant library files for devices utilized on the project. Files shall be working copy of final approved power system study.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Power system studies are to be performed by independent, third party firm or by manufacturer of project electrical distribution equipment. Study to be stamped and signed by a professional engineer registered within the state where the project is located.
2. Submit credentials of individual(s) performing study and background of firm for review approval prior to start of work. Minimum five years of experience in medium- and low-voltage power system analysis is required for individual in charge of producing study.

1.5 POWER SYSTEM STUDIES – WORKFLOW PROCESS

- A. Study engineer shall be responsible for review of proposed equipment from the selected equipment vendor and incorporation of proposed equipment into Submittal 1 data.
- B. Submittal 1 shall be submitted for review and approved prior to release of any equipment for production.
- C. Study engineer shall be responsible for collection and incorporation of actual equipment make/model data for use within the selective coordination and arc flash hazard analysis.
- D. Study engineer shall be responsible for collection of final installed cable sizes and cable lengths from the installing contractor, and incorporation of these values into the final power system study submittals.
- E. Project Electrical contractor shall be responsible for implementation of settings provided as part of this study when these settings are not implemented by the firm performing the power system study. Personnel applying device settings in the field shall record all as-found and as-left settings and provide submittal of these values for project record.

PART 2 - PRODUCTS

2.1 SOFTWARE

- A. Software utilized to complete power system studies shall be one of the following:
 - 1. SKM Power Tools for Windows. Latest version.
 - 2. ETAP software for Windows. Latest version.

PART 3 - EXECUTION

3.1 POWER SYSTEM STUDIES

- A. Provide computer generated power system study of specified electrical power distribution system in accordance with IEEE 399 and 3004.5.
 - 1. Include electrical distribution system from main distribution equipment (including utility and generator sources) down to each 208 V branch circuit panelboard, industrial control panel, elevator controller, Uninterruptible Power Supply System, and lighting inverter. Study shall include each valid system operating/switching mode under all probable source conditions.
 - 2. Scenarios that result in maximum fault conditions shall be adequately covered in study. For example, if closed transition transfer switches are provided or if utility is paralleled with standby generators at any time, combined contribution from utility and generators shall be considered for equipment where the paralleled transfer operation is occurring.
 - 3. Report format:
 - a. Provide sufficient number of log-log plots to indicate degree of system protection and coordination. Log-log plots shall include transformer ANSI withstand points damage curves, and inrush currents of transformers, motors, and generator alternators where appropriate.
 - b. Computer printouts or equivalent tabular format to accompany log-log plots containing descriptions for all devices indicated on plot, settings of adjustable devices, device numbers to simplify location of devices on system one-line diagram.
 - 1) Provide data in tabular format of suggested settings of adjustable overcurrent protective devices, equipment where each device is located, device number corresponding to device on system one-line diagram, and number of time-current log-log plots where they are illustrated. Similar or like devices may be illustrated by using "typical" plots. Every device need not be separately illustrated.
 - 2) Provide discussion section evaluating degree of system protection and system continuity with overcurrent devices, with recommendations as required for increased protection or coordination.

- 3) Include complete title and one-line diagram with legend with each curve sheet identifying specific portion of system covered by that particular curve sheet.
- 4) Include detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics.
- 5) Tabulate recommended device tap, time dial, pickup, instantaneous and time delay settings.
- 6) Provide time-current curves graphically indicating coordination proposed for system, centered on 8.5 x 11 inches, log-log forms.
- 7) Any inadequacies shall be called to attention of Engineer and recommendations shall be made for improvements.

B. Data collection:

1. Provide required data for preparation of studies. Performer of studies shall furnish contractor with listing of required data immediately after award of contract.
2. Expedite collection of data to assure completion of studies as required for final approval of equipment shop drawings.
3. Input data shall include power company's short circuit contribution as calculated and verified by them.
4. Verify characteristics of utility service overcurrent devices with power company.

C. Short circuit (fault) current study:

1. Study shall include calculated fault currents at each bus, including at a minimum:
 - a. 3-phase fault.
 - b. 2-phase (line-to-line) fault.
 - c. 2-phase (line-to-line) to ground fault.
 - d. Single line-to-ground fault.
2. Provide calculation methods and assumptions, base per unit quantities selected, one-line diagrams, source impedance data including utility company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations.
3. Provide computer generated system one-line diagram clearly identifying individual equipment buses, bus numbers, device numbers and maximum available short-circuit current at each bus. Where entire system is not legible on a single drawing, provide multiple single-line diagrams with clear demarcations between drawings.
4. Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, and/or generators.
5. Calculate 1/2 cycle (or 5 cycle where appropriate for MV equipment) short circuit interrupting and momentary (asymmetrical 'close and latch') duties, when applicable for an assumed 3-phase bolted fault at each load interrupter switchgear, transformer primary and secondary terminals, low-voltage switchgear, switchboard, distribution panelboards, bus duct, automatic transfer switch, motor control center, 480 V panelboard, 208 V panelboard and other significant locations throughout system.
6. Include equipment/device ratings, X to R ratios and symmetrical fault currents in tabulations. Where actual (calculated) X/R ratio exceeds device test X/R ratio, appropriate fault duty adjustment shall be made in accordance with ANSI/IEEE standards and included in tabulations.
7. Base transformer impedance on lowest tolerance limit allowed by ANSI C57.12 (7.5 percent below listed value). Use actual nameplate impedance when available.
8. Include fault contribution of all motors over 25 HP not controlled by a Variable Frequency Drive (VFD)
9. Assume variable frequency drives of the two largest motors are in bypass position as applicable where bypass starters are provided.

10. Notify Engineer in writing of equipment not properly rated for fault conditions. Identify any prohibited operating/switching scenarios that would over-duty certain identified equipment.

D. Coordination study:

1. Provide determination of settings, ratings, or types for overcurrent protective devices supplied. Where necessary, appropriate compromise shall be made with system protection and service continuity considered to be of equal importance.
2. Breakers shall be set to trip as quickly as possible without compromising overall coordination to limit arc flash hazard energy to the lowest level possible.
3. All potential scenarios shall be considered in study. Scenarios to be considered include but are not limited to:
 - a. Single source/service: show coordination between main, feeder, and downstream overcurrent devices.
 - b. Multiple-source service: show coordination between main, tie, feeder, and downstream devices when tie breaker is closed. Where operating curve overlap cannot be avoided, prioritize coordination between main and tie breaker.
 - c. If multiple levels of ground fault are provided time current curves shall be provided that indicate coordination of ground fault between main, tie and feeder breakers when tie breaker is closed. Where overlap cannot be avoided, prioritize coordination between main- and tie breaker.
 - d. Provide TCC plot to indicate coordination between typical 20 A, 277 V, single pole breaker and nearest upstream 480 V overcurrent device with ground fault protection as applicable.
 - e. Evaluate proper operation of ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided. Include discussion of Neutral-Ground bonding points and ground fault current flows during a line-to-ground fault.
 - f. Include phase and ground coordination of generator protective devices. Indicate generator decrement curve and damage curve along with operating characteristic of protective devices. Obtain information from generator manufacturer and include generator actual impedance value, time constants, and current boost data in study. Do not use typical values for generator.
 - g. For motor control circuits, indicate distribution equipment full-load current plus symmetrical and asymmetrical of largest motor starting current and time to ensure protective devices will not trip during major or group start operation.
4. Emergency Power Systems:
 - a. Selective coordination of overcurrent protective devices associated with emergency and legally required standby and critical operations power systems shall fully coordinate per applicable requirements of NEC 700, 701, and 710. Where this is not possible due to pre-determined device types, sizing, or trip unit selections, notify Engineer immediately of inadequacies and include recommendations for resolution.
5. Elevator Systems:
 - a. Selective coordination of overcurrent protective devices associated with power distribution circuits serving elevators shall fully coordinate per applicable requirements of NEC 620. Where this is not possible due to pre-determined device types, sizing, or trip unit selections, notify Engineer immediately of inadequacies and include recommendations for resolution.
6. Graphs shall include as applicable:
 - a. Utility relay and fuse characteristics.
 - b. Campus substation relay and fuse characteristics.
 - c. Medium-voltage equipment relay and fuse characteristics.
 - d. Low-voltage equipment circuit breaker trip device characteristics.
 - e. Pertinent transformer characteristics.

- f. Pertinent motor and generator characteristics.
 - g. Characteristics of other system load protective devices.
 - h. All devices down to and including largest branch circuit overcurrent protective device in each motor control center, distribution panel, and branch panelboard.
 - i. All adjustable settings for ground fault protective devices.
 - j. Manufacturing tolerance and damage bands in plotted fuse characteristics.
7. Indicate transformer full load and 150, 400 or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters and significant symmetrical and asymmetrical fault currents.
 8. Select each primary protective device required for delta-wye connected transformer so that its characteristic or operating band is within transformer characteristics including point equal to 58 percent of ANSI withstand point to provide secondary line-to-ground fault protection. Where primary device characteristic is not within transformer characteristics, indicate transformer damage curve.
 9. Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device could be exposed.
- E. Arc flash study:
1. Provide arc flash study in conjunction with short circuit and protective device coordination study.
 2. Include all electrical distribution equipment in study including but not limited to:
 - a. Switchgear and switchboards.
 - b. Distribution and branch circuit panel boards.
 - c. Motor control centers and control panels.
 - d. Individual circuit breakers, disconnect switches, and molded case switches.
 - e. Utilization equipment with integral disconnects or panels such as adjustable frequency drives, packaged mechanical equipment and UPS.
 - f. Automatic transfer switches.
 3. Arc flash boundary distances and incident energy at each device shall be determined by worst case incident energy at that device resulting from maximum and minimum available fault current at main distribution switchgear or switchboard for each valid system operating/switching mode under all probable source conditions. For low voltage equipment (600 V and below), incident energy calculations shall be made at 100 percent and 85 percent arcing current per IEEE 1584.
 4. Where energy-reduction methods are employed, provide arc flash hazard data for the following:
 - a. Energy reduction methods engaged.
 - b. Energy reduction methods disengaged.
 5. Provide following data for each bus analyzed.
 - a. Bus Name.
 - b. Protective Device Name.
 - c. Bus Operating Fault Current.
 - d. Protective Device Bolted Fault Current.
 - e. Protective Device Arcing Fault Current.
 - f. Trip/Delay Time (seconds).
 - g. Breaker Opening Time (seconds).
 - h. Ground.
 - i. Equipment Type.
 - j. Gap (mm).
 - k. ARC Flash Boundary (inches).

- 1) Working Distance (inches) per IEEE 1584 Table 3 default values.
- l. Incident Energy (CAL/cm²).
- m. Required Protective FR Clothing (PPE) Category.
6. Provide following data on each arc flash hazard warning label:
 - a. Flash Hazard Protection Boundary.
 - b. Incident Energy Level.
 - c. Required Personal Protective Equipment Category with brief description.
 - d. Shock hazard when cover is removed.
 - e. Limited Approach Boundary.
 - f. Restricted Approach Boundary.
 - g. Prohibited Approach Boundary.
 - h. Include date of calculation, utility short circuit capacity, and voltage as of that date.
 - i. Arc flash study.

3.2 FIELD IMPLEMENTATION AND VERIFICATION

- A. Implementation and Verification of Device Settings:
 1. Onsite representative from firm performing power system studies shall perform field adjustments of protective devices as required to place equipment in final operating condition, or direct setting implementation to electrical contractor.
 2. Settings shall be in accordance with approved power system study.
 3. Study engineer shall be responsible for verifying that all device settings have been implemented in accordance with the final, approved power system study submittal.
 4. As-found and as-left settings for each device shall be recorded and submitted for record.
- B. Arc flash labels:
 1. Provide Arc flash hazard warning label on each piece of electrical equipment.

END OF SECTION

SECTION 26 09 43
NETWORKED LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Networked Lighting Control System, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SYSTEM DESCRIPTION

- A. This specification describes the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide networked lighting control system.
- B. Networked Lighting Control System is specified to perform scheduled and automated lighting control sequences.
- C. Networked Lighting Control System includes but is not limited to the following components:
 - 1. Wall stations.
 - 2. Touch screen panels.
 - 3. Dimmers.
 - 4. Switches.
 - 5. Occupant sensors.
 - 6. Photo sensors.
 - 7. Daylight harvesting lighting controls.
 - 8. Time clock.
 - 9. Motorized shade controls.
 - 10. Room-combining partition sensors.
 - 11. System contact closures (input and output devices).
 - 12. Scene setting and selection controllers.
 - 13. DMX controllers.
 - 14. Distributed relay lighting controllers.
 - 15. Relay-based lighting and receptacle control panels.
 - 16. Energy control units for load shedding.
 - 17. System server.
 - 18. Lighting control system software – graphical user interface-based.
 - 19. Communication wiring.
 - 20. Interface to fire alarm system.
 - 21. Interface to security system.
 - 22. Interface to building management system (BMS).
 - 23. Interface to audio-visual equipment.
 - 24. Emergency lighting control devices.
- D. The system shall perform, at a minimum, the following functions:
 - 1. Networking of Luminaires and Devices.
 - a. The capability of luminaires and control devices to exchange digital data with other luminaires and control devices on the system.

2. Occupancy Sensing.
 - a. The capability to affect the operation of lighting or other equipment based upon detecting the presence or absence of people in a space.
 3. Daylight Harvesting.
 - a. The capability to automatically affect the operation of lighting or other equipment based on the amount of daylight and/or ambient light that is present in a space.
 4. High-End Trim (also known as Task-Tuning).
 - a. The capability to set the maximum light output of an individual or group of luminaires at the time of installation and/or commissioning. The high-end trim feature must be field configurable.
 5. Low-End Trim.
 - a. The capability to set the minimum light output of an individual or group of dimmable luminaires at the time of installation and/or commissioning. The low-end trim feature must be field configurable and is designed to mitigate flicker when luminaires are dimmed.
 6. Zoning.
 - a. The capability to group luminaires and form unique lighting control zones for a control strategy. Zoning is required for occupancy sensing, high-end trim, and daylight harvesting control strategies.
 7. Device Addressability.
 - a. The ability to uniquely identify and/or address each individual sensor, controller, and user interface device in the lighting system, allowing for configuration and reconfiguration of devices and control zones independent of electrical circuiting.
 8. Continuous Dimming.
 - a. The capability of the control system to provide control with sufficient resolution (100+ steps) to support light level changes perceived as smooth (as opposed to step dimming with a limited number of discrete levels).
 9. User interface.
 - a. The control software shall permit users with proper password access to read and adjust settings during system start-up, commissioning, and/or ongoing operation.
 10. Localized Processing / Distributed Intelligence.
 - a. The capability of sensors and luminaires to execute pre-programmed energy saving strategies in the absence of (resulting from either a loss of network connection or failure) a gateway or central processor.
 11. Scheduling.
 - a. The ability to affect the operation of lighting and/or other equipment based on time of day or astronomical event.
 12. Personal Control.
 - a. The capability for individual users to adjust the illuminated environment to their personal preferences within a space.
 13. Plug Load Control.
 - a. The ability to control power delivered to receptacles through scheduling or occupancy sensing.
 14. Other Building Systems Integration.
 - a. The ability to exchange data with other building systems such as Building or Energy Management Systems (BMS/EMS), Heating Ventilation and Air Conditioning (HVAC) Systems, or other lighting systems.
- E. Related Information:
1. a

2. Division 25 Section "Building Management and Control System" for software and integration hardware for network lighting controls.
3. Division 26 Section "Electrical General Requirements".
4. Division 26 Section "Wiring Devices".
5. Division 26 Section "Lighting Control Devices" for line voltage lighting controls.
6. Division 26 Section "Building Lighting" for luminaires controlled by lighting control systems.
7. Division 26 Section "Site Lighting" for luminaires controlled by lighting control system.

1.3 THIRD PARTY SYSTEM INTEGRATION

- A. Pre-Bid Coordination: Third party interface with the lighting control system shall be coordinated with all parties to assign responsibility for equipment and installation of all equipment necessary for a fully functional system as described. Provide statement with bid indicating each manufacturer this specification has been reviewed and coordinated with.
- B. Building Management System (BMS):
 1. The lighting control system shall integrate with Building Management System as follows:
 - a. Allow one-way communication for the BMS system to monitor lighting control system status.
 - b. Allow two-way communication for the BMS system to both monitor and control lighting system components.
 2. The following lighting control system information should be mapped to the Building Management System:
 - a. Monitor (One-Way Communication):
 - 1) Occupant sensor detection status.
 - 2) Aggregate occupant sensor status for each room.
 - 3) Wall station button state.
 - 4) Load status.
 - 5) Schedule State – normal or after-hours.
 - 6) Electrical current (when available).
 - 7) Log the hours of operation (cumulative run time) for each relay or load controller. Provide the ability to re-set.
 - 8) Total watts per controller.
 - 9) Demand response – enabled or disabled.
 - 10) Lighting watts/sq ft by room.
 - 11) Total lighting and plug loads by room.
 - b. Monitor and Control (Two-Way Communication):
 - 1) Read/write the normal or after-hours schedule state.
 - 2) Read/write the ON/OFF state of loads.
 - 3) Read/write the dimming intensity level of loads.
 - 4) Log the hours of operation (cumulative run time) for each relay or load controller. Provide the ability to re-set.
 - 5) Read/write occupant sensor sensitivity setting and time delay.
 - 6) Activate pre-set scene(s).
 - 7) Read/write partition control status.
 - 8) Read/write daylight sensor fade time and setpoints.
 - 9) Read/write momentary wall switch functional status.
 - 10) Write maximum dimming levels per load for demand response mode.
 - 11) Activate/restore demand response mode.

- C. Fire Alarm System: The lighting control system shall integrate with the facility fire alarm system to receive dry contact output from fire alarm system upon general alarm to activate predetermined scene(s).
- D. Security System: The lighting control system shall integrate with the facility fire alarm system to receive [dry contact] [IP based] [serial based] output from fire alarm system upon general alarm to activate predetermined scene(s).
- E. Audio/Visual System: The lighting control system shall integrate with audio/visual systems where indicated on Drawings. The lighting control system shall receive [dry contact] [IP based] [serial based] output from audio/visual system to activate predetermined scene(s) or adjust lighting zones as described in the lighting control sequence of operations on drawings.

1.4 REFERENCES

- A. National Fire Protection Association (NFPA):
 - 1. NFPA 70 National Electrical Code
- B. Underwriters Laboratories (UL):
 - 1. UL 20 Plug Load Controls
 - 2. UL 508 Industrial Control Equipment
 - 3. UL 916 Energy Management Equipment
 - 4. UL 924 Emergency Lighting
 - 5. UL 1008 Emergency Transfer Switching Devices

1.5 SUBMITTALS

- A. Timing:
 - 1. Provide submittals after successful review of luminaire shop drawings. Coordinate driver types with control devices.
 - 2. Provide shop drawings and product data concurrently. Submittals provided individually will be rejected without review.
- B. Specification Compliance Review: Provide an annotated copy of this specification section to demonstrate compliance. This may be submitted prior to shop drawing review or concurrent.
 - 1. The following letters shall be marked in the margins to identify compliance, deviations, or exceptions:
 - a. "C" – Comply with no exceptions.
 - b. "D" – Comply with deviations. Provide footnote that indicates reason for deviation and how the intent of this performance specification is satisfied.
 - c. "E" – Exception, does not comply. Provide footnote that indicates reason for non-compliance, impact on system performance, and possible alternatives means of compliance.
 - 2. Unless deviations or exceptions are specifically noted, it will be assumed the Contractor and equipment manufacturer is in complete compliance with the Drawings and Specifications.
 - 3. Deviations and exceptions are subject to review and approval.
 - 4. Deviations or exceptions taken in other documents or by other Contractors do not release the Div 26 contractor from compliance unless specifically noted in this Specification Section Compliance Review document.
- C. Shop Drawings:
 - 1. Connection Schematics: Composite wiring, schematic diagram, or both, of each control circuit as proposed for installation.
 - 2. Plans: Show device locations for each area on reflected ceiling plans.

- a. Identify every system component with exact nomenclature indicated for that device on Drawings, and every component shall be labelled with corresponding room number.
 - b. Provide a schedule of every control station indicating all standard and custom wall station engraving.
 - 3. Sequence of Operation: Provide a sequence of operation for each lighting zone, including those connected to emergency power. Refer to Part 3 – Execution.
 - 4. System Riser Diagram: Include building levels indicated. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems.
 - 5. Compatibility Statement with Third Part Systems: Provide a compatibility statement from third party system manufactures certifying lighting control system compatibility with required integrations.
 - 6. Identify all power supply connections on riser diagrams. Indicate load type, normal or emergency, voltage, and amperage. Division 26 contractor is responsible for supplying power to all devices in accordance with manufacturer's instructions; power supply connections are not shown on drawings.
- D. Product Data:
- 1. Manufacturer's literature demonstrating compliance with requirements for each type of product required for complete distributed lighting control system.
- E. Refer to Section 01 81 33 - Cyber Security Requirements for required cyber security related submittals.
- F. Contract Closeout Information:
- 1. Operating and Maintenance Data.
 - a. See Section 01 78 23.
 - 2. Project Record Documents.
 - a. See Section 01 78 39.
 - 3. Warranty.
 - a. See Section 01 78 36.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualification:
- 1. Manufacturer of relay lighting controls with minimum five (5) years satisfactory manufacturing and support of components comparable to basis of design system.
- B. Project Conditions:
- 1. Environmental Conditions Range.
 - a. Temperature: 32 to 104 deg F 0 to 40 deg C.
 - b. Relative Humidity: 10 – 90 percent, noncondensing.

1.7 WARRANTY

- A. Manufacturer's warranty agreeing to repair or replace components of lighting controls system that fail in materials or workmanship within specified warranty period following substantial completion.
- 1. Warranty Period: One year.
 - 2. Software and firmware updates and onsite software and firmware support: One (1) year.
 - 3. Technical hotline support: Unlimited.
 - 4. Response time for on-site system maintenance: 72 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Networked lighting control system:
 - 1. Acuity Brands: nLight.
 - 2. Crestron.
 - 3. Legrand WattStopper: DLM.
 - 4. Lutron: Quantum.
 - 5. Current: NX.
- B. Other manufacturers desiring approval, comply with Section 01 61 00.

2.2 DIGITAL LOCAL NETWORK

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security-related product requirements.
- B. The digital local network uses free topology lighting control physical connections and communication protocol.
- C. Local Network:
 - 1. Automatic recognition of devices connected.
 - 2. Replacement of any device in local network shall not require significant re-configuration or setup.
 - 3. System with automatic configuration must permit the ability to change and override the automatic settings, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - 4. If used, two-way infrared communication with handheld remote controllers, and configuration by handheld tool including adjusting load parameters, sensor configuration and binding, must be limited to within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
- D. Digital Cabling:
 - 1. Provide factory pre-terminated connectors and devices.
 - 2. Field terminated cables are not permitted without prior approval.
- E. If manufacturer's pre-terminated cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results.

2.3 DIGITAL ROOM CONTROLLERS

- A. Digital controllers for lighting loads bind room loads to connected devices in the space and have the ability to assign and bind any device in the network. Provide room controllers to match luminaire dimming driver specifications and lighting control sequence of operations. .
- B. Control units will include following features:
 - 1. Ability for automatic room configuration to most energy-efficient, code-compliant, sequence of operation based upon the devices in the room.
 - 2. Ability for custom programming and assignment of sequence of operation for each control zone.
 - 3. Simple replacement and re-assignment of device settings to replacement devices. A room controller may be replaced without the need for factory re-programming.
 - 4. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are sequentially assigned using each controller's device IDs from highest to lowest.

5. Device Status LEDs to indicate:
 - a. Data transmission.
 - b. Device has power.
 - c. Status for each load.
 - d. Configuration status.
 6. Quick installation features:
 - a. Standard junction box mounting.
 - b. Quick low voltage connections using standard RJ-45 patch cable.
 7. Based on individual configuration, each critical and normal load shall be capable of being assigned one of the following behaviors upon power up following the loss of normal power:
 - a. Turn on to 100 percent.
 - b. Turn off.
 - c. Return to prior state.
 8. Each emergency load shall be capable of bypassing control status and turning on to 100 percent upon loss of normal power.
 9. Each load shall at a minimum be configurable to operate in following sequences based on occupancy:
 - a. Auto-ON/Auto-OFF.
 - b. Manual-ON/Auto-OFF.
 - c. Auto-Partial ON/Manual adjust/Auto-OFF.
 - d. Auto-ON/Auto-DIM (Never off).
 10. UL 2043 plenum rated.
 11. Manual override ON and OFF with LED indication for each load.
 12. Dual voltage 120/277 VAC, 60 Hz, or 347 VAC, 60 Hz. 120/277 volt models rated for 20A total load, de-rating to 16A required for dimmed loads, forward phase dimming; 347 VAC models rated for 15A total load; plug load controllers carry application-specific UL 20 rating for receptacle control.
 13. Zero cross circuitry for each load.
 14. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- C. ON/OFF Room Controllers:
1. Single or multiple relay configuration.
 2. Integral switching power supply.
 3. Integral digital network terminals or ports.
 4. Real time current monitoring.
 5. Logging of cumulative operating hours with the ability to manually re-set via software.
- D. ON/OFF/Dimming Room Controllers:
1. Real time current monitoring.
 2. Single or multiple relay configurations.
 3. Integral switching power supply.
 4. Logging of cumulative operating hours with the ability to manually re-set via software.
 5. Integral digital network terminals or ports.
 6. One dimming output per relay.
 - a. 0-10V Dimming:
 - 1) One 0-10 volt analog output per relay for control of compatible LED drivers.

- 2) Emergency controllers shall shunt control signal upon loss of normal power to assure full light output during emergency conditions.
- b. Line Voltage, Phase-Cut Dimming:
 - 1) Where indicated, one magnetic low voltage (MLV) or electronic low voltage (ELV) phase-cut dimming output per relay compatible with connected LED drivers.
- c. Dimming output channel:
 - 1) Independently configurable minimum and maximum trim level to set dynamic range of output generated by switch within 0-100 percent dimming range defined by minimum and maximum calibration trim.
- d. Set calibration and trim levels digitally per output channel.
 - 1) Devices that set calibration or trim levels per controller or multiple zone groupings are not acceptable.
- E. Plug Load Controllers:
 - 1. One relay configuration with additional connection for unswitched load.
 - 2. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay, e.g., a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated.
 - 3. Factory default operation is Auto-ON/Auto-OFF, based on occupancy.
 - 4. Real time current monitoring of both switched and un-switched load.
 - 5. Integral switching power supply.

2.4 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

- A. Wall or ceiling mounted (as shown on drawings) passive infrared (PIR), ultrasonic or dual technology (passive infrared and ultrasonic OR passive infrared and microphonic) occupancy sensor.
- B. Occupancy Sensors shall include the following:
 - 1. Calibration and configuration for the following variables:
 - a. Sensitivity – 0-100 percent in 10 percent increments.
 - b. Time delay – 1-30 minutes in 1 minute increments.
 - c. Test mode – Five second time delay.
 - d. Detection technology assignment for ON and OFF signals when using dual-technology sensors. ON/OFF trigger modes can be configured to an individual technology, either (either technology detects/fails to detect presence), or both (both technologies must detect/fail to detect presence).
 - e. Walk-through mode.
 - 2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are integral to occupancy sensor.
 - 3. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating programmable lighting scenes.
 - c. Adjustable retrigger time period for returning to automatic operation after manual override.
 - 1) On dual technology sensors: If either technology detects presence the lights will turn on. Both technologies must fail to detect presence for lights to turn off.
 - d. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies.
 - 4. Manual override of controlled loads.
 - 5. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

- C. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.

2.5 DIGITAL WALL SWITCHES WITH OCCUPANCY SENSOR

- A. Wall box mounted passive infrared PIR or dual technology (passive infrared and ultrasonic OR passive infrared and microphonic) occupancy sensor with 1 or 2 load switch buttons.
- B. Occupancy Sensors shall include the following:
 - 1. Calibration and configuration for the following variables:
 - a. Sensitivity – 0-100 percent in 10 percent increments.
 - b. Time delay – 1-30 minutes in 1 minute increments.
 - c. Test mode – Five second time delay.
 - d. Detection technology – assignment for ON and OFF signals when using dual-technology sensors. ON/OFF trigger modes can be configured to an individual technology, either (either technology detects/fails to detect presence), or both (both technologies must detect/fail to detect presence).
 - e. Walk-through mode.
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are integral.
 - 2. Programmable control functionality including:
 - a. Each manual load switch or sensor may be programmed to control specific loads within a local network.
 - b. Sensor or manual load switch shall be capable of activating programmable lighting scenes.
 - c. Adjustable retrigger time period for retuning to automatic operation after manual override.
 - d. On dual technology sensors If either technology detects presence the lights will turn on. Both technologies must fail to detect presence for lights to turn off.
 - 3. Independently configurable sensitivity settings.
 - 4. Assignment of any occupancy sensor to a specific load within the room or to a specific dimming level.
 - 5. Assignment of local buttons to specific loads within the room.
 - 6. Manual override of controlled loads.
 - 7. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.
- C. Each Load switch shall include and ON and OFF button, clearly labeled.

2.6 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches. Wall switches shall include the following features:
 - 1. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switching device from the wall.
 - 2. Two button switches shall have top button engraved “ON” and bottom button engraved “OFF” unless otherwise noted.
 - 3. Programmable control functionality including:
 - a. Programmable time-out operation.
 - 1) Two button timed switches shall have top button engraved “TIMED ON” and bottom button engraved “OFF.” Pressing top button shall trigger the programmable count-down time period assigned to the device.

- 2) Multi-button timed switches shall have various time settings assigned to each switch and shall have buttons engraved to reflect assigned time.
 - 3) Timed switches shall have optional blink warning.
 - 4) Two button override switches shall have top button labeled ON and bottom button labeled OFF.
 - 5) Multi-button scene switches shall be engraved as specified on drawings. Refer to drawings for scene selection settings.
- b. Scene settings, once set, may be locked to prevent overwriting of the preset levels.
4. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. Multiple wall switches may be installed in a room by simply connecting them to the local network to achieve multi-way switching and dimming.

2.7 DIGITAL PHOTOCELL SENSORS

- A. Digital photocell sensors shall work with load controllers and relays to provide automatic switching and dimming capabilities for assigned networked relays. Photocell sensors shall be interchangeable without the need for rewiring.
1. Open loop sensors measure incoming daylight in the space, and generally located in close proximity to glazing.
 2. Closed loop sensors measure the ambient light in the space, both daylight and electric, and generally are located away from glazing and outside of the field of indirect distribution from pendant luminaires.
- B. Digital photocell sensors shall include the following features:
1. The sensor's internal photodiode shall only measure light waves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.
 2. Sensor light level range shall be from 1-6,500 footcandles (fc).
 3. Sensor shall have programmable dead band setting to prevent lights from cycling.
- C. Daylight harvesting systems shall be programmed to include the following features:
1. The capability to turn ON/OFF individual or multiple zones.
 2. The ability to dim and adjust intensity relative to the amount the daylight.
 3. A networked dimming switch shall allow occupants to override the photosensor adjusted dimming set point lower but may not increase the dimming level established by the photocell.
 4. Any load or group of loads in the room can be assigned to a daylighting zone.
 5. Each load or relay within a daylighting zone can be individually enabled or disabled, and individually dimmed for discrete control.
 6. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.
- D. Photocell sensors shall be capable of reverse daylight harvesting or increasing electric illumination when high levels of daylight are present to accommodate adaptation, as noted in lighting control zone sequence of operation.

2.8 LIGHTING MANAGEMENT SEGMENT NETWORK

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.

- B. The segment network shall be a linear topology, BACnet-based MS/TP subnet to connect local devices and relays for centralized control.
 - 1. Each segment network shall include a network bridge. The network bridge interconnects room-based devices with the segment network.
 - 2. Multiple segment networks may be connected to form a networked building control system that may consist of a single building or multiple buildings.
 - 3. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate “in” and “out” terminations, for segment network connections.
 - 4. The segment network shall utilize cable supplied by the lighting control manufacturer. The maximum cable run for each segment is 4,000 feet.
 - 5. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device. Manufacturer shall provide termination instructions.
 - 6. Substitution of manufacturer-supplied cable must be pre-approved by lighting controls manufacturer.
 - 7. Segment networks shall be capable of connecting to BACnet-compliant BAS (provided by others) either directly, via MS/TP, or through NB-ROUTERs, via BACnet/IP or BACnet/Ethernet. Gateways may be utilized to limit BAS system transmissions not related to shared lighting points.

2.9 NETWORK BRIDGE

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
- B. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.
 - 1. The network bridge shall be provided as a separate module connected on the local network.
 - 2. Provide automatic discovery of room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. .

2.10 SEGMENT MANAGER

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
- B. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).
- C. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as needed for a complete and operable system as described.
- D. Operational features of the Segment Manager shall include the following:
 - 1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
 - 2. Easy to learn and use graphical user interface. Provide PC access to lighting control software with password protected access through local server. .
 - 3. Log in security capable of restricting some users to view-only or other limited operations.
 - 4. Segment Manager shall provide two main sets of interface screens – those used to initially configure the unit (referred to as the config screens) and those used to allow users to dynamically monitor the performance of their system and provide a centralized scheduling interface.
 - 5. Capabilities using the Config Screens shall include:

- a. Automatic discovery of devices and relay panels on the segment networks. Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.
 - b. Information entered into the lighting management software should not have to be re-entered manually via keystrokes into the Segment Manager.
 - c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
 - d. Ability to view and modify device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-ON or Auto-ON.
 - e. One-way communication with BMS using BACnet protocol may use an "Export Table" that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator's request for info and the overall system performance.
- 6. Segment Managers shall be integrated into a larger control network by the addition of a Campus View or Network Supervisor package. The Supervisor is a server level computer interfacing the local system software with dedicated communication and networking capability, able to pull information so individual Segment Managers can be accessed and stored on the Supervisor's hard drive.
 - 7. The Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.
- E. Segment Manager shall support multiple segment networks, network bridges and rooms.

2.11 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

- A. PC-native application for programming of relay operation and device settings, including all parameters accessible or inaccessible via BACnet. Software must be capable of accessing room-level parameter information.
- B. System shall include a central atomic time clock, with automatic daylight savings adjustment and astronomic 24-hr programming.
- C. Additional parameters exposed through networked software include but are not limited to:
 - 1. Ability to assign both normal-hour and after-hour settings.
 - 2. Ability to provide Blink Warn prior to turning off, including the ability to adjust grace time.
 - 3. Separate fade time adjustments per load for both normal and after hours, adjustable from 0 - 4 hours.
 - 4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
 - 5. Per-load DR (demand response) shed level in units of dimming percentage.
 - 6. Ability to establish the dimmer command level at which point a switched load closes or opens its relay to allow for ON/OFF operation of switched loads in response to a dimmer.
- D. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
 - 1. Device list report: All devices in a project listed by type.
 - 2. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
 - 3. BACnet points report: Per room identify Device ID and associated BACnet point mapping.
 - 4. Device parameter report: Per-room lists of all configured parameters for all control devices for use with O&M documentation.

- a. Include time delay and sensitivity settings for all occupancy sensors.
 - b. Include measured room illumination target and associated sensor illumination readings along with dead-band settings for all daylight harvesting photocells.
- 5. Scene setting reports: All project scene setting values associated with each named scene.
- E. Network-wide programming of parameter data on an individual or group basis, including but not limited to the following operations:
 - 1. Set, copy/paste sensor time delays.
 - 2. Set, copy/paste sensor sensitivity settings.
 - 3. Search based on room name and text labels.
 - 4. Filter by product type to allow parameter set by product.
 - 5. Filter by parameter value to search for product with specific configurations.
- F. Network-wide firmware upgrading ability.

2.12 EMERGENCY LIGHTING CONTROL DEVICES

- A. An Emergency Lighting Control Device (ELCD): A UL 924 listed control device that controls emergency lighting simultaneously with the adjacent normal lighting. Such devices shall continuously monitor the normal lighting branch circuit independently of the emergency power source, and operate as follows:
 - 1. During normal power conditions, emergency lighting operates with adjacent normal lighting.
 - 2. Upon normal branch circuit loss, device shall force emergency lighting ON to full brightness, regardless of normal lighting control state.
 - 3. Normal control resumes upon restoration of normal branch circuit.
- B. Acceptable Products:
 - 1. LVS: EPC-D series.
 - 2. Bodine: BLCD-DIM series.
 - 3. Functional devices RIB: ESR series.
 - 4. Other Products: A listed alternate device proprietary to the lighting control system providing equivalent functionality.
- C. Compatible with normal and emergency branch circuit voltage and overcurrent protection rating.
- D. Normally Open auxiliary contacts for low voltage lighting control wiring.
- E. Auxiliary input for remote test or third party interface.
- F. Integral push-to-test button.

2.13 EMERGENCY LIGHTING TRANSFER DEVICES

- A. An Emergency Lighting Transfer Device (ELTD): A UL 1008 listed transfer device that controls emergency lighting simultaneously with the adjacent normal lighting. Such devices shall continuously monitor the normal lighting branch circuit independently of the emergency power source, and operate as follows:
- B. Acceptable Products:
 - 1. LVS: EPC-D-F-ATS
 - 2. Myers: RLY-DIM-D
 - 3. ETC: SC1008
 - 4. Other Products: A listed alternate device proprietary to the lighting control system providing equivalent functionality.
- C. Compatible with normal and emergency branch circuit voltage and overcurrent protection rating.
- D. Normally Open auxiliary contacts for low voltage lighting control wiring.

- E. Auxiliary input for remote test or third party interface.
- F. Integral push-to-test button

PART 3 - EXECUTION

3.1 PRE-INSTALLATION MEETING

- A. The successful bidder shall review required installation and pre-start-up procedures with the factory-authorized manufacturer's representative during pre-installation meetings.
 - 1. The pre-installation site visit shall be scheduled after receipt of approved submittals:
 - a. Confirm location and mounting of digital devices, with special attention to placement of occupancy and daylighting sensors.
 - b. Review specifications for low voltage control wiring and termination.
 - c. Discuss functionality and configuration of products, including sequences of operation, per design requirements.
 - d. Discuss requirements for interface with other trades.

3.2 IT NETWORK INFRASTRUCTURE COORDINATION

- A. The successful bidder is required to coordinate with the Owner's representative to secure all required network connections to the Owner's IT network infrastructure.
 - 1. The bidder shall provide to the Owner's representative all network infrastructure requirements of the networked lighting control system.
 - 2. The bidder shall provide to the factory-authorized manufacturer's representative all necessary contacts pertaining to the Owner's IT infrastructure to ensure that the system is properly connected and started up.

3.3 INSTALLATION

- A. General:
- B. Coordinate, receive, mount, connect, and place into operation all equipment.
 - 1. Provide conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown in Drawings including but not limited to system field devices, power supplies and communication wire.
 - 2. Coordinate all dimming drivers provided with approved lighting fixtures.
 - 3. Maintain performance criteria stated by manufacturer without defects, damage, or failure.
- C. Wiring:
 - 1. Comply with Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables.
 - 2. Test branch load circuits for operation before connecting loads to sensor system load terminals.
 - a. De-energize circuits before installation.
 - 3.
 - 4. Install devices and wiring and tagline voltage connections to indicate circuit and switched legs.
 - 5. Low voltage wiring topology must comply with manufacturer's specifications.
 - 6. Route network wiring as shown in submittal drawings.
 - 7. Document final wiring location, routing, and topology on record drawings.
- D. Sensors:
 - 1. Calibrate sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
 - a. Adjust time delay so controlled area remains lighted while occupied.

- b. Adjust sensitivity or install masking on sensor devices to avoid false "ON's" from occurring. Install masking only after all furnishings are installed.
 - 2. Vacancy sensor configurations shall be made via the system's control software.
 - 3. Install occupancy sensors on vibration-free stable surfaces.
 - 4. Coordinate the location and quantity of all occupancy sensors based on the manufacturer's coverage patterns and coordination will all trades.
 - 5. Do not locate wall switches and occupancy sensors behind door swings, shelving, or tall equipment.
- E. Software:
- 1. Install and program software with initial settings of adjustable values.
 - 2. Generate backup copies of software and user-supplied values.
 - 3. Provide current site licenses for software.
- F. Provide written or computer generated documentation of room-by-room configuration of system including:
- 1. Sensor parameters, time delays, sensitivities, and daylighting set points.
 - 2. Sequence of operation, e.g., manual ON, Auto OFF.
 - 3. Load Parameters, e.g., blink warning.

3.4 DOCUMENTATION

- A. The installing contractor shall be responsible for documenting installed location of all networked devices, including networked luminaires. This includes responsibility to provide record drawings showing device addresses corresponding to locations of installed equipment.
- B. The installing contractor is also responsible for the following additional documentation to the manufacturer's representative if visualization / graphical floor plan software is provided as part of bid package:
 - 1. Record plan drawings showing daisy-chain wired network control zones outlined, in addition to device address locations required above. Documentation shall remain legible when reproducing\scanning drawing files for electronic submission.
 - 2. Record electrical lighting drawings (reflected ceiling plan) in PDF and CAD format. Architectural floor plans shall be based on as-built conditions.
 - a. CAD files shall have layers already turned on/off as desired to be shown in the floor plan background images. The following CAD elements are recommended to be hidden to produce an ideal background graphic image:
 - 1) Title block.
 - 2) Text- Inclusive of room names and numbers, fixture tags and drawings notes.
 - 3) Fixture wiring and homeruns.
 - 4) Control devices.
 - 5) Hatching or poche of light fixtures or architectural elements.

3.5 SYSTEM START-UP

- A. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed by a factory-authorized manufacturer's representative.
 - 1. Low voltage network cable testing shall be performed prior to system start-up.
- B. System start-up and programming shall include:
 - 1. Verifying operational communication to all system devices (wall stations, sensors, etc.).
 - 2. Programming the network devices into functional control zones to meet the required sequence of operation.
 - 3. Programming and verifying sequence of operations.

4. Customization of Owner's software interfaces and applications.
- C. Initial start-up and programming are to occur on-site.
1. The manufacturer's representative must walk the site with the Design Engineer to confirm the programming of typical spaces prior to the final programming of all similar spaces.
 2. Daylight harvesting settings shall maintain specified illumination levels as indicated on drawings or as described below if values are not provided on drawings:
 - a. Corridors and Lobbies – maintain an average of 5 fc on floor.
 - b. Offices and Conference rooms – maintain an average of 50 fc at 30" above finished floor.
 - c. Laboratories – maintain an average of 90fc at 36" above finished floor.
 - d. Collaboration and Break areas – maintain an average of 30 fc at 30" above finished floor.

3.6 TRAINING

- A. The provider of the system shall train the facility staff or end users responsible for managing the building lighting. Training shall include how to install and access lighting control software, including how to adjust, operate, utilize, troubleshoot, and monitor lighting status. Review field selectable device settings as well as programmable settings.
1. The initial training session shall be for a maximum of 8 hours and shall follow project close-out.
 2. After the installation has been occupied by the Owner for a period of 6 months, a follow-up on-site training session shall occur. The factory-authorized manufacturer's representative shall provide training to the Owner for a maximum of 2 hours, and a programmer, either on-site or remotely, shall spend a maximum of 6 hours confirming all daylight harvesting system settings and making programming adjustments to the system as requested/identified by the Owner.

3.7 CLOSEOUT ACTIVITIES

- A. Refer to Section 01 81 33 - Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

SECTION 26 22 13
LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Low Voltage Distribution Transformers, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Department of Energy (DOE):
 - 1. 10 CFR Part 431 (DOE 2016), Energy Efficiency Program for Certain Commercial and Industrial Equipment.
- B. Institute of Electronic and Electronics Engineers, Inc. (IEEE):
 - 1. C57.12.91, Standard Test Code for Dry-Type Distribution and Power Transformers.
 - 2. C57.94, IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers.
- C. National Electrical Contractors Association:
 - 1. 409, Standard for Installing and Maintaining Dry-Type Transformers.
- D. National Electrical Manufacturers Association (NEMA):
 - 1. ST20, Dry Type Transformers for General Applications.
 - 2. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. Underwriters Laboratories, Inc. (UL):
 - 1. 1561, Standard for Dry-Type General Purpose and Power Transformers.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Technical data on each type of transformer.
 - 2. No-load core loss and full-load coil loss data.
 - 3. Percent impedance and X/R ratio data.
 - 4. Load efficiency curve plots for each type of transformer.
 - 5. Absolute Peak Inrush (rms) amps.
 - 6. Practical Max Inrush (rms) amps.
 - 7. All transformers must be clearly identified in submittal by name, i.e., "NT1A".
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - a. See Section 01 78 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Dry-type Transformers:
 - 1. Base:

- a. Schneider Electric/Square D.
- b. Eaton.
- c. ABB/General Electric.
- d. Siemens.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Insulating materials are to exceed NEMA ST20 standards and be rated for 220 degrees C UL component recognized insulation system.
- B. Three phase transformers 15 kVA and larger and less than or equal to 30 kVA shall be 150 degrees C temperature rise above 40 degrees C ambient.
- C. Transformers larger than 30 kVA and less than or equal to 112.5 kVA shall be 115 deg C temperature rise above 40 deg C ambient and shall be capable of carrying a 15% continuous overload without exceeding a 150 deg C rise in a 40 deg C ambient.
- D. Transformers greater than 112.5 kVA shall be 80 deg C temperature rise above 40 deg C ambient and shall be capable of carrying a 30% continuous overload without exceeding a 150 deg C rise in a 40 deg C ambient.
- E. Transformers shall be supplied with quality, full width electrostatic shields resulting in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal loaded operating conditions, attenuation of line noise and transients shall meet or exceed following limits:
 - 1. Common Mode:
 - a. 0 to 1.5 kHz: 120 dB.
 - b. 1.5 kHz to 10 kHz: 90 dB.
 - c. 10 kHz to 100 kHz: 65 dB
 - d. 100 kHz to 1 MHz: 40 dB.
 - 2. Transverse Mode:
 - a. 1.5 kHz to 10 kHz: 52 dB.
 - b. 10 kHz to 100 kHz: 30 dB.
 - c. 100 kHz to 1 MHz: 30 dB.
- F. Maximum temperature of top of enclosure shall not exceed 50 deg C rise above a 40 deg C ambient.
- G. Transformer efficiencies shall be in accordance with DOE 10 CFR Part 431 defined levels effective January 1, 2016. Older in-stock transformers are unacceptable. Efficiency values shall be determined in accordance with DOE 10 CFR Part 431.

Single Phase		Three Phase	
kVA	Efficiency percent	kVA	Efficiency percent
15	97.70	15	97.89
25	98.00	30	98.23
37.5	98.20	45	98.40
50	98.30	75	98.60
75	98.50	112.5	98.74
100	98.60	150	98.83
167	98.70	225	98.94
250	98.80	300	99.02
333	98.90	500	99.14

2.3 CONSTRUCTION

- A. Transformer coils (except buck/boost type) shall be dual winding of continuous wound construction and shall be impregnated with non-hygroscopic, thermosetting varnish.
- B. Cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below saturation point to prevent core overheating.
- C. Completed core and coil shall be bolted to base of enclosure but isolated by means of rubber vibration-absorbing mounts.
- D. Provide aluminum or copper windings.
- E. There shall be no metal-to-metal contact between core and coil and enclosure except for a flexible safety ground strap.
- F. Sound isolation systems requiring complete removal of all fastening devices will not be acceptable.
- G. Core of transformer shall be visibly grounded to enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.
- H. Transformer enclosures shall be ventilated (30 kVA and above) and fabricated of heavy gauge, sheet steel construction.
- I. Provide finish suitable for outdoor applications as applicable.
- J. Provide weather shields for outdoor units.
- K. Sound levels shall be warranted by manufacturer not to exceed following:
 - 1. 15 to 50 kVA: 45 dB.
 - 2. 51 to 150 kVA: 50 dB.
 - 3. 151 to 300 kVA: 55 dB.
 - 4. 301 to 500 kVA: 60 dB.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Arrange transformers as shown on Drawings. Electrical Room layout and transformer installation shall maximize the ability to install additional equipment in rooms. Contractor to submit coordination drawings per section 26 00 10 indicating final layout of equipment with actual transformer(s) submitted.
- B. Install transformers in accordance with NECA 409, IEEE C57.94 and manufacturer's recommendations and instructions.
- C. Provide minimum of 2 inches clearance on both sides and rear of all ventilated transformers or greater when required by manufacturer.
- D. External wiring connections: See Section 26 05 33.
- E. Mounting provisions:
 - 1. Provide wall mounting brackets and/or trapeze mounting supports and bracing as indicated or as required.
 - 2. Floor-mounted transformers shall be mounted on concrete pads per Section 26 00 10.
 - 3. Transformers 15 kVA and less: Suitable for wall, floor, or trapeze mounting.
 - 4. Transformers 30 kVA through 45 kVA: Suitable for floor or trapeze mounting.
 - 5. Transformers 75 kVA and larger: Suitable for floor mounting.
- F. Provide labeling per Section 26 05 53.
- G. When stacking transformers, provide sheet metal heat shield between transformers.

END OF SECTION

SECTION 26 24 13

SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Low voltage switchboards.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 09 13 - Electrical Power Monitoring.
 - 3. Section 26 09 16 - Electrical Control Components.
 - 4. Section 26 28 01 - Low-Voltage Circuit Protective Devices.
 - 5. Section 26 43 13 - Surge Protection Devices for Low-Voltage Electrical Power Circuits.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. PB 2, Deadfront Distribution Switchboards.
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. 891, Switchboards.
- B. Verify the space required for the switchboard is equal to or less than the space allocated.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data.
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - 2. See Specification Section 26 05 00 for additional requirements.
 - 3. Fabrication and/or layout drawings:
 - a. Switchboard layout with alphanumeric designation, protective devices size and type, as indicated in the one-line diagram or switchboard schedule.
 - b. Front elevation and plan drawing of the assembly.
 - c. Three-line or single line and schematic diagrams.
 - d. Conduit space locations within the assembly.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - 2. Fabrication and/or layout drawings updated with as-build conditions
- C. Informational Submittals:
 - 1. Equipment marking and documentation.
 - 2. Ground fault protection system test report signed by the projects supervising electrical foreman.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Eaton.
 - 2. Square D by Schneider Electric.
 - 3. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 SWITCHBOARDS

- A. Ratings:
 - 1. Voltage, number of phases, number of wires, and main bus current rating as indicated on the Drawings.
 - 2. Assembly short circuit current and interrupting device rating as indicated on the Drawings.
 - 3. When low voltage power circuit breakers are utilized, the switchboard shall have a 30 cycle withstand rating corresponding to the breaker rating.
 - 4. Service Entrance Equipment rated when indicated on the Drawings.
- B. Construction:
 - 1. Standards: NEMA PB 2, UL 891.
 - 2. Completely enclosed, dead-front, self-supporting metal structure.
 - 3. Vertical panel sections bolted together.
 - 4. Frames bolted together to support and house bus, cables and other equipment.
 - 5. Frames and insulating blocks to support and brace main buses for short circuit stresses up to ratings indicated on the Drawings.
 - 6. All sections front and rear aligned.
 - 7. Devices front removable and load connections front and rear accessible.
 - 8. NEMA 3R rated weatherproof enclosure:
 - a. Nonwalk-in type with sloping roof downward toward rear.
 - b. Thermostatically controlled space heaters to minimize internal condensation.
 - c. Power for heater derived internal to the switchboard.
 - 9. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturer's standard paint.
- C. Buses:
 - 1. Material: Tin-plated copper.
 - 2. Main horizontal bus:
 - a. Fully rated and continuous over length of switchboard with all three phases arranged in the same vertical plane.
 - b. Sufficient size to limit temperature rise to 65 degrees C over average air temperature outside the enclosure of 40 degrees C.
 - 3. Neutral bus: Fully rated and continuous over length of switchboard.
 - 4. Ground bus: 1/4 x 2 inches copper, continuous over length of switchboard and solidly grounded to each vertical section structure.
 - 5. Bus joints connected using through bolts and conical spring-type washers for maximum conductivity.
- D. Overcurrent and Short Circuit Protective Devices:
 - 1. Main overcurrent protective device:
 - a. Individually mounted molded case circuit breaker.

2. Feeder overcurrent protective devices:
 - a. Group mounted molded case circuit breaker.
 3. See Specification Section 26 28 01 for overcurrent and short circuit protective device requirements.
 4. Factory installed.
 5. Means to padlock all main and feeder devices in the open position.
- E. Surge Protective Device: Integrally mounted, see Specification Section 26 43 13.
- F. Metering:
1. Utility:
 - a. Separate barriered-off compartment with hinged sealable door.
 - b. Bus work with provisions for required current and potential transformers and meter mounting.
 2. Power monitor:
 - a. Through cabinet mounting.
 - b. See Specification Section 26 09 13 for meter requirements.
- G. Arc Flash Reduction Maintenance Switch (ARMS)
1. Factory installed.
- H. Accessories:
1. Thermograph viewing windows for infrared surveys without opening doors:
 - a. Provide windows at manufacturer's recommended locations to view cable connections and bus connections.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install switchboards in accordance with manufacturer's instructions.
- B. Arrange switchboard as shown on the Drawings.
- C. Outdoor location:
 1. NEMA 3R enclosure.
 2. Install on concrete pad, align front of switchboard with top edge of pad chamfer and securely fasten to pad.
- D. Equipment Marking and Documentation:
 1. Provide labeling per NFPA 70 and other applicable codes.
 2. Service equipment:
 - a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A) and (B))
 - b. Available fault current label and documentation of the calculations made for compliance with marking requirements. (Ref. NFPA 70 Article 110.24)
 3. Other than service equipment:
 - a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A))
 - b. Available fault current label. (Ref. NFPA 70 Article 408.6)
 4. Identify (tag) all equipment and equipment components.
 5. Provide labels and tags in accordance with Section 10 14 00.
 6. Available fault current and other required label data from Coordinated Power System Study as required by the contract documents.
- E. Miscellaneous:

1. Provide circuit protective devices and other associated equipment as indicated on the Drawings.
2. All control wiring shall be neatly laced and have flexibility at hinge locations.

3.2 FIELD QUALITY CONTROL

- A. Test the ground fault protection system as indicated in Specification Section 26 28 01.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Panelboards, as indicated, in accordance with provisions of Contract Documents.
- B. Provide power, distribution and lighting and appliance panelboards as specified and indicated on schedules and drawings.
- C. Completely coordinate with work of other trades.

1.2 DEFINITIONS

- A. Lighting and appliance branch circuit: Branch circuit that has a connection to the neutral of the panelboard and that has overcurrent protection of 30 amperes or less in one or more conductors.
- B. Lighting and appliance branch-circuit panelboards: Panelboard having more than 10% of its overcurrent devices protecting lighting and appliance branch circuits.
- C. Power Panelboard: Panelboard having 10% or fewer of its overcurrent devices protecting lighting and appliance branch circuits. The terms "power panelboard" and "distribution panelboard" will be used interchangeably.
- D. Load Center: Panelboard used in residential or light commercial applications.

1.3 REFERENCES

- A. Canadian Standards Association (CSA):
 - 1. C22.2 No. 29-15, Panelboards and Enclosed Panelboards.
- B. Federal Specification (USGSA):
 - 1. W-P-115C, Type I Class 1.
 - 2. W-P-115C, Type II Class 1.
- C. National Electrical Manufacturers Association (NEMA):
 - 1. PB-1, Panelboards.
 - 2. PB-1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000 V or Less.
 - 3. KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- D. InterNational Electrical Testing Association (NETA):
 - 1. ATS, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. Underwriters Laboratories, Inc. (UL):
 - 1. 50, Electrical Equipment Enclosure Testing.
 - 2. 50E, Electrical Equipment Enclosure Testing, Environmental Considerations.
 - 3. 67, Panelboards.

1.4 SUBMITTALS

- A. Submit Panelboard Shop Drawings and Product Data along with, or subsequent to, a complete short circuit analysis and coordination study per Section 26 05 73. Product data or shop drawings submitted prior to power system studies will be rejected.
- B. Shop Drawings:

1. Identify panelboards by alphanumeric designations indicated in panelboard schedules or one-line-diagram and include outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device types, arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, enclosure types, and provided features and accessories.
- C. Product Data:
 1. Technical data on each type of panelboard, including the manufacturer's standard catalog pages and data sheets for panelboards, enclosures, finishes, and other required components and accessories
- D. Contract Closeout Information:
 1. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Panelboards:
 1. Base:
 - a. Eaton.
 - b. ABB/General Electric.
 - c. Schneider Electric/Square D.
 - d. Siemens.
- B. Other manufacturers desiring approval comply with Section 01 61 00.
 1. Eaton types listed for quality and performance reference.

2.2 MATERIALS

- A. Panelboards:
 1. Dead front type.
 2. Provide lighting panelboards with branch circuit connection to main bus arranged for sequence phasing.
 3. Provide feed-thru lugs or sub-feed lugs for 2 and 3 section panels.
 4. Equip bus bars for panelboard with main lugs, main fused switch or main circuit breaker, capacity as required or indicated.
 5. Equipment Ground Bus:
 - a. Adequate for feeder and branch-circuit equipment grounding conductors, bonded to box.
 - b. Non-insulated equipment grounding terminal strip located in top or bottom gutter including main grounding lug and individual terminals for at least 50% of panel circuits including spare circuits and space provisions; increase gutter space accordingly for grounding strip.
 6. Panelboard bussing to be tin-plated aluminum.
 7. Provide special features such as split bus, lighting contactors, extra-width gutters as required.
 8. Provide panelboard busses fully rated for specified interrupting rating. Series rating of panelboards and overcurrent protective devices is not acceptable.
 9. Provide full length bussing including areas indicated as space only.
 10. Enclosures: Flush- and surface-mounted cabinets rated for environmental conditions at installed location.

- a. Indoor Dry and Clean Locations: NEMA 250, Type 1
 - b. Outdoor Locations: NEMA 250, Type 3R
 - c. Wash-down Areas: NEMA 250, Type 4X stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
11. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- B. Circuit Breaker Panelboards:
- 1. Provide bolted-on circuit breaker type (or breakers equipped with an integral mounting bracket). Plug-in circuit breakers not acceptable.
 - 2. Do not install feeder or branch circuit breakers in sub-feed section of panel.
 - 3. Provide main busses and back panels which permit changing of circuit breakers without additional machining, drilling, or tapping.
 - 4. All multi-pole breakers provide single handle with common trip.
 - 5. All multi-pole breakers, 100 A rated and larger shall include means for padlocking in "OFF" position.
 - 6. Include provisions for locking specific circuit breakers in the "ON" position where indicated.
 - 7. Provide shunt trip mechanism on breakers where indicated.
 - 8. Provide ground fault protection as indicated coordinated with upstream devices.
 - 9. Design so a combination of one, two and three pole circuit breaker can readily be assembled in the same panelboard.
 - 10. Circuit breakers operable in horizontal or vertical position and removable from front of panelboard without disturbing adjacent units.
 - 11. Tandem or half-size circuit breakers not allowed.
 - 12. Panelboard short circuit current ratings:
 - a. In 120/208 V panelboards: Minimum 10,000 AIC symmetrical, as indicated on drawings, or as required by power systems studies, whichever is greatest.
 - b. In 277/480 V panelboards: Minimum 14,000 AIC symmetrical, as indicated on drawings, or as required by power systems studies, whichever is greatest.
 - 13. Lighting and appliance branch-circuit panelboards:
 - a. Eaton types PRL1a, PRL2a and PRL3a or approved equal.
 - 14. Distribution panel boards (circuit breaker type):
 - a. Eaton type PRL4B or approved equal.
- C. Cabinets:
- 1. Galvanized sheet steel, code thickness.
 - 2. Lighting and appliance panel boards 5-3/4 inches 145 mm deep by 20 inches 508 mm wide minimum.
 - 3. Standard door and trim with lock on inner door.
 - 4. Multi-section panels shall have equal height enclosures in finished areas.
 - 5. Fasten trim to cabinet by means of adjustable clamps.
 - 6. Equip door with chrome-plated combination lock and catch; supply two milled keys with each lock; key locks alike.
 - 7. Identify all circuit locations in each respective panel with load and location served.
 - a. Provide typed directory installed inside panelboard door, mounted in metal frame with transparent protective cover.
 - b. Typed directory database (Microsoft Excel file, Microsoft Word file, or equivalent) to be given to Owner to incorporate future circuit changes.
 - c. Mechanical equipment identified in directory shall be same as designation indicated on plans.

- d. Room names and numbers in directory shall be final building room names and numbers as identified by Owner and not necessarily the name or number indicated on plans.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories as indicated and in accordance with manufacturer's recommendations and instructions and according to NECA 407 and NEMA PB.1.1.
- B. Arrange panelboards as shown on Drawings. Electrical Room layout and panelboard installation shall maximize the ability to install additional equipment in rooms. Contractor to submit coordination drawings per section 26 00 10 indicating final layout of equipment with actual panelboards submitted.
- C. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
- D. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- E. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
- F. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
- G. Panelboard Cabinet Supports:
 - 1. Gypsum Wall Board walls:
 - a. Attach to studs via unistrut cross members or metal backing bolted or welded to studs where not otherwise shown.
 - 2. Masonry or concrete walls:
 - a. Attach to wall via unistrut cross members.
- H. Wall mounted panelboards shall be installed 153mm 6 inches above floor minimum.
 - 1. Large panels that rest on floor shall be mounted on house-keeping pads per Section 26 00 10.
- I. Provide spare conduits into accessible ceiling space from all flush wall mounted panelboards.
 - 1. Provide one spare 3/4 inches conduit for each 3 spare and/or space branch circuit poles or fraction thereof but no less than two spare 3/4 inches conduits.
- J. Electrical Room layout and panelboard installation shall maximize the ability to install additional equipment in rooms. Contractor to submit coordination drawings per section 26 00 10 indicating final layout of equipment with actual panelboards submitted.

3.3 LABELING

- A. Provide panelboard labeling as specified in Section 26 05 53.
- B. Permanently post, at each panelboard, the conductor color coding scheme specified in Section 26 05 53.

3.4 ADJUSTING

- A. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 28 00 "Overcurrent Protective Devices."

3.5 CLEANING

- A. In completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 24 19
MOTOR CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Motor Control Equipment, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. Motor control equipment:
 - a. Outline drawings of assembly.
 - b. One line diagrams and wiring diagrams for assembly and components.
 - c. Interconnection wiring diagrams.
- B. Product Data:
 - 1. Technical data on each type of controller and/or feeder device.
- C. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - 2. Owner instruction report.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Motor Control Equipment:
 - 1. Base:
 - a. Eaton.
 - b. General Electric.
 - c. Schneider Electric/Square D.
 - d. Siemens.
 - e. Allen-Bradley.
- B. Other manufacturers (not assemblers) desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Motors:
 - 1. Motors 1/2 hp and above: 460V, three phase, 60 cycle; provide 3 phase combination magnetic starters.
 - 2. Do not provide starters if indicated as part of Mechanical Specifications Divisions work.
 - 3. Motors below 1/2 hp: 115V, single phase, 60 cycle; provide manual thermal element units.
- B. Enclosures:
 - 1. General:
 - a. Service voltage: 480 V, 3 phase, 60 cycle.
 - b. Branch circuit short circuit protection: Motor circuit protector (MCP).
 - 1) Operating handle shall clearly indicate whether MCP is on, off or tripped.

- 2) Provide means to lock each operating handle in off position with cover closed by means of one to three padlocks.
- 3) Interlock so that operating handle must be in off position before door can be opened.
- c. Finish: Thoroughly clean structure inside and out after fabrication and apply prime coat, and two coats of light gray (ANSI Color 61) or medium light gray (ANSI Color 49) enamel, inside and out.

C. Automatic Controllers:

1. General:

- a. Provide with three overload relays for complete single-phasing and overload protection.
- b. Provide START-STOP push button station or selector switch and red pilot light, or pilot light only, for each motor starter on cover of each unit where indicated on drawings or schedules.
- c. Provide with two extra NO interlocking contacts in addition to seal-in contacts.
- d. Provide 480/120 volt control transformer with 2 primary and one secondary fuse.
- e. Overload relays:
 - 1) Bimetallic type.

2. Combination full voltage non-reversing starters:

- a. External manual reset thermal overload relays.
- b. Eaton Class A-206 with motor circuit protector.

D. Manual Controller:

1. Manual thermal element units: 120/240 volt, single phase, maximum 1 hp, with overload protection and toggle switch.
 - a. Provide means for padlocking in off position.
 - b. Eaton Type MS.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
- B. Set adjustable trip settings of motor circuit protectors to match characteristics of motor installed.
- C. Provide heater elements which match characteristics of motor installed.

3.2 LABELING

- A. Provide labeling as specified in Section 26 05 53.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Wiring Devices, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Provide wiring devices conforming to the following standards:
 - 1. Underwriter's Laboratories (UL).
 - a. UL 498 – Standard for Attachment Plugs and Receptacles.
 - b. UL 514D – Cover Plates for Flush-Mounted Wiring Devices.
 - c. UL 943 – Standard for Safety for Ground-Fault Circuit-Interruption.
 - 2. National Electric Manufacturers Association (NEMA).
 - a. WD-1 – General Color Requirements for Wiring Devices.
 - b. WD-6 – Wiring Devices – Dimensional Requirements.
 - 3. US Federal Specifications.
 - a. Fed Spec receptacles (WC-596F).
 - b. Fed Spec device plates (W-P-455).

1.3 SUBMITTALS

- A. Product Data:
 - 1. Technical data on each type of device.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Wiring Devices:
 - 1. Base:
 - a. Hubbell.
 - 2. Optional:
 - a. Eaton.
 - b. Leviton Manufacturing.
 - c. Pass & Seymour (Legrand).
 - 3. All wiring devices shall be provided by the same manufacturer.
- B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Duplex and Single Receptacles:
 - 1. Flush, grounding convenience outlets for side wiring, or side and back wiring.
 - 2. Listed per UL 498 for general use and certified by UL to Fed Spec WC-596F and shall be visibly marked with the "UL-FS" mark to confirm certification.
 - a. Constructed with impact resistant nylon or polyester face and body.

- b. 0.050 inches brass nickel-plated back strap with one piece (non-riveted) ground design.
 - c. 0.040 inches brass nickel-plated contacts.
- 3. Refer to Symbol Legend on Drawings for types.
- 4. Refer to table at end of Section 26 05 53 for description of device colors.
- 5. Receptacles:
 - a. Specification grade for general use.
 - b. 20A, 125V, 2 pole, 3-wire grounding, duplex, specification grade, NEMA 5-20R; Hubbell HBL5362.
 - c. 20A, 125V, 2 pole, 3-wire grounding, single, specification grade, NEMA 5-20R; Hubbell HBL5361.
- 6. Ground Fault Circuit Interrupter (GFCI) type receptacle:
 - a. With built-in ground fault interruption, 4 to 6 mA trip sensitivity, 0.025 second trip time, 10,000 A maximum interrupting capacity, self-testing technology, indicator and reset.
 - b. 20A, 125V, 3-wire duplex, specification grade, NEMA 5-20R; Hubbell GFRST20.
- 7. Tamper resistant (safety-type) receptacles.
 - a. NEC Article 406.12 compliant.
 - b. 20A, 125V, hospital grade, 2 pole, 3-wire, grounding, duplex, safety type: NEMA 5-20R; Hubbell HBLSLG-63H.
- 8. USB charger duplex receptacles:
 - a. Combination USB ports, one type A, one type C, 5 amp, 5 volts DC.
 - b. Complies with battery charging specification USB BC1.2.
 - c. Compatible with USB 1.1/2.0/3.0 devices, including Apple products.
 - d. Complies with Part 15 of the FCC rules.
 - e. 20A, 125V, 3-wire duplex, specification grade, NEMA 5-20R; Hubbell USB20AC5.
- B. Special Purpose Receptacles:
 - 1. Straight Blade:
 - a. NEMA 6-20R receptacle: 20A, 250V, 2 pole, 3 wire grounding, side and back wired, single; ivory, Hubbell HBL5461I.
 - b. NEMA 14-20R receptacle: 20A, 125/250V, 3 pole, 4 wire, 1 phase grounding, single; black; Hubbell HBL8410.
 - c. NEMA 15-20R receptacle: 20A, 250V, 3 pole, 4 wire, 3 phase grounding, single, black; Hubbell HBL8420.
 - d. NEMA 5-30R receptacle: 30A, 125V, 2 pole, 3 wire grounding, single, black; Hubbell HBL9308.
 - e. NEMA 6-30R receptacle: 30A, 250V, 2 pole, 3 wire grounding, single, black; Hubbell HBL9330.
 - f. NEMA 10-30R receptacle: 30A, 125/250V, 3 pole, 3 wire, 1 phase, single, brown; Hubbell HBL9350.
 - g. NEMA 14-30R receptacle: 30A, 125/250V, 3 pole, 4 wire, 1 phase grounding, single, black; Hubbell HBL9430A.
 - h. NEMA 15-30R receptacle: 30A, 250V, 3 pole, 4 wire, 3 phase, grounding, single, black; Hubbell HBL8430A.
 - i. NEMA 6-50R receptacle: 50A, 250V, 2 pole, 3 wire, 1 phase, grounding, single, black; Hubbell HBL9367.
 - j. NEMA 10-50R receptacle: 50A, 125/250V, 3 pole, 3 wire, 1 phase; black; Hubbell HBL7962.
 - k. NEMA 14-50R receptacle: 50A, 125/250V, 3 pole, 4 wire, 1 phase, grounding, single, black; Hubbell HBL9450A.

- I. NEMA 15-50R receptacle: 50A, 250V, 3 pole, 4 wire, 3 phase, grounding, single, black, Hubbell HBL8450A.
2. Twist-Lock:
 - a. NEMA L5-20R receptacle: 20A, 125V, 2 pole, 3 wire, 1 phase, grounding, single, twist-lock; black; Hubbell HBL2310.
 - b. NEMA L6-20R receptacle: 20A, 250V, 2 pole, 3 wire, 1 phase, grounding, single, twist-lock; black; Hubbell HBL2320.
 - c. NEMA L14-20R receptacle: 20A, 125/250V, 3 pole, 4 wire, 1 phase, grounding, single, twist-lock; black; Hubbell HBL2410.
 - d. NEMA L15-20R receptacle: 20A, 250V, 3 pole, 4 wire, 3 phase, grounding, single, twist-lock; black; Hubbell HBL2420.
 - e. NEMA L5-30R receptacle: 30A, 125V, 2 pole, 3 wire, 1 phase, grounding, single, twist-lock; black; Hubbell HBL2610.
 - f. NEMA L6-30R receptacle: 30A, 250V, 2 pole, 3 wire, 1 phase grounding, single, twist-lock; black; Hubbell 2620.
 - g. NEMA L14-30R receptacle: 30A, 125/250V, 3 pole, 4 wire, 1 phase, grounding, single, twist-lock; black; Hubbell HBL2710.
 - h. NEMA L21-30R receptacle: 30A, 250V, 3 pole, 4 wire, 3 phase, grounding, single, twist-lock; black; Hubbell HBL2810.
- C. Device Plates:
 1. Device plates for concealed wiring: Same manufacturer as devices to suit device covered; single, or ganged, in one piece with beveled edges that match faces of plates.
 - a. Flush, brushed-finish, type 304 stainless steel.
 2. Labeling:
 - a. General:
 - 1) Where labeling of device plates is required, provide clear adhesive labels.
 - a) Label inside of device plates with panelboard and circuit number supplying the devices.
- D. Plug-In Strip:
 1. Plug-in strip: Surface steel raceway plug-in strip with pre-wired receptacles.
 - a. Base, snap-on cover, and fittings as required.
 - b. Nominal dimensions 1-1/4 inches wide x 3/4 inches deep.
 - c. Provide 3 feet, 5 feet or 6 feet lengths as indicated on Drawings.
 - d. Gray enamel.
 - e. 15A, 125V, 2 pole, 3 wire grounding, single, specification grade, NEMA 5-15R receptacles.
 - f. Space receptacles 12 inches O.C.
 - g. UL listed under ANSI/UL-5.
 - h. Conductors: TW or THHN, 2 No.12 and 1 No.12 TW green for connection to receptacle grounding terminals. Effectively connect green grounding conductor and raceway to building equipment grounding system.
 - i. Wiremold Type 2000 Series Plugmold.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate devices as indicated and as scheduled in Section 26 00 10.
- B. Center outlets with regard to paneling, furring, trim, tile, etc.
- C. Where several outlets occur in a room, symmetrically arrange them.

- D. Any outlet which is improperly located must be corrected at Contractor's expense.
- E. Set outlets plumb or horizontal and flush with face of finished surface of wall, ceiling, or floor.
- F. Install receptacles indicated on wood trim, cases, or other fixtures symmetrically. Where necessary, set with long dimension of plate horizontal, or gang in tandem.
- G. GFCI receptacles shall be connected to provide ground fault protection of downstream devices on same circuit within 6 feet in any direction of the edge of a sink. All other downstream devices shall not be protected by GFCI receptacle.
 - 1. Protected downstream devices shall be labeled as protected by upstream GFCI receptacle.

END OF SECTION

SECTION 26 28 00
OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Overcurrent Protective Devices, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Canadian Standards Association (CSA):
 - 1. C22.2 No. 5.1 - M91, Molded Case Circuit Breakers.
- B. Federal Specifications (USGSA):
 - 1. W-C-375B/GEN, Circuit Breakers, Molded Case; Branch Circuit and Service.
- C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. C37.13, Low-Voltage AC Power Circuit Breakers Used in Enclosures.
 - 2. C37.16, Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers.
 - 3. C37.17, Standard for Trip Systems for Low-Voltage (1000 V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers.
 - 4. C37.50, Standard for Trip Systems for Low-Voltage (1000 V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers.
- D. National Electrical Manufacturers Association (NEMA):
 - 1. AB-1, Molded Case Circuit Breakers and Molded Case Switches.
 - 2. SG-3, Low Voltage Power Circuit Breakers.
- E. Underwriters Laboratories, Inc. (UL):
 - 1. 489, Molded Case Circuit Breakers and Circuit Breaker Enclosures.
 - 2. 943, Standard for Ground Fault Circuit Interrupters.
 - 3. 1066, Standard for Low Voltage Circuit Breakers.

1.3 SUBMITTALS

- A. Submit Overcurrent Protective Devices Product Data along with, or subsequent to, a complete short circuit analysis and coordination study per Section 26 05 73. Product data or shop drawings submitted prior to power system studies will be rejected.
- B. Product Data:
 - 1. Technical data on each type of device including:
 - a. Outline drawings with dimensions.
 - b. Ratings for voltage, amperage, and maximum interrupting ratings.
 - c. Trip unit functions and adjustments
 - d. Accessories.
 - e. Wiring diagrams.
 - f. Manufacturer shall provide hard copy time/current characteristic trip curves (and I_p and I^2t let through curves for current limiting circuit breakers) for each type of circuit breaker.
 - 2. Submit under this section and clearly identify each overcurrent device with the associated switchgear, switchboard, panelboard, or other assembly.

- C. Refer to Section 01 81 33 - Cyber Security Requirements for required cyber security related submittals.
- D. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - a. Include instructions for circuit breaker mounting, trip unit functions and adjustments, trouble shooting, accessories and wiring diagrams.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Overcurrent Protective Devices.
 - 1. Base:
 - a. Eaton.
 - b. ABB / General Electric.
 - c. Schneider Electric/Square D.
 - d. Siemens.
- B. Fuses:
 - 1. Base:
 - a. Bussmann.
 - b. Mersen.
 - c. Brush.
 - d. Littelfuse.
- C. Equipment and devices by same manufacturer.
- D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
- B. Circuit Breakers:
 - 1. Provide circuit breakers as required by other specifications and drawings. Provide special features as indicated including but not limited to:
 - a. Drawout construction.
 - b. Electrical operation.
 - c. Key interlock for main-tie-main arrangements.
 - d. Ground fault protection.
 - 2. Provide lugs rated for 75 deg C wire minimum.
 - 3. Contractor shall review one line diagrams and confirm that circuit breakers have adequate lugs to accommodate size and quantity of conductors indicated on one line diagrams, panel, and motor control schedules.
 - 4. Lugs shall be UL Listed to accept solid (not larger than #8 AWG) and/or stranded copper and aluminum conductors.
 - 5. Circuit breakers shall be capable of accepting bus connections.
 - 6. Overcurrent devices shall be fully rated for available fault current unless otherwise specifically indicated.
 - 7. Frame sizes 1000 A and greater shall include ground fault protection.

8. Frame sizes 1200 B and greater shall include "Arc Flash Maintenance Mode" switch and local annunciator.
9. Molded case type:
 - a. Constructed of glass reinforced insulating material. Current carrying components shall be completely isolated from handle and accessory mounting area.
 - b. Provide over center, trip free, toggle operating mechanism which shall provide quick-make, quick-break contact action. Provide common tripping of two and three pole circuit breakers.
 - c. Circuit breaker handle shall reside in a tripped position between ON and OFF to provide local trip indication. Circuit breaker escutcheon shall be clearly marked ON and OFF in addition to providing International I/O markings.
 - d. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.
 - e. Provide each circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit breaker tripping mechanism for maintenance and testing purposes.
 - f. Provide factory seal with date code on face of circuit breaker.
 - g. Provide circuit breakers equipped with UL Listed electrical accessories as noted on associated schedule or drawing.
 - h. Provide circuit breaker handle accessories with provisions for locking handle in ON and OFF position as noted on associated schedule or drawing.
 - i. Provide circuit breakers UL Listed for reverse connection without restrictive line and load markings and suitable for mounting in any position.
 - j. Provide circuit breakers UL Listed to accept field installable/removable mechanical type or compression type lugs. Provide lug body bolted in place, snap in design not acceptable.
 - k. Thermal-Magnetic Circuit Breakers:
 - 1) Used only as follows unless otherwise indicated:
 - a) Main, feeder and branch circuit breakers in lighting and appliance panelboards as defined in Section 26 24 16.
 - b) Main, feeder, and branch circuit breakers rated 125 A and less in distribution panel boards as defined in Section 26 24 16.
 - c) Motor circuit protectors.
 - 2) Do not use in switchboards rated over 400 amps.
 - 3) Provide permanent trip unit containing individual thermal and magnetic trip elements in each pole.
 - 4) Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true rms sensing and thermally responsive to protect circuit conductors in a 40 deg C ambient temperature.
 - 5) Provide circuit breaker frame sizes above 150 A with magnetic trip adjustment located on front of circuit breaker.
 - 6) Provide UL Listed HACR type for two- and three-pole circuit breakers rated up to 250 A at 600 VAC.
 - 7) Provide Class A (5 mA) sensitivity breaker where GFCI circuit breakers are indicated.
 - l. Electronic trip circuit breakers with standard function trip system:
 - 1) Provide standard function trip system on circuit breakers rated less than 400 amps unless otherwise indicated.

- 2) Provide circuit breaker trip system with microprocessor-based true rms sensing design with sensing accuracy through thirteenth (13th) harmonic and sensor ampere ratings as indicated on associated schedules or drawings.
 - 3) Provide integral trip system independent of any external power source and with industrial grade electronic components.
 - 4) Determine ampere rating of circuit breaker by combination of interchangeable rating plug, sensor size, and long-time pickup adjustment on circuit breaker. Clearly mark sensor size, rating plug, and adjustment positions on face of circuit breaker.
 - 5) Provide circuit breakers UL listed to carry 80 percent of ampere rating continuously.
 - 6) Provide following time/current response adjustments, each with discrete settings independent from other adjustments:
 - a) Instantaneous Pickup.
 - b) Long time pickup and delay.
 - c) Short time pickup.
 - d) Short time delay (I²t IN only).
 - e) Ground fault pickup and delay (I²t OUT only) where indicated.
 - 7) Provide means to seal trip unit adjustments in accordance with NEC.
 - 8) Provide local visual trip indication for overload, short circuit, and ground fault trip occurrences as applicable.
 - 9) Provide ammeter to individually display all phase currents flowing through circuit breaker including indication of inherent ground fault current flowing in system on circuit breakers with integral ground fault protection. Display current values in true rms with 2 percent accuracy.
 - 10) Provide Long Time Pickup indication to signal when loading approaches or exceeds adjusted ampere rating of circuit breaker.
 - 11) Provide trip system with Long Time memory circuit to sum time increments of intermittent overcurrent conditions above pickup point and means to reset Long Time memory circuit during primary injection testing.
 - 12) Provide circuit breakers equipped with thermal protection in trip unit to protect breaker from catastrophic failure and instantaneous magnetic override set at the withstand rating of the circuit breaker.
 - 13) Provide trip system equipped with externally accessible test port for use with Universal Test Set. Disassembly of circuit breaker shall not be required for testing. Provide test set capable of verifying operation of trip functions with or without tripping circuit breaker.
- m. Electronic trip circuit breakers with full function trip system:
- 1) Provide full function trip system on circuit breakers rated 400 A and greater.
 - 2) Provide circuit breaker trip system with microprocessor-based true rms sensing design with sensing accuracy through thirteenth (13th) harmonic and sensor ampere ratings as indicated on associated schedules or drawings.
 - 3) Provide integral trip system independent of any external power source and with industrial grade electronic components.
 - 4) Determine ampere rating of circuit breaker by combination of interchangeable rating plug, sensor size, and long-time pickup adjustment on circuit breaker. Clearly mark sensor size, rating plug, and adjustment positions on face of circuit breaker.
 - 5) Provide circuit breakers UL listed to carry 80 percent of ampere rating continuously.
 - 6) Provide following time/current response adjustments, each with discrete settings independent from other adjustments:
 - a) Instantaneous pickup.
 - b) Long time pickup and delay.
 - c) Short time pickup.

- d) Short time delay (I^2t IN and I^2t OUT).
 - e) Ground fault pickup and delay (I^2t IN and I^2t OUT) where indicated.
 - f) Ground fault alarm only where required by NEC.
- 7) Provide means to seal rating plug and trip unit adjustments in accordance with NEC.
 - 8) Provide ammeter to individually display all phase currents flowing through circuit breaker including indication of inherent ground fault current flowing in system on circuit breakers with integral ground fault protection. Display current values in true rms with 2 percent accuracy.
 - 9) Provide Long Time Pickup indication to signal when loading approaches or exceeds adjusted ampere rating of circuit breaker.
 - 10) Provide trip system with Long Time memory circuit to sum time increments of intermittent overcurrent conditions above pickup point and means to reset Long Time memory circuit during primary injection testing.
 - 11) Provide circuit breakers equipped with thermal protection in trip unit to protect breaker from catastrophic failure and instantaneous magnetic override set at the withstand rating of the circuit breaker.
 - 12) Provide trip system equipped with externally accessible test port for use with Universal Test Set. Disassembly of circuit breaker shall not be required for testing. Provide test set capable of verifying operation of trip functions with or without tripping circuit breaker.
 - 13) Provide communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information. Required communications protocols:
10. Motor circuit protector (MCP) with adjustable instantaneous short circuit protection only by means of a magnetic or solid state trip element.
 - a. Molded case construction.
 - b. Current-limiting as indicated or required providing 200,000 AIC by means of a current-limiter attachment.
 - c. See motor control center schedules for required sizes and interrupting ratings.

C. Individually Enclosed Circuit Breakers:

1. Provide circuit breakers of types specified herein and mounted in individual listed enclosures.
 - a. Rate enclosures NEMA 1 unless otherwise indicated.
 - b. Flush mount enclosures located in finished areas unless otherwise indicated. Coordinate depth of enclosure with wall depth. Install enclosure cover flush with finished wall. Advise Engineer if enclosure is too deep for available wall depth prior to installation of enclosure.

D. Fuses:

1. UL Class L fuses: Dual-element time-delay and current-limiting type fuses; UL Class L listed for 200,000 rms AIC symmetrical; Bussmann "Low-Peak" 600V, 601-6000A, Type KRP-C.
 - a. Use for main and main feeder devices over 600A, where fuses are indicated.
2. UL Class RK-1 dual-element fuses: Dual-element time-delay and current-limiting rejection type fuses; UL Class RK-1 listed for 200,000 rms AIC symmetrical; Bussmann "Low-Peak" 0-600A, 250V Type LPN-RK and 600V Type LPS-RK.
 - a. Use for main feeder devices 600A and smaller where fuses are indicated.
3. UL Class RK-1 single-element fuses: Fast-acting current-limiting rejection type fuses; UL Class RK-1 listed for 200,000 rms AIC symmetrical; Bussmann "Limitron" 1/10-600A, 250V Type KTN-RK and 600V Type KTS-RK.
 - a. Use as indicated.

4. UL Class RK-5 fuses: Dual-element time-delay and current-limiting rejection type fuses; UL Class RK-5 listed for 200,000 rms AIC; Bussmann "Fusetron" 1/10-600A, 250V Type FRN-RK and 600V FRS-RK.
 - a. Use for motor feeder and branch circuit devices where fuses are indicated.
 5. UL Class J quick acting fuses: Rated for 600V applications where 101-200A fuses are required on load side of self-contained utility meters.
 6. Elevator fuses: Type and rating as required by elevator manufacturer. Confirm requirements with elevator manufacturer prior to ordering fuses.
- E. Fusible Switches:
1. Provide panelboard type suitable for mounting in switchboards or panelboards as indicated.
 - a. 200,000 AIC, 30 thru 1200 A, with fuses specified above.
 - b. Provide ground fault protection system with current sensor, shunt trip and control power transformer where indicated.
 2. Provide bolted pressure contact switches suitable for mounting in switchboards as indicated.
 - a. 200,000 AIC, 800 thru 4000 A, with fuses specified above.
 - b. Electrically operated as indicated.
 - c. Provide ground fault protection with current sensor, shunt trip and control power transformer where indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide overcurrent protective devices in switchboards, panelboards and motor control centers as indicated in those sections.
- B. Provide individually enclosed overcurrent protective devices:
 1. Wall mounted:
 - a. Finished areas: Attach to studs via Unistrut cross members or metal backing bolted or welded to studs where not otherwise shown.
 - b. Masonry or concrete walls: Attach to wall via Unistrut cross members where not otherwise shown.
 - c. Mounting height shall be as indicated on symbol legend or elsewhere in this specification but bottom of enclosure shall not be less than 12 inches AFF.
 2. Where floor mounted provide pad per specification 26 00 10.
 3. Arrange individually enclosed overcurrent protective devices as shown on Drawings. Electrical Room layout and individually enclosed overcurrent protective devices installation shall maximize the ability to install additional equipment in rooms. Contractor to submit coordination drawings per section 26 00 10 indicating final layout of equipment with actual individually enclosed overcurrent protective devices submitted.
- C. Field Settings:
 1. Perform field adjustments of protective devices as required to place equipment in final operating condition. Settings shall be in accordance with approved power system study.
 - a. Refer to Section 26 05 73.
 2. Provide certified calibration report for each protective device.
- D. Arc Flash Labels:
 1. Arc flash hazard warning label on each piece of electrical equipment.
- E. Arc Flash Boundaries:

1. Identify arc flash protection boundaries in front of all electrical switchboards, switchgear, panel boards, motor control centers, UPS distribution panels, automatic transfer switches, and individual disconnects and circuit breakers. Provide outline of arc flash protection boundaries with 2 inches wide strip of red/white Seton M6356 OSHA warning tape or equivalent.

3.2 CLOSEOUT ACTIVITIES

- A. Refer to Section 01 81 33 - Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

SECTION 26 28 16
ENCLOSED SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Enclosed Safety Switches, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Technical data on each type of disconnect switch.
 - a. Include dimensioned elevations, sections, weights, features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1) Enclosure types and details for types other than NEMA 250, Type 1.
 - 2) Current and voltage ratings.
 - 3) Short-circuit current ratings.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data.
 - a. See Section 01 78 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Enclosed Safety Switches:
 - 1. Eaton.
 - 2. ABB/General Electric.
 - 3. Schneider Electric/Square D.
 - 4. Siemens.
- B. Elevator Control Switch:
 - 1. Eaton.
 - 2. Bussman.
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 SAFETY SWITCHES

- A. Safety Switches:
 - 1. Fusible and non-fusible type, NEMA Type HD Heavy Duty construction, unless otherwise indicated.
 - 2. Enclosure: NEMA 1 unless otherwise indicated.
 - 3. Provide weatherproof disconnect switches as required by Section 26 00 10.
 - 4. Switch blades fully visible in OFF position with door open.
 - 5. Contact operation quick-make and quick-break.
 - 6. Switches for motor circuits to be horsepower rated.

7. Switches for motor circuits controlled by Variable Frequency Drives (VFD) shall include one N.O. and one N.C. contact which operate with the initial movements of the switch and prior to the opening of the main switch.
 8. Provide padlocking provisions, with a minimum capacity of 1 padlock, in OFF position.
 9. Finish: Baked enamel over rust-inhibiting primer.
 10. Fuses for fusible switches: See Section 26 28 00.
 11. Switches shall have interlock with cover in closed position.
- B. Elevator Control Switch:
1. Single NEMA enclosure with relays, control transformer and other options, as listed below, and shown on drawings.
 2. Construct, listed and certified to standards as listed in above.
 3. Elevator Control Switch shall have an ampere rating as shown on Contract Drawings, and include a horsepower rated fusible switch with shunt trip capabilities.
 4. Amp rating of switch shall be based upon elevator manufacturer requirements and utilize Class J Fuses, provided separately.
 5. Include 100VA control power transformer with primary and secondary fuses.
 - a. Primary voltage rating: 480 V with a 120 V secondary.
 6. Include an isolation relay, 3PDT, 10 A , 120 V.
 - a. Isolation relay coil: 120 V or 24 V.
 7. Provide normally open dry contact to energize isolation relay and activate shunt trip solenoid, 140 VA inrush at 120 V.
 8. Module shall contain following options:
 - a. Key to Test Switch
 - b. "ON" Pilot Light - Green, Red or White.
 - c. Isolated Full Capacity Neutral Lug
 - d. 1P NC Mechanically Interlocked Auxiliary Contact.
 - e. Fire Alarm Voltage Monitoring Relay as required to comply with NFPA 72.
 - f. NEMA 1 Enclosure, optional 12, 3R or 4.
 9. Group and mount multiple switches in panelboard.
 - a. Group as shown on drawings and schedules.
 - b. Meet requirements of Section 26 24 16.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate layout and installation of switches, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Arrange enclosed safety switches as shown on Drawings. Electrical Room layout and enclosed safety switches installation shall maximize the ability to install additional equipment in rooms. Contractor to submit coordination drawings per section 26 00 10 indicating final layout of equipment with actual enclosed safety switches submitted.
- C. Install as indicated and in accordance with manufacturer's instructions and recommendations.
- D. Switches for motor circuits controlled by VFD's shall be electrically interlocked to the controlling VFD via contacts provided in switch.
- E. Provide labeling per Section 26 05 53.

END OF SECTION

SECTION 26 32 14
NATURAL GAS DRIVEN GENERATOR SET

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Natural Gas Engine Driven Generator Sets, as indicated, in accordance with provisions of Contract Documents.
- B. Essential electrical system:
 - 1. Power source and all connected distribution systems and equipment for supporting health care facility electrical loads when normal power fails as required by NFPA 70, Article 517.
- C. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. B11.19, Safeguarding and Machinery Risk Reduction.
- B. American Society of Mechanical Engineers (ASME):
 - 1. ASME B31.3/ B31.8, Code for Pressure Piping.
- C. Institute of Electrical Electronics Engineers Standards (IEEE):
 - 1. 446, Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.
- D. National Electrical Manufacturers Association (NEMA).
 - 1. MG-1.1, Motors and Generators.
- E. National Fire Protection Association (NFPA):
 - 1. 30, Flammable and Combustible Code.
 - 2. 37, Stationary Combustion Engines and Gas Turbines.
 - 3. 54, National Fuel Gas Code.
 - 4. 70, National Electrical Code (NEC) as amended by Authority Having Jurisdiction.
 - 5. 99, Standard for Health Care Facilities.
 - 6. 110, Emergency and Standby Power Systems.
- F. Underwriters Laboratories (UL):
 - 1. 2200, Standard for Stationary Engine Generator Assemblies.
- G. Engine exhaust emissions:
 - 1. EPA Tier 2.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Interconnection diagram with BMS and LAN (Webpages) per spec 25 55 00, indicating scope of installation between all equipment manufacturers and contractors.
 - 2. Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.
 - a. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 - 3. Wiring Diagrams: Power, signal and control drawings and interconnection details, including field connections.

4. Submit components together to permit checking of entire system, coordination between components and coordination of sensing devices required for local and remote annunciator panels.
5. Method of field assembly, components, and location and size of each field connection.
6. Outline dimensions.
7. Weight loading.
8. Required clearances.
9. Construction details and field connection details.
10. Control and annunciator wiring diagrams.
11. Generator sets kW and voltage output rating at 0.8 PF.
12. Calculations verifying unit submitted is sized to provide power for loads indicated and meeting performance criteria specified for unit installation location.
13. Control panel elevation.
14. Block diagram clearly indicating quantity and size of conductors and conduits and types of conductors between control and/or annunciator enclosures mounted remote from generator unit.
15. Battery charger including calculations used to size battery charger and anticipated input current at rated output voltage.
16. Make and model of engine.
17. Number of cylinders.
18. Engine mounted circuit breaker(s) if required.
19. Generator insulation class and temperature rise at 40 deg C ambient.
20. Fuel delivery rate required and fuel consumption at full load.
21. List of recommended spare parts with prices.
22. Unit enclosure.
23. Ambient air temperature calculations to verify battery heaters are required or not.
24. Remote annunciator panel.
25. Certified letter stating designed exhaust system, when previously designed, has been reviewed and found acceptable for unit provided or stating proposed modifications for engineering review.

B. Product Data:

1. For each type of packaged engine generator indicated include rated capacities, operating characteristics, and furnished specialties and accessories. Include the following:
 - a. Generator set manufacturer's general specifications and data sheet(s) for the generator set proposed.
 - b. Engine manufacturer's engine data sheet describing horsepower available and derating basis for the engine.
 - c. Alternator manufacturer's data sheet describing alternator ratings at the temperature rise required by this specification, short circuit characteristics and reactance values based on the ratings of this application.
 - d. Time-current characteristic curves for alternator protective device demonstrating adequate protection for the entire operating range of the generator set based on the alternator thermal damage curve.
 - e. Recommended settings for all AC protective equipment provided.
 - f. Detailed data sheet and drawings describing the generator set control system, including all interfaces to the engine, alternator, and external components of the system as it will be installed, features, and performance.
 - g. Sound test data, based on a free field requirement.
 - h. Prototype test certification/report, describing tests completed and results of tests.

- i. Detailed description of all accessories required for this project with manufacturers' data sheets and interconnection details.
- C. Project Information:
 - 1. Factory test reports prior to shipping.
 - 2. Certified letter stating generator set is in compliance with NFPA 110, Chapter 3, section headed "Rotating Equipment".
 - 3. Certified letter stating unit was tested and found to be in conformance with "Installation Acceptance" criteria section of NFPA 110.
 - 4. Factory performance test report.
- D. Source quality-control test reports.
 - 1. Certified summary of prototype-unit test report.
 - 2. Certified Test Reports:
 - a. For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 - 3. Certified Summary of Performance Tests:
 - a. Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 - 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 - 5. Report of sound generation.
 - 6. Report of exhaust emissions showing compliance with applicable regulations.
 - 7. Certified Torsional Vibration Compatibility:
 - a. Comply with NFPA 110.
- E. Refer to Section 01 81 33 - Cyber Security Requirements for required cyber security related submittals.
- F. Contract Closeout Information:
 - 1. Operating and maintenance data.
 - a. Factory and Field test results.
 - b. Instructional Material: Provide complete instructions covering operation of engine-generator set and associated equipment, together with manual covering engine operation and maintenance. Include any minor adjustments necessary to obtain optimum operation of generator set(s), complete troubleshooting and diagnostic information, disassembly instructions, assembly instructions, preventative maintenance schedule, recommended lubricants and all necessary service checks.
 - c. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - 2. Owner instruction reports.
- G. Maintenance material submittals:
 - 1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 - b. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - c. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Technician Qualifications:

1. Technicians working on the generator set shall be specifically trained and qualified via test to demonstrate their technical qualifications for work. Provide names and a brief resume of all technicians expected to work on the site with the supplied equipment.

C. Source Limitations:

1. Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Outdoor Ambient Temperature: -30 deg C -21.0 deg F to 40.0 deg C 104.0 deg F.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: 1000.0 feet 304.8 m.

E. Rated gas pressure:

1. The on-site gas pressure is 14 inches of water column.

F. Performance of the generator set shall be demonstrated by documentation from the engine and alternator manufacturers describing basic performance and derating factors. Test results of the generator set package with the specific cooling system, engine, and alternator model at maximum site ambient shall be required to document this capability.

G. Manufacturer Qualifications:

1. A qualified manufacturer. Maintain, within 8 hours travel time of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

H. Source Limitations:

1. Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

I. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

J. Engine Exhaust Emissions:

1. Comply with applicable federal, state, and local government requirements, including published requirements that will be in effect at the date of system commissioning.

K. Noise Emission:

1. Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.5 WARRANTY

A. The manufacturer of the standby electric generating system components, complete genset and instrumentation panel shall provide base warranty coverage for all materials and workmanship for a minimum of twenty-four (24) months after system is fully commissioned. Warranty shall cover all travel, service technician costs, and all parts (except filters and lubricants), with no deductions.

1. Warranty is valid for up to 400 hours of operation.

B. Provide a pricing option for a five (5) full year extended warranty.

1.6 SERVICE AGREEMENT

- A. Provide a maintenance program by skilled employees of the manufacturer's designated service organization for 2 years after system is turned over to Owner.
 - 1. Include quarterly exercising to check for proper starting, load transfer, and running under load.
 - 2. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Diesel Engine Driven Generator Sets:
 - 1. Base:
 - a. Caterpillar.
 - b. Cummins.
 - c. Generac.
- B. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 ENGINE

- A. General:
 - 1. Provide a generator system of kW and voltage ratings as indicated on Drawings to supply electrical power at 60 Hz, 3 Phase. The generator shall consist of a liquid cooled, natural gas driven engine, a synchronous AC alternator and system controls with all necessary accessories for a complete operating system.
- B. Engine Rating and Performance:
 - 1. The prime mover shall be a liquid cooled, spark-ignited, 4-cycle engine. It will have adequate horsepower to achieve rated kW output.
 - 2. The engine shall support a 100 percent load step.
 - 3. The system shall be sized and sequenced to allow emergency system loads as defined by NEC 700 to be transferred onto the generator(s) within 10 seconds. Non-emergency system loads will be sequenced onto the generator(s) as generator capacity comes on-line.
 - 4. The generator shall accept a load step that does not cause a maximum frequency dip exceeding 4 Hz.
- C. Engine Oil System:
 - 1. Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have a replaceable oil filter(s) with internal bypass and replaceable element(s).
 - 2. The engine shall operate on mineral based oil. Synthetic oils shall not be required.
 - 3. The oil shall be cooled by an oil cooler which is integrated into the engine system.
- D. Engine Cooling System:
 - 1. The engine is to be cooled with a unit mounted radiator, fan, water pump, and closed coolant recovery system. The coolant system shall include a coolant fill box which will provide visual means to determine if the system has adequate coolant level. The radiator shall be designed for operation in 122 deg F 50 deg C, ambient temperature.
 - 2. The engine shall have (a) unit mounted, thermostatically controlled water jacket heater(s) to aid in quick starting. The wattage shall be as recommended by the manufacturer. The

wattage shall be upsized to support very cold environments, and the heater shall utilize a circulating pump.

3. Engine coolant and oil drain extensions, equipped with pipe plugs and shut-off valves, must be provided to the outside of the mounting base for cleaner and more convenient engine servicing.
4. A radiator fan guard must be installed for personnel safety that meets UL and OSHA safety requirements.

E. Engine Starting System:

1. Starting shall be by a solenoid shift, DC starting system.
2. The engine's cranking batteries shall be lead acid. The batteries shall be sized per the manufacturer's recommendations. The batteries supplied shall meet NFPA 110 cranking requirements of 90 seconds of total crank time. Battery specifications (type, amp-hour rating, cold cranking amps) to be provided in the submittal.
3. The genset shall have an engine driven, battery charging alternator with integrated voltage regulation.
4. The genset shall have an automatic dual rate, float equalize, 10 amp battery charger. The charger must be protected against a reverse polarity connection. The chargers charging current shall be monitored within the generator controller to support remote monitoring and diagnostics. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.
5. Thermostatically controlled battery pad heaters are to be provided to maximize the batteries cold cranking capabilities.

F. Engine Fuel System:

1. The engine shall be configured to operate on pipe line grade natural gas.
2. The engine shall utilize a fuel system inclusive of carburetor, gas regulator, low gas pressure switch, and fuel shut-off solenoid. Generators larger than 80 kW are to include air-fuel-ratio control.
3. The engines internal fuel connections shall be terminated to the generator frame via an NPT fitting for easy installation.

G. Engine Controls:

1. Engine speed shall be controlled with an integrated isochronous governor function with no change in alternator frequency from no load to full load. Steady state regulation is to be 0.25 percent.
2. To support EPA emission requirements, gensets larger than 80 kW will incorporate an active air-fuel-ratio controller. The air-fuel-ratio controller shall be integrated into the generator controller to ensure security of settings and to support monitoring and remote diagnostics. External air-fuel-ratio controllers are not acceptable.
3. Engine sensors used for monitoring and control are to be conditioned to a 4-20ma signal level to enhance noise immunity.
4. All engine sensor connections shall be sealed to prevent corrosion and improve reliability.

H. Engine Exhaust and Intake:

1. The engine exhaust emissions shall meet the EPA emission requirements for stationary emergency power generation.
2. For generators larger than 80 kW, the engine will incorporate a 3-way catalytic convertor to meet EPA emission requirements.
3. The manufacturer shall supply its recommended stainless steel, flexible connector to couple the engine exhaust manifold to the exhaust system. A rain cap will terminate the exhaust pipe after the silencer. All components must be properly sized to assure operation without excessive back pressure when installed.

4. The manufacturer shall supply a critical grade exhaust silencer as standard. For applications with site specific sound requirements (reference section 1.1), the silencer shall be selected to achieve site sound levels.
5. For gensets in a weather or sound attenuated enclosure, all exhaust piping from the turbo-charger discharged to the silencer shall be thermally wrapped to minimize heat dissipation inside the enclosure.
6. The engine intake air is to be filtered with engine mounted, replaceable, dry element filters.

2.3 ALTERNATOR

- A. The alternator shall be the voltage and phase configuration as specified above.
- B. The alternator shall be a 4-pole, revolving field, stationary armature, synchronous machine. The excitation system shall utilize a brushless exciter with a three phase full wave rectifier assembly protected against abnormal transient conditions by a surge protector. Photo-sensitive components will not be permitted in the rotating exciter.
- C. The alternator shall include a permanent magnet generator (PMG) for excitation support. The system shall supply a minimum short circuit support current of 300 percent of the rating (250 percent for 50 Hz operation) for 10 seconds.
- D. Three phase alternators shall be 12 lead, broad range capable of supporting voltage reconnection. Single phase alternators shall be four lead and dedicated voltage designs (600 V) shall be six lead. All leads must be extended into a NEMA 1 connection box for easy termination. A fully rated, isolated neutral connection must be included by the generator set manufacturer.
- E. The alternator shall use a single, sealed bearing design. The rotor shall be connected to the engine flywheel using flexible drive disks. The stator shall be direct connected to the engine to ensure permanent alignment.
- F. The alternator shall meet temperature rise standards of UL2200 (120 deg C). The insulation system material shall be class "H" capable of withstanding 150 deg C temperature rise.
- G. The alternator shall be protected against overloads and short circuit conditions by advanced control panel protective functions. The control panel is to provide a time current algorithm that protects the alternator against short circuits. To ensure precision protection and repeatable trip characteristics, these functions must be implemented electronically in the generator control panel – thermal magnetic breaker implementation are not acceptable.
- H. An alternator strip heater shall be installed to prevent moisture condensation from forming on the alternator windings. A tropical coating shall also be applied to the alternator windings to provide additional protection against the entrance of moisture.

2.4 CONTROLS

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
- B. The generator control system shall be a fully integrated microprocessor based control system for standby emergency engine generators meeting all requirements of NFPA 110 level 1.
- C. The generator control system shall be a fully integrated control system enabling remote diagnostics and easy building management integration of all generator functions. The generator controller shall provide integrated and digital control over all generator functions including bi-fuel control, engine protection, alternator protection, speed governing, voltage regulation, and all related generator operations. The generator controller must also provide seamless digital integration with the engine's electronic engine control module (ECM) if so equipped. Generator controller's that utilize separate voltage regulators and speed governors or do not provide seamless integration with the engine management system are considered less desirable.
- D. Communications shall be supported with building automation via the Modbus protocol without network cards. Optional internet and intranet connectivity shall be available.

- E. The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections. The use of non-encapsulated boards, edge cards, and pc ribbon cable connections are considered unacceptable.
- F. Circuit boards shall utilize surface mount technology to provide vibration durability. Circuit boards that utilize large capacitors or heat sinks must utilize encapsulation methods to securely support these components.
- G. A predictive maintenance algorithm that alarms when maintenance is required. The controller shall have the capability to call out to the local servicing dealer when maintenance is required.
- H. Diagnostic capabilities should include time-stamped event and alarm logs, ability to capture operational parameters during events, simultaneous monitoring of all input or output parameters, callout capabilities, support for multi-channel digital strip chart functionality and .2 msec data logging capabilities.
- I. In addition to standard NFPA 110 alarms, the application loads should also be protected through instantaneous and steady state protective settings on system voltage, frequency, and power levels.
- J. The control system shall provide pre-wired customer use I/O: 4 relay outputs (user definable functions), communications support via RS232 and RS485. Additional I/O must be an available option.
- K. Customer I/O shall be software configurable providing full access to all alarm, event, data logging, and shutdown functionality. In addition, custom ladder logic functionality inside the generator controller shall be supported to provide application support flexibility. The ladder logic function shall have access to all the controller inputs and customer assignable outputs.
- L. The control panel will display all user pertinent unit parameters including engine and alternator operating conditions; oil pressure and optional oil temperature; coolant temperature and level alarm; fuel level (where applicable); engine speed; DC battery voltage; run time hours; generator voltages, amps, frequency, kilowatts, and power factor; alarm status and current alarm(s) condition per NFPA 110 Level 1.

2.5 ENGINE/ALTERNATOR PACKAGING

- A. The engine/alternator shall be isolated from the generator frame with rubber isolators. The packaging shall not require the addition of external spring isolators.
- B. A mainline, electronic LSI circuit breaker carrying the UL mark shall be factory installed. The breaker shall be rated between 100 to 125 percent of the rated ampacity of the genset.
- C. The generator shall include a unit mounted auxiliary power 120/208 V, 3-phase, 4-wire load center. All ancillary AC devices (block heater, battery charger, alternator strip heater, etc.) shall have a dedicated breaker within the load center.
- D. Enclosure:
 - 1. The genset shall be packaged with a Level II sound attenuating weather protective enclosure.
 - 2. The enclosure shall be completely lined with sound deadening material. This material must be of a self-extinguishing design with a reflective surface for enhanced serviceability.
 - 3. Sound attenuation:
 - a. Design sound levels shall be 76 dba, as measured at a distance of 23 feet around housing in a free field environment.
 - 4. The enclosure shall be made of steel with a minimum thickness of 16 gauge. The enclosure is to have hinged, removable doors to allow access to the engine, alternator, and control panel. The hinges shall allow for door fit adjustment. Hinges and all exposed fasteners will be stainless steel or Sermagard coated. The use of pop-rivets weakens the paint system and not allowed on external painted surfaces. Each door will have lockable hardware with identical keys.

5. The enclosure shall be coated with electrostatic applied powder coat, baked and finished to manufacturer's specifications. The color will be manufacturer's standard.
6. The enclosure shall utilize an upward discharging radiator hood. Due to concerns related to radiator damage, circulating exhaust, and prevailing winds, equipment without a radiator discharge hood will not be acceptable.
7. The genset silencer shall be mounted on the discharge hood of the enclosure. Due to architectural concerns, silencers mounted on the top of the generator enclosure are not acceptable. Gensets with silencers mounted inside the main generator compartment are acceptable only if the silencer is thermally wrapped to minimize heat stress on the surrounding components.
8. The enclosure shall include a thermostatically controlled space heater designed to maintain the enclosure at 40 deg F.
9. Structurally stable in 100 mph wind.
10. Support roof load of 40 psf.
11. Pitch roof for moisture run-off.

2.6 LOOSE ITEMS

- A. Supplier to itemize loose parts that require site mounting and installation. Preference will be shown for gensets that factory mount items like mufflers, battery chargers, etc.
- B. Spare Parts:
 1. Fuses: One spare set.
 2. Filters: One spare set (air, fuel, oil).
- C. Provide a remote annunciator panel to be located in the Fire Command Center that meets the monitoring requirements of the IBC and supports running the generator remotely. The panel shall have an ALARM switch that when moved to the OFF position silences the audible alarm. A TEST/RESET switch must be included to verify the lights are functional and reset any condition after it has cleared. The annunciator shall be controlled using RS485 communications from the generator controller.

2.7 ENGINE-GENERATOR SET

- A. Factory-assembled and factory-tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
- C. Capacities and Characteristics:
 1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 300kW, at 80 percent lagging power factor, 277/480, Series Wye, Three phase, 4 -wire, 60 hertz.
 2. Nameplates: For each major system component, identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.
- D. Generator-Set Performance:
 1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load. (NEMA MG1 steady state voltage regulation of 1 percent from no load to full load.) The generator set shall provide a stable RMS voltage regardless of the magnitude of non-linear load applied to the machine.
 2. Transient Voltage Performance: The alternator with proposed voltage regulator operating at constant speed shall meet the following performance requirements:
 - a. Alternator shall be capable of accepting maximum 2200.0 kVA in a single step and recover to a minimum of 90 percent of rated no load voltage following the application of

the specified kVA load at near zero power factor applied to the generator set in compliance to the requirements of NEMA MG1-Part 32 section 18. The generator set shall fully recovery to rated voltage as engine accelerates and kVAR load drops to within normal levels.

- b. On application of 50 percent rated load and power factor, the generator set shall have a maximum voltage dip of 20 percent and recover to rated conditions within 5 seconds.
 3. Steady-State Frequency Operational Bandwidth: ± 0.5 percent of rated frequency from no load to full load.
 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 5. Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. On application of a 50 percent load step the generator set shall recover to stable frequency within 5 seconds.
 6. Output Waveform: At full linear load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
 7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
 8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.
 9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.
- E. Prototype Testing: The generator set shall be designed, prototype tested, manufactured, factory tested, and site tested per the requirements of NFPA 110 for level 1 systems.
1. The suitability of the mechanical structure of the generator set shall be validated by testing of prototype(s) with control, alternator and engine models equal to that proposed for this project, in an endurance test of a minimum of at varying loads equal to the ISO standby duty cycle , and including vibration monitoring throughout the test.
 2. The generator set shall be free of damaging torsional stresses within the normal operating range of the engine. The engine manufacturer shall certify torsional compatibility of the system.
 3. The generator set assembly shall operate successfully while be subjected to radio frequency interference and surge voltages in compliance to the requirements of IEEE C37 and C62.
 4. The generator set assembly shall be tested as a unit for noise level in either an anechoic or free field environment.
 5. Provide a prototype test certificate summarizing tests results of testing.

2.8 ENGINE

- A. The engine shall be rated by the engine manufacturer per ISO 8528 to provide necessary horsepower to deliver the required kW output based on site conditions, including all parasitic loads.
- B. Engine: The engine shall be 1800 rpm Natural Gas, with unit mounted radiator. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. The engine shall be EPA SI NSPS Compliant Capable or EPA Certified
 1. Lubrication System: The following items are mounted on engine or skid:

- a. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
 - b. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
 - c. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
2. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions and the requirements of NFPA 54.
 - a. The engine fuel system shall include equipment as described in section 2.4, supplied by the installing contractor or owner.
 - b. Complete engine fuel system, including all flexible fuel lines, pressure regulators, strainers, and control valves.
 3. Governor: The engine fuel control system shall be engine-mounted and manage the engine based on speed sensor(s) integral to the engine and the operating state of the generator set control system (starting sequence, operating isolated from the electrical system. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. Fuel rate shall be regulated as a function of starting, accelerating to start-disconnect speed, accelerating to rated speed, and operating in various states described herein. All the functions specified in this paragraph shall be configurable through the operating panel of the generator set, without removing any covers and without use of tools or a computer connection/program. Settings shall be password-protected.
- C. Cooling System: Closed- loop, liquid- cooled.
1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 100 deg F. Form of data required shall be one of the following:
 - a. Prototype test data of the specific engine proposed and similar alternator with the specific cooling system (radiator and fan) operating in a controlled environment of a minimum of 100 deg F with a minimum air flow restriction of 0.5 in. of water external static head.
 2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent de-mineralized water, with anticorrosion additives as recommended by engine manufacturer. Generator sets with skid-mounted radiators shall ship with coolant installed.
 3. Cooling system design shall be adequate to contain expansion of total system coolant from cold start to 110 percent load condition. The cooling system shall include provisions for convenient draining of the system and for monitoring coolant level.
 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- D. Coolant Jacket Heater: UL 499 listed and labeled electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance. The coolant heaters shall heat the engine to an appropriate temperature to assure 10-second starting and load pick up at the minimum ambient temperature specified for the installation, but not require operation at more than 40 deg C engine coolant temperature for required starting time and load pick up as specified.
1. Heater voltage shall be shown on the project drawings.
 2. Flexible hoses shall be high temperature silicon. Installation shall include isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss. Steel coolant lines shall be provided for coolant line runs of more than 2 feet.
 3. Provided with a DC thermostat, installed at the engine thermostat housing
 4. Coolant heaters shall be either UL listed or CSA certified.

- E. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
- F. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.
- G. Starting System: 12 or 24V, or as recommended by the engine manufacturer; battery powered electric, with negative ground.
 - 1. Components: Sized so they will not be damaged during three full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 - 2. Cranking Cycle: As required by NFPA 110 for a level 1 system.
 - 3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
 - 4. Battery Compartment: Factory fabricated of metal with acid-resistant finish. Battery terminals shall be protected from accidental contact.
 - 5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to fully recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence while powering all DC loads connected to the generator set control.
- H. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
 - 1. Rating: Chargers shall be rated based on the batteries supplied, to fully recharge the batteries within 24 hours in compliance to NFPA 110 requirements for Level 1 systems.
 - 2. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - a. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 50 deg C to prevent overcharging at high temperatures and undercharging at low temperatures. The charger shall be located close to the battery bank for direct monitoring of battery temperature and accurate charging.
 - b. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - c. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Any alarm condition shall close contacts that provide a battery-charger malfunction indication at the generator set control and monitoring panel.
 - d. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.
 - e. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet. The charger shall not be mounted on the generator set unless it has been prototype-tested in an endurance test to verify suitability for that application. Provide suitable prototype test documentation as required.
- I. Provide vibration isolators, spring/pad type or as recommended by the manufacturer, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.

2.9 CONTROL AND MONITORING

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
- B. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit as described by this specification. The control system shall be designed and manufactured by the generator set manufacturer. Third party controls that are brand-labeled by the generator set manufacturer may be accepted if evidence documenting reliable service and parts support is provided.
- C. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the AUTOMATIC mode, remote-control contacts in one or more separate automatic transfer switches (or other device) initiate starting and stopping of generator set based on a normally open contact that closes, or a normally closed contact that opens (field configurable for either option). When mode-selector switch is in the MANUAL mode and is switched to the RUN position, generator set starts. When mode-selector switch is in the MANUAL mode and is running, operating the switch for the OFF position will cause shutdown of the generator set. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. No AC voltage devices shall be mounted in the control panel other than fused voltage reference signals which are shielded from direct contact per the requirements of UL 2200 or CSA 22.1.
- E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
 - 1. AC metering equipment shall include the following functions:
 - a. AC voltmeter (3-phase, line to line and line to neutral values).
 - b. Bus AC voltmeter (3-phase, line to line and line to neutral values).
 - c. AC ammeter (3-phases).
 - d. AC frequency meter.
 - e. AC kW output (total and for each phase). Display shall indicate power flow direction.
 - f. AC kVA output (total and for each phase). Display shall indicate power flow direction.
 - g. AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.
 - h. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
 - 2. Provide an analog AC display panel indicating all phases of AC voltage and current, power factor, kW, and frequency. The display shall be color coded "green/yellow/red" to indicate normal, impending problem, and near shutdown level conditions.
 - 3. Emergency Stop Switch: Switch shall be a red "mushroom head" pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating. The switch shall directly operate on the fuel supply valve without operating through any other components.
 - 4. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
 - 5. Engine status conditions to include:
 - a. DC voltmeter (alternator battery charging).
 - b. Engine-coolant temperature gauge.
 - c. Engine lubricating-oil pressure gauge.
 - d. Inlet fuel pressure gauge.
 - 6. Quantity (2) running time meters. One meter shall display total operating hours, and the second shall display total operating hours since reset.

7. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5 percent of the voltage and frequency operating set point (not nominal voltage and frequency values.) Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
8. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
9. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
10. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).
11. Data Management:
 - a. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
 - b. The control system shall maintain a duty cycle log for the generator set which reports percent of operating hours in 10 percent increments from no load to 110 percent of rated load.
12. The control system shall include configurable input and output for up to 16 discrete inputs and 16 discrete outputs. The inputs and outputs shall be configurable for function and display their status on the generator set control operator panel. The I/O shall be capable of logical interaction with the generator control system. The input conditions shall be field configurable for status message and function (status, warning, shutdown, shutdown with cooldown). The outputs shall be configurable for function and provide dry contact indications for field use.
13. The control system shall include a native Modbus RTU/RS485 output for remote monitoring of the control.
14. Control Heater: Generator sets that are installed in outdoor enclosures, or are in tropical or coastal environments shall be provided with control heaters for anti-condensation protection.
15. Remote Alarm Annunciator (shipped loose): Comply with NFPA 110. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. The annunciator shall include a horn silence button and a means for clearing fault conditions displayed.
16. Remote Emergency-Stop Switch (shipped loose): Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
17. Field control terminations shall be made in a single common terminal box which is isolated from the control enclosure and includes no terminal points operating at more than 50 volts. Field connections to higher voltage devices shall be made in a separate AC control termination box.

2.10 ALTERNATOR (INCLUDING EXCITER) AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1-32 for both hardware requirements and reporting of alternator capability.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.

- D. Temperature Rise: 80C maximum as required to meet performance requirements of this specification.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
- G. Enclosure: Drip-proof.
- H. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- I. Subtransient Reactance: 12 percent maximum, based on the rating of the engine generator set.
- J. The alternator shall be capable of operating with stable voltage with reverse kVAR of 0.20 per unit based on the generator set rating.
- K. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted. The voltage regulator shall be adjustable for voltage and dynamic characteristics by an operator through the generator control panel without tools, without removing any protective panels on the generator set. Settings shall be password-protected. The engine fuel control system shall be engine-mounted and manage the engine based on speed sensor(s) integral to the engine and the operating state of the generator set control system (starting sequence, operating isolated from the electrical system). All the functions specified in this paragraph shall be configurable through the operating panel of the generator set, without removing any covers and without use of tools or a computer connection/program. Settings shall be password-protected.

2.11 ALTERNATOR OVERCURRENT AND FAULT PROTECTION

- A. Alternator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
 - 1. The protective device shall allow continuous operation at rated current level of the generator set without tripping for a minimum of two hours under maximum rated operating conditions. It shall initiate a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 - 2. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110 percent of rated current for more than 10 seconds.
 - 3. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator. The control logic of the protective device shall include integrated time-based functions to prevent alternator damage on multiple fault conditions that occur over short time periods.
 - 4. The protective system provided shall not include an instantaneous trip function.
 - 5. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
 - 6. The over current protective system shall include a maintenance mode in compliance to the National Electrical Code section 240.87 which disables the alternator excitation system within 50 milliseconds when output current on any phase is more than three times rated current. The mode shall be operational for any fault from the terminals of the generator throughout the distribution system.

7. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120 percent of nominal voltage.
- B. Ground-Fault Protection/Indication: The control system shall include an input for measurement of ground fault current, and protection that is configurable for current level and time delay, as well as trip or alarm. The control shall display ground fault current level. The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0 10.0 seconds. The relay shall be configurable for shutdown or for indication only, and configured for indication only. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.

2.12 ENGINE GENERATOR WEATHERPROOF ENCLOSURE

- A. Size enclosure to contain engine-generator set with accessories.
- B. On units 500 kW and larger, independently mount enclosure and separate from vibrating parts to eliminate excessive sheet metal noise and vibration.
 1. Provide enclosure with hinged lockable doors.
 2. Provide bird and rodent screens on openings.
 3. Provide ventilation openings to provide air cooling and combustion.
 4. Provide ambient temperature calculations to indicate enclosure air temperature will not drop below 32 deg F or provide battery heaters as required thermostatically controlled to maintain battery temperature at 50 deg F minimum and automatically shut off at a battery temperature of 90 deg F.
- C. Engine generator enclosure:
 1. Sound attenuated weatherproof enclosure.
 - a. Heavy gauge Aluminum with side servicing doors, air intake and exhaust louvers, pitched roof and muffler system installed inside the enclosure.
 - b. Enclosure to allow full load operation of engine generator system with accessories and design for unit being installed
- D. Generator Enclosure shall have the following features:
 1. Designed to allow walking area around the sides and rear of the generator set. A minimum 24 inches of walking space shall be at each side and 36 inches at the rear control panel.
 2. Sound attenuation:
 - a. Design sound levels shall be 85 dba, as measured at a distance of 23 feet 7 m around housing in a free field environment.
 - b. Install additional wall and insulation thickness, plus air discharge and intake hoods or sound attenuators to meet design sound levels.
 - c. Provide Alternate pricing for sound attenuation as follows:
 - 1) 80dba enclosure
 3. Base (floor) of the enclosure shall incorporate a UL 2085 Listed and labeled double wall fuel tank
 4. Provide working code clearance in front of electrical components
 5. Construction:
 - a. Aluminum frame and exterior panels.
 - b. Structurally stable in 160 km/h 100 mph wind.
 - c. Support roof load of 40 psf 1915 Pa.
 - d. Pitch roof for moisture run-off
 - e. Fiberglass or mineral wool insulation to provide minimum R11 insulation in side walls and roof for thermal transmission.
 - f. Sound attenuation material can be in addition to or include thermal insulation.

6. Air intake and exhaust louvers shall be combination of motorized dampers and fixed louvers with bird screen.
 - a. Include sound attenuated baffles or hoods at openings to meet the sound attenuation.
 - b. Design to prevent entrance of blown sand, rain, snow, and dirt.
 - c. Motorized louvers:
 - 1) Include bronze oilite pivots and Belimo No. AF120.9US power open/ spring closed or power close/spring open 120 volt, motors.
 - 2) Louver blade and frame:
 - a) Heavy gauge aluminum with with expanded aluminum screen.
7. Provide double doors at each side of enclosure at engine area.
 - a. 60 inches wide X 84 inches high.
8. Provide single door at generator set circuit breaker and control panel locations.
 - a. 36 inches wide X 84 inches high.
9. Mount generator set on spring isolators designed for weight of generator set and provide maximum of 1 inch deflection.
 - a. Install flexible duct adapter between generator radiator and exhaust air outlet louver.
10. Wrap muffler, flexible exhaust connectors, and piping with high temperature insulation.
 - a. Extend exhaust pipe through roof with stainless steel rain cap and rain bonnet.
11. Provide electrical stub-up area for electrical connections at generator circuit breaker and enclosure electrical distribution panel.
12. Lights for enclosure to include high temperature lamps with protective covers.
 - a. Lamps to include wall switches with receptacles located at each door.
 - b. Provide emergency battery backup fixture.
 - c. Install wiring of lamps and switches in conduit and wire to electrical distribution panel.
13. Fuel tank heater:
 - a. Minimum of 2,000 watts.
 - b. Thermostatically controlled with safety shutdown feature for low fuel level conditions.
14. Provide electrical distribution panel sized to operate the generator set block heater, jacket water heater, lights, louvers wall mounted battery charger, receptacles, fuel tank heaters, fuel pumps, battery jacket heater, and space heater.
 - a. Prewire loads and install wiring in conduit.
 - b. Provide electrical stub-up area through generator power conductor area for service to the distribution panel.
 - c. Installation to include 15kVA 480:208/120V xftransformer.
15. Exterior color selected by Architect.
 - a. Provide touch-up paint in finish color.
16. Provide electric unit heaters to maintain internal temperature at 50 deg F 10 deg C.
 - a. Interlock so unit heaters shut off when generators are running.
17. Resist intake of blown sand or rain through intake air assembly.
18. Provide anchor bolts for casting into concrete base for attaching enclosure to pad.
 - a. Coordinate enclosure with concrete pad and foundations.
19. Coordinate the enclosure with the engine generator furnished to assure physical clearances, sound attenuation, airflow and pressure drop through the system.
20. Provide doors and access panels for removal of large assemblies.
21. Flash and seal exit of exhaust stack in roof.

22. Provide ventilation fan with gravity damper, thermostatically controlled to operate continuously at internal temperatures adjustable from 16 to 32 deg C 60 to 90 deg F.
 - a. Interlock ventilation fans to prevent them from running when the engine generators are running.
 - b. Interlock ventilation fan with motorized inlet dampers.
23. Field test installation under load.
 - a. Use precision sound measuring instrument meeting ANSI-S1.4 type 1.
 - b. Provide measurements to Engineer.
24. Approved for installation in local seismic zone.
25. Provide structural calculations for enclosure as required by AHJ.

2.13 REMOTE EMERGENCY STOP

- A. Remote Emergency Stop Station:
 1. Stops associated engine generator.
 2. Label: "Generator Remote Emergency Off".
 3. Provide with protective cover.
 4. Locate outside and immediately adjacent to generator room door.

2.14 BMS INTERFACE

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
- B. Provide all communication devices and cabling to communicate with the BMS and LAN.
- C. BMS Generator Graphics:
 1. Graphics of devices (generator, gen breaker, ATS, etc.) shall change colors with labeled descriptions. Include Web address adjacent to device.
 2. Green indicates de-energized or open, Red indicates energized or closed, Gray indicates unknown position.
 3. Generator running or not running, or in cool down.
 4. ATS position, Normal Power Available, Generator Power available.
 5. Generator running alarm.
 - a. BMS to send page and text and email to facilities manager.
 6. Generator not in auto alarm.
 - a. BMS to send page and text and email to facilities manager.
 7. Generator general alarm.
 - a. BMS to send page and text and email to facilities manager.
 8. Generator analog speedometer for kW, Avg L-L Volts, Avg Amps, Frequency.

2.15 EMBEDDED WEB SERVICES

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
- B. Shall match functionality and display characteristics of Cummins PowerCommand 500.
- C. Include 8hrs of custom screen programming.
- D. Provide UPS 120 power connection to device.
- E. Locate in Electrical Room adjacent to ATS distribution.
- F. Interconnect and annunciate all ATS parameters/information.
- G. Generator test report.
 1. Conform to NFPA 110 standards.

2. Time tagged Generator Alarm History report.
3. Test shall be initiated locally or remotely.
4. Date and Time tagged report including a time-trending graph of parameters as follows:
 - a. Run-time (from start to cool-down shutdown).
 - b. Percent load.
 - c. Exhaust temperature.
5. Tabulated values reported as follows:
 - a. ATS transfer time (both to Emergency and back to Normal).
 - b. Generator Run Time.
 - c. Exhaust up-to-temperature run-time.
 - d. Generator percent load run-time.
 - e. Generator cool-down time.
6. Send Test reports to Owner text or email addresses, customize as requested by Owner.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generator system(s). Cast anchor-bolt inserts into bases.
 1. See Section 26 00 10.
- B. Arrange generator as shown on approved Shop Drawings. Electrical Room layout and generator installation shall maximize the ability to install additional equipment in rooms. Contractor to submit coordination drawings per section 26 00 10 indicating final layout of equipment with actual generator submitted.
 1. Provide required clearances and maintenance access.

3.2 INSTALLATION

- A. Install components as indicated and in accordance with manufacturer's recommendations and instructions.
- B. Provide control wiring in conduit between generator control panel and other components as required including but not limited to generator switchgear, automatic transfer switches, remote alarm annunciator panel(s), and remote devices as required.
- C. Provide connection to driven electrode ground from set frame sized as a minimum in accordance with National Electrical Code, unless otherwise indicated.
- D. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL or CSA listed products.
- E. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- F. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- G. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.

- H. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
- I. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.
- J. Identify system components according to Section 23 05 53 "Mechanical Identification Systems" and Section 26 05 53 "Identification for Electrical Systems."

3.3 FACTORY PERFORMANCE TEST

- A. The generator set supplier shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided.
 - 1. Generator sets for use in applications powering fire pumps or NEC Article 700 or 701 loads shall be provided with a certified test report of the engine safeties.
- B. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include run at full load, maximum power, voltage regulation, transient and steady state governing (at 0.8 and 1.0 power factor), single step load pickup, and function of safety shutdowns. Provide a certified test report documenting testing completed and performance.

3.4 FIELD PERFORMANCE TEST

- A. The supplier of the electric generating plant and associated items covered herein shall provide factory trained technicians to check out the completed installation and to perform an initial start-up inspection to include:
 - 1. Ensuring the engine starts (both hot and cold) within the specified time.
 - 2. Verification of engine parameters within specification.
 - 3. Verify no load frequency and voltage, adjusting if required.
 - 4. Test all automatic shutdowns of the engine-generator.
 - 5. Perform a load test of the electric plant, ensuring full load frequency and voltage are within specification by using building load. Perform a load test for 1.5 hours using building load. In addition to the building load test, load the generator at 30 percent for 30 minutes, 50 percent for 30 minutes, and 100 percent for 60 minutes.
- B. Infrared Scanning:
 - 1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
 - a. Follow-up Infrared Scanning:
 - 1) Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
 - b. Instrument:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning:
 - 1) Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Section 01 79 00 "Demonstration and Training."

- B. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration, and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. The load bank manufacturer shall provide one-day start-up service of the load bank on-site after the load bank has been installed and connected.

3.7 CLOSEOUT ACTIVITIES

- A. Refer to Section 01 81 33 - Cyber-Security Requirements for cyber security related closeout requirements.

3.8 SERVICE AND SUPPORT

- A. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, electronics, and power transfer equipment.
- B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year.
- C. The manufacturer shall maintain model and serial number records of the generator set for at least 20 years.

3.9 COMMISSIONING RESPONSIBILITIES

- A. The Contractor shall be responsible for cooperating and coordinating their work with the Commissioning Authority (CxA) as described in Section 01 91 13. The Contractor shall also be responsible for carrying out all the physical activities required for installation of components and systems and operating them during the commissioning process as required in this section.
- B. Refer to Section 26 08 00 for Commissioning of Electrical Systems.

3.10 ACCEPTANCE TESTING

- A. Perform equipment start-up by factory authorized technician. Provide completed start-up documentation on factory start-up forms.
- B. Perform NETA testing and provide testing results in accordance with NETA-ATS, Chapter 7, for equipment within this specification.

3.11 PRIORITY LOADS

- A. Prioritize loads as follows:
 - 1. Other than Health Care Facilities loads:
 - a. Priority 1:
 - 1) ATS(s) of Emergency System.
 - b. Priority 2:
 - 1) ATS(s) of Optional Standby System.

END OF SECTION

SECTION 26 32 90
GENERATOR CONNECTION CABINET

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Generator Connection Cabinet.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 26 05 00 - Common Work Results for Electrical.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. 1773, Standard for Termination Boxes.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. See Section 26 05 00 for additional requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. See Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS : THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Generator Connection Cabinet:
 - a. Gus Berthold Electric Co.
 - b. Trystar

2.2 GENERATOR CONNECTION CABINET

- A. Ratings:
 - 1. Voltage and amperage: As indicated on the Drawings.
 - 2. Short circuit withstand: Equal to or greater than the upstream equipment.
- B. Construction:
 - 1. Bus material: Silver plated copper.
 - 2. Bus supported with UL Recognized Component insulators.
 - 3. Permanent bus connection:
 - a. Mechanical set screw lugs
 - b. Quantity: As required for the number of conductors indicated on the Drawings.

- 4. Field wiring connection:
 - a. Color coded male Camlok connectors with caps.
 - b. Quantity: As required for the number of conductors indicated on the Drawings.
- C. Enclosure:
 - 1. Wall mount.
 - 2. NEMA 3R rated.
 - 3. Material: Aluminum or Stainless steel.
 - 4. Lockable latches on front door.
 - 5. Independent access panel door for field terminated cables.
 - 6. Welded construction.
 - 7. Drip hood.
- D. Standards: UL 1773.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
- B. Connect as indicated in one-line diagram.

END OF SECTION

SECTION 26 36 23
AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Automatic Transfer Switches, as indicated, in accordance with provisions of Contract Documents.
- B. Provide automatic transfer switches with number of poles, amperage, voltage, withstand, and close-on ratings as shown on plans.
- C. Each automatic transfer switch shall consist of an inherently double-throw power transfer switch mechanism and microprocessor controller to provide automatic operation. All automatic transfer switches and controllers shall be products of the same manufacturer.
- D. Provide interface control wiring in conduit to other equipment as required for complete and operational system.
- E. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. 446, Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
- B. National Electrical Manufacturers Association (NEMA):
 - 1. ICS.1, Industrial Control and Systems: General Requirements.
 - 2. ICS-10, Electromechanical AC Transfer Switch Equipment.
- C. National Fire Protection Association (NFPA):
 - 1. 70, National Electrical Code (NEC) as amended by Authority Having Jurisdiction.
 - 2. 99, Healthcare Facilities Code.
 - 3. 101, Life Safety Code.
 - 4. 110, Emergency and Standby Power Systems.
- D. Underwriters Laboratories, Inc. (UL):
 - 1. 508, Industrial Control Equipment.
 - 2. 1008, Standard for Transfer Switch Equipment.

1.3 SUBMITTALS

- A. ATS shop drawings and product data shall be submitted along with, or subsequent to, a complete short circuit analysis and coordination study per Section 26 05 73. Product data or shop drawings submitted prior to power system studies will be rejected.
- B. Shop Drawings:
 - 1. Switches:
 - a. Dimensional drawings of equipment, including:
 - 1) Plan, elevation, and side views
 - 2) Equipment weights and center of gravity.
 - 3) Location of all needed access points and required clearances.
 - 4) Mounting and anchoring points.
 - 5) Conduit entry points and gutter space.
 - 6) Installed features and devices, and material lists for each switch specified.

- b. One line diagrams and wiring diagrams for assembly and components.
 - c. Interconnection wiring diagrams specific to project conditions.
- C. Product Data:
 - 1. Technical data on each size and type of transfer switch
 - 2. Withstand and close ratings (WCR) of each switch, including ratings table for use with vendor-specific overcurrent protective devices.
 - 3. Project-specific WCR rating coordinated with vendor-specific upstream circuit breakers serving each ATS.
- D. Project Information:
 - 1. Factory test reports, prior to shipping equipment.
 - 2. Letter certifying compliance with all requirements of specification including compliance with applicable codes and standards and withstand and closing ratings. Certification shall identify, by serial number(s), equipment involved. No exceptions to specifications, other than those stipulated at time of submittal, shall be included in certification. Submit prior to shipping equipment.
- E. Refer to Section 01 81 33 - Cyber Security Requirements for required cyber security related submittals.
- F. Contract Closeout Information:
 - 1. Operating and maintenance data.
 - 2. Final time delay settings for each ATS, in tabular format. Provide relay setting and calibration instructions, including software, where applicable.
 - 3. Owner instruction report.
 - 4. Approved factory test reports.
 - 5. Field test reports.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Automatic transfer switch manufacturer shall maintain national service organization throughout contiguous United States. Service center's personnel must be factory trained and must be on call 24 hours per day, 365 days per year.
 - 2. Manufacturer shall maintain records of each switch, by serial number, for minimum of 20 years.
 - 3. Manufacturer of switches shall have a certified service representative capable of responding within a period of less than 8 hours and available of being at project site within 24 hours from time of initial notification.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.
- B. Store in a clean, dry space with controlled required temperature and humidity levels. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Automatic Transfer Switches:

1. ASCO (Schneider Electric):
 - a. 300-Series ATs with Group G controller.
2. RussElectric (Siemens):
 - a. RTSCD Series with RTSCD controller.
3. Eaton:
 - a. ATC with 300+ Controller.
4. Zenith (ABB)
 - a. ZTG T-Series with Level 3 TruONE controller.
5. Caterpillar:
 - a. ATC-Series contractor based ATs's with ATC-300 controller to provide real-time Voltage, Current, and Frequency.
 - b. CG ATs with Level 3 TruONE controller.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.

B. Automatic Transfer Switches:

1. Provide ATs's in Utility-to-Generator configuration unless noted otherwise.
2. Electrically operated and mechanically held.
3. Electrical operator shall be momentarily energized by single or dual-solenoid mechanisms. Main operators which include overcurrent disconnect devices or gears are not acceptable.
4. Transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
5. Switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at constant value and contact temperature rise is minimized for maximum reliability and operating life.
6. Main contacts shall be silver composition.
7. Switches rated 600 A and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
8. Inspection of all contacts shall be possible from front of switch without disassembly of operating linkages and without disconnection of power conductors.
9. Switches rated 600 A and higher shall have front removable and replaceable contacts.
10. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
11. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching, or transfer between two active power sources, are not acceptable.

C. Open Transition Transfer Switches:

1. Open transition transfer switches shall have mechanical design of switch such that it will positively open all ungrounded conductors from preferred source before connection is made to alternate source and will positively open all ungrounded conductors from alternate source before connection is made to preferred source.

2. Design mechanical interlock so it cannot be readily disabled, disconnected, improperly adjusted, removed, or otherwise made inoperative.
 3. Provide open transition automatic transfer switches for following loads:
 - a. Emergency loads.
 - b. Optional Standby loads.
- D. Combination Bypass Isolation/Automatic Transfer Switches:
1. Two-way bypass-isolation switches shall provide manual bypass of load to either source and permit isolation of automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.
 2. Power interconnections shall be silver-plated copper bus bar. Only field installed power connections shall be at service and load terminals of bypass-isolation switch. All control interconnecting wiring shall be provided with disconnect plugs.
 3. Separate bypass and isolation handles shall be utilized to provide clear distinction between functions. Handles shall be permanently affixed and operable without opening enclosure door. Designs requiring insertion of loose operating handles or opening of enclosure door to operate are not acceptable.
 4. Bypass to load-carrying source shall be accomplished with no interruption of power to load (make before break contacts). Designs which disconnect load when bypassing are not acceptable.
 5. Bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." Operating speed of bypass contacts shall be same as associated transfer switch and shall be independent of speed at which manual handle is operated.
 6. In "Automatic" mode, bypass contacts shall be out of power circuit so that they will not be subjected to fault currents to which system may be subjected.
 7. Isolation handle shall provide three operating modes: "Closed," "Test," and "Open."
 - a. "Test" mode shall permit testing of entire emergency power system, including automatic transfer switches with no interruption of power to load.
 - b. "Open" mode shall completely isolate automatic transfer switch from all source and load power conductors. When in "Open" mode, it shall be possible to completely withdraw automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or use of any tools.
 - c. When isolation switch is in "Test" or "Open" mode, bypass switch shall function as manual transfer switch.
 8. Designs requiring operation of key interlocks for bypass isolation or ATS's which cannot be completely withdrawn when isolated are not acceptable.
 9. Provide open transition combination bypass isolation automatic transfer switches for following loads:
 - a. Emergency branch.
- E. Switch Construction:
1. Automatic transfer switches shall be furnished in NEMA Type 1 enclosure unless otherwise shown on the plans.
 2. Standard and optional door-mounted switches and pilot lights shall be 16mm industrial grade type or equivalent for easy viewing and replacement.
 3. Transfer switches serving line to neutral loads shall be 4 pole switches unless otherwise noted. Neutral pole current rating shall match phase pole current rating.
 4. Transfer switches serving strictly line to line loads shall be 3 pole switches unless otherwise noted.
 5. Withstand and closing ratings:
 - a. Automatic transfer switches shall be rated to close on and withstand available RMS symmetrical short circuit current at switch terminals with type of overcurrent protection shown on plans.

- b. Where manufacturer's ATS of required ampacity has a withstand and closing rating less than the available fault current at the ATS terminals, a larger-ampacity ATS with adequate fault current withstand and closing rating shall be provided.
 - c. Automatic transfer switches shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1-1/2 and 3 cycle ratings.
 - d. Automatic transfer switches not tested and labeled with 1-1/2 and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.
 - e. Where fed directly from UL-1558 circuit breakers, ATS vendor shall provide documentation showing suitability with vendor-specific circuit breakers.
- 6. Switch shall have provisions for visual inspection of switch blades and contacts.
- 7. Silver-surface main contacts, protected by arcing contacts.
- 8. Make all contacts and coils readily accessible for replacement from front of panel without major disassembly.
- 9. Provide red and green indicating lights with fuses, identification nameplates, and test switch on front to simulate normal power failure at switch.
- 10. Provide cable terminal lugs to accommodate conductors indicated on one line diagram.
- F. Continuously monitor voltage and frequency on both normal and emergency sources and provide adjustable dropout and pickup setting ranges as follows:
 - 1. Under-voltage dropout: 70 to 98 percent of nominal voltage. (3 phase)
 - 2. Under-voltage pickup: 85 to 100 percent of nominal voltage. (3 phase)
 - 3. Over-voltage dropout: 102 to 115 percent of nominal voltage. (3 phase)
 - 4. Over-voltage pickup: 2 percent below over-voltage dropout. (3 phase)
 - 5. Under-frequency dropout: 85 to 98 percent of nominal frequency.
 - 6. Under-frequency pickup: 90 to 100 percent of nominal frequency.
 - 7. Over-frequency dropout: 102 to 110 percent of nominal frequency.
 - 8. Over-frequency pickup: 2 percent below over-frequency dropout.
 - 9. Voltage unbalance dropout: 5 to 20 percent of nominal voltage.
 - 10. Voltage unbalance pickup: 1 percent below voltage unbalance dropout.
 - 11. Provide engine starting contacts and all other auxiliary contacts and accessory devices for functions to be performed.
- G. Microprocessor Controller:
 - 1. Sensing and logic shall be provided by single built-in microprocessor in each switch for maximum reliability, minimum maintenance, and ability to communicate serially through optional serial communication module.
 - 2. Single controller shall provide selectable nominal voltages for maximum application flexibility and minimal spare part requirements.
 - a. Voltage sensing shall be true RMS type and shall be accurate to plus or minus 1 percent of nominal voltage.
 - b. Frequency sensing shall be accurate to plus or minus 0.2 percent.
 - c. Panel shall be capable of operating over temperature range of minus 20 to plus 60 deg C and storage from minus 55 to plus 85 deg C.
 - 3. Controller shall be connected to transfer switch by interconnecting wiring harness with keyed disconnect plug to enable controller to be disconnected from transfer switch for routine maintenance.
 - a. Interfacing relays shall be industrial grade plug-in type with dust covers.
 - b. Panel shall be enclosed with protective cover and be mounted separately from transfer switch unit for safety and ease of maintenance. Protective cover shall include built-in pocket for storage of operator's manuals.

4. Customer connections shall be wired to common terminal block to simplify field-wiring connections.
 5. Provide LCD display and keypad as part of controller for viewing all available data and setting desired operational parameters.
 6. Controller shall meet or exceed all IEC requirements for Electromagnetic Compatibility (EMC) and field immunity.
- H. Provide three position momentary-type test/automatic/reset switches:
1. Test position will simulate normal source failure.
 2. Reset position shall bypass time delays on either transfer to emergency or retransfer to normal.
 3. Switches which have no manual time delay bypass means are not acceptable.
- I. Provide SPDT contact, rated 5 A at 30 VDC, for low-voltage engine start signal. Start signal shall prevent dry cranking of engines by requiring generator sets to reach proper output, and run for duration of cool down setting, regardless of whether normal source restores before load is transferred.
- J. Provide minimum of two sets of auxiliary contacts, rated 10 A, 250 VAC consisting of one contact, closed when transfer switch is connected to normal source and one contact closed, when automatic transfer switch is connected to emergency source.
- K. Provide LED indicating lights shall be provided; one to indicate when automatic transfer switch is connected to normal source (green) and one to indicate when automatic transfer switch is connected to emergency source (red).
- L. Provide LED indicating lights energized by controller to provide true source availability of normal and emergency sources, as determined by voltage sensing trip and reset settings for each source.
- M. Time Delay Parameters:
1. Provide time delay on engine start, field adjustable from 0 to 6 seconds to avoid unnecessary starting caused by short time outages.
 2. Provide time delay on transfer to emergency, field adjustable from 0-60 minutes.
 3. Automatic transfer switches serving the following branches shall have no delay in transferring to the non-preferred source. Transfer to the non-preferred source shall be made within 10 seconds of a loss of normal power in accordance with NFPA-110.
 - a. Emergency branch.
 4. Provide two independently adjustable time delay modes on retransfer to normal, field adjustable from 0 to 60 minutes to avoid erratic operation caused by short time reestablishment of normal source.
 - a. Mode 1: For actual normal power failures.
 - b. Mode 2: For test mode function.
 - c. Automatically bypass time delay if emergency source fails and normal source is available.
 5. Provide engine shut down time delay for engine generator cool down, adjustable from 0 to 60 minutes.
 6. Provide time delay activated output signal to drive external relay(s) for selective load disconnect control.
 - a. Controller shall have ability to activate adjustable 0 to 5 minute time delay in any of following modes:
 - 1) Prior to transfer only.
 - 2) Prior to and after transfer.
 - 3) Normal to emergency only.
 - 4) Emergency to normal only.

- 5) Normal to emergency and emergency to normal.
- 6) All transfer conditions or only when both sources are available.
7. All time delays shall be adjustable in 1 second increments unless otherwise indicated,
8. All time delays shall be adjustable by using LCD display and keypad or with remote device connected to serial communications port. Time delay value displayed on LCD or remote device shall be remaining time until next event occurs.

N. Time Delay Settings (all times in mm:ss format):

1. Settings Common to all ATSs:
 - a. Generator Start delay after S1 failure: 00:02
 - b. Generator Cool down: 05:00
 - c. Return to available S1 upon S2 failure: 00:00
 - 1) For delayed transfer ATSs, center-position delay shall be applied prior to return to S1.
2. Provide time delay and transfer settings to each ATS per the following:

Time Delay and Transfer Settings					
ATS Name	Delay-Transfer to S2	Delay-Neutral Position to S2	Delay-Return to S1	Delay-Neutral Position to S1	Load Shed Priority
ATS-Emergency	00:00	N/A	15:00	N/A	0
ATS-Optional Standby	00:05	N/A	15:20	N/A	0

3. Delayed transition “ATS-Optional Standby” timing example:
 - 1) After 2 seconds of S1 failure, send generator start signal.
 - 2) Upon S2 reaching stable operating condition, wait 5 seconds to transfer to S2 (delay-transfer to S2).
 - 3) After 5 seconds have elapsed, ATS transfers to center/neutral position.
 - 4) After 45 seconds in center position, ATS transfers to S2 (delay – neutral position to S2).
 - 5) Upon return of S1, wait 16 minutes to re-transfer to S1 (delay-Return to S1).
 - 6) After 16 minutes have elapsed, ATS transfers to center/neutral position; after 45 seconds in center position, ATS transfers to S1 (delay – neutral position to S1).
 - 7) Remove ATS generator run signal 5 minutes after load has transferred back to S1 (generator cool-down).
4. Load shed scheme implementation:
 - a. Load shall be shed upon overload/undervoltage condition of generator system:
 - b. Loads shall be shed based on priority assigned in table above.
 - 1) Priority 0 loads shall never be shed from generator system.
 - 2) Priority 3 loads shall be shed first, followed by priority 2 loads and priority 1 loads shall be shed last.
 - 3) Provide sufficient delay between load shed blocks to allow generator system to re-stabilize.
 - c. Load re-addition scheme implementation:
 - 1) Once generator system is determined to have sufficient capacity to accommodate additional load, ATSs shall be re-transferred to S2 based on the priority assigned in the table above.
 - a) Priority 1 loads shall be re-added first, followed by priority 2 loads and priority 3 loads shall be re-transferred last.
 - b) Provide delay between load blocks to allow generator system to stabilize.

2.3 OPERATION

- A. Engine starting contacts shall be normally open contacts that close to start engine(s).
- B. Controller operational parameters shall be available for viewing and limited control through serial communications input port. Following parameters shall be adjustable on controller:
 - 1. Nominal line voltage and frequency.
 - 2. Single or three phase sensing.
 - 3. Operating parameter protection.
 - 4. Transfer operating mode configuration. (Open, closed, or delayed transition as applicable)
- C. All instructions and controller settings shall be easily accessible, readable, and accomplished without use of codes, calculations, or instruction manuals.
- D. Repetitive accuracy of all settings shall be within plus or minus 0.5 percent over an operating temperature range of minus 20 deg C to plus 60 deg C.
- E. Voltage and frequency settings shall be field adjustable in 1 percent increments either locally with display and keypad or remotely via serial communications port access.
- F. Controller shall be capable (when activated by keypad or through serial port) of sensing phase rotation of both normal and emergency sources. Source shall be considered unacceptable if phase rotation is not preferred rotation selected (ABC or CBA).
- G. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.
- H. Following features shall be built into controller and shall also be capable of being activated through keypad programming or serial port when required by user:
 - 1. Provide ability to select "commit/no commit to transfer" to determine whether load should be transferred to the emergency generator if normal source restores before generators are ready to accept load.
 - 2. Provide terminals for remote contact which opens to signal automatic transfer switch to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both inhibit signals can be activated through keypad or serial port.
 - 3. Provide in-phase monitor in controller to control transfer so that motor load inrush currents do not exceed normal starting currents and shall not require external control of power sources. In-phase monitor shall be specifically designed for and be product of automatic transfer switch manufacturer.
 - 4. Controller shall be capable of accepting normally open contact that will allow transfer switch to function in non-automatic mode using an external control device.
 - 5. Provide internal engine exerciser that allows user to program up to seven different exercise routines.
 - a. For each routine, user shall be able to:
 - 1) Enable or disable routine.
 - 2) Enable or disable transfer of load during routine.
 - 3) Set start time:
 - a) Time of day.
 - b) Day of week.
 - c) Week of month (1st, 2nd, 3rd, 4th, alternate or every).
 - 4) Set duration of run.
 - b. At end of specified duration switch shall transfer load back to normal and run generator(s) for specified cool down period.
 - c. 10-year life battery that supplies power to real time clock in event of power loss will maintain all time and date information.

I. System Status:

1. Controller LCD display shall include "System Status" screen which shall be readily accessible from any point in menu by depressing "ESC" key maximum of two times. This screen shall display clear description of active operating sequence and switch position.
 - a. Example:

Normal Failed Load on Normal TD Normal to Emerg 2min 15s

2. Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in operator's manual, are not permissible.

J. Self-Diagnostics:

1. Controller shall contain diagnostic screen for purpose of detecting system errors. Screen shall provide information on status input signals to controller which may be preventing load transfer commands from being completed.

K. Communications Interface:

1. Controller shall be capable of interfacing, through optional serial communication module, with network of transfer switches, locally (up to 4000 feet.) or remotely through modem serial communications.
2. Standard software specific for transfer switch applications shall be available by transfer switch manufacturer.
3. Software shall allow for monitoring, control, and setup of parameters.

L. Communications Module:

1. Full duplex RS485 interface shall be installed in controller to enable serial communications.
2. Serial communications shall be capable of direct connect or multi-drop configured network.
3. Module shall allow for seamless integration of existing or new communication transfer devices.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Arrange ATS(s) as shown on Drawings and approved Shop Drawings. Electrical Room layout and ATS installation shall maximize the ability to install additional equipment in rooms. Contractor to submit coordination drawings per section 26 00 10 indicating final layout of equipment with actual ATS(s) submitted.
 1. Provide required clearances and maintenance access.
- B. Install switches in accordance with manufacturer's written instructions and NECA-1.
- C. Provide all circuits and connections as required for fully operational system.
- D. Unless otherwise indicated, install and anchor floor-mounted transfer switches on raised concrete pads 4 inches high, reinforced, with chamfered edges.
- E. Set field-adjustable intervals and delays, relays and engine exerciser clock per manufacturer's recommendations unless otherwise noted.
- F. Provide and terminate all interface control wiring in conduit from automatic transfer switches to other equipment or systems as required including but not limited to:
 1. Standby generator control panel:
 - a. Engine start circuiting.

- 1) Provide separate engine start circuit from each transfer switch to generator control panel.
2. Annunciator/control panels if provided.
3. Time delay signal prior to and after transfer from one source to another where indicated.
4. Building Control Systems where indicated. (Termination at BCS control panels by Mechanical Contractor)
5. Label both ends of all conductors noting points of opposite termination.

3.2 INTEGRATION

- A. Coordinate anticipated network connections and data to be transmitted by new ATS data monitors with BMCS vendor prior to start of power meter integration.
- B. All circuit monitor data, status of monitored switches, and PLC registers shall be provided to the BMCS vendor via circuit monitor and/or programmable controller register lists.
- C. Provide all programming required to communicate power monitoring data to BMCS.
- D. Provide a representative of power meter manufacturer to supervise integration, start-up, and testing of system.
- E. Testing to include a complete working demonstration of the power monitoring system with simulation of possible operating conditions which may be encountered.

3.3 TESTING

- A. Each automatic transfer switch shall be factory tested to ensure proper operation of individual components, correct overall sequence of operation and to ensure that operating transfer time, voltage, frequency, and time delay settings are in compliance with specification requirements. Document and submit report.

3.4 FIELD QUALITY CONTROL

- A. Each automatic transfer switch shall be field tested by authorized factory representative to confirm proper operation of individual components, correct overall sequence of operation and to verify that operating transfer time, voltage, frequency, and time delay settings are in compliance with specification requirements. Document and submit report.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.

- d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- 5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
 - 6. Coordinate tests with tests of generator(s) and run them concurrently.
 - 7. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
 - 8. Remove and replace malfunctioning units and retest as specified above.
 - 9. Prepare test and inspection reports.
 - 10. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 TRAINING

- A. Train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
 - 1. Coordinate this training with that for generator equipment.

3.6 CLOSEOUT ACTIVITIES

- A. Refer to Section 01 81 33 - Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

SECTION 26 41 13
LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Lightning Protection System, as indicated, in accordance with provisions of Contract Documents.
- B. Scope of work:
 - 1. Provide system complying with UL and provide Master-UL Certification Letter.
- C. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. National Fire Protection Association (NFPA):
 - 1. 780, Standard for the Installation of Lightning Protection Systems.
- B. Underwriters Laboratories, Inc. (UL):
 - 1. 96, Standard for Safety for Lightning Protection Components.
 - 2. 96A, Standard for Installation Requirements for Lightning Protection Systems.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Lightning protection system:
 - a. Roof penetration details.
 - b. Complete layout indicating air terminals, connections, down conductors, and grounding electrodes.
- B. Product Data:
 - 1. Technical data on each component.
- C. Contract Closeout Information:
 - 1. UL Master Label Certification Letter.
 - 2. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
 - 3. Field quality-control reports.
 - 4. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
 - 5. Plans showing dimensioned as-built locations of grounding components.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Certified member of Lightning Protection Institute to install lightning protection systems.
 - 2. UL listed manufacturer and installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Lightning Protection System:

1. Thompson Lightning Protection.
2. Robbins Lightning Inc.
3. Heary Brothers Lightning Protection.
4. Independent Protection.
5. National Lightning Protection.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. Lightning Protection System:

1. Complete Master Label lightning protection system.
2. Labeled for lightning protection systems by UL.
3. Design components complying with requirements of UL96 and NFPA 780 that blend with appearance of building.
4. Maximum concealed system.

B. Conductors:

1. Main and bonding conductors: Copper or aluminum.

C. Air Terminals:

1. Solid copper or aluminum rod with tapered point, of height required.
2. Attach rods to building with proper cast bronze or copper base to adapt to building design.
 - a. Air terminals longer than 600 mm 24 inches shall be provided with proper cast bronze or copper brace attached to the terminal at not less than half the height of the terminal.

D. Ground Rods:

1. Copper-clad steel 19 mm 3/4 inches in diameter by 3 m 10 feet long.

E. Main Ground Connection Fittings:

1. See Section 26 05 26.

2.3 SURGE SUPPRESSION

A. Surge Protective Devices (SPD's) shall be provided as required by NFPA 780 for the following:

1. All power service equipment.
2. At all points where electrical and electronic conductors leave a structure to supply another structure when the conductors are run over 100 feet.
3. See Spec Section 26 43 13 and electrical drawings for more information regarding SPD provision requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Do not install copper conductors or fastenings in contact with aluminum surfaces.
- B. Install down conductors from air terminals to ground electrodes.
- C. Structural steel may be used as main conductor in accordance with NFPA 780.
- D. Coordinate installation of air terminals attached to roof systems with roofing contractor.
 1. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.
- E. Terminate each down conductor at grounding electrode suitable to local soil condition and applicable codes.
 1. Maximum ground resistance: 10 ohms.

2. Make connection to ground rods with Cadweld method or UL listed compression fitting for connections buried in earth.
 3. If necessary, drive additional ground rods to obtain 10 ohms.
 4. Do not cover or bury ground rods until observed by Architect/Engineer.
- F. Interconnect metal items on roof such as ventilators, exhaust fans, stacks, pipes, gutters, downspouts, ducts, tracks, antennas, water pipes, ladders, etc., to main conductor system.
- G. Provide connection to building grounding electrode system at incoming electrical service for common bonding.
- H. Provide roof flashings or other method approved by roof manufacturer for down conductor or fittings passing through roofs.
- I. Remove and replace lightning protection system components found not in compliance with specification requirements.
- J. Installation of protection system to allow free movement of flashing and coping systems.
- K. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components. Conceal the following conductors unless otherwise is allowed by the Architect or Owner:
1. Down conductors.
 2. Interior conductors.
 3. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.
- L. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
- M. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure and other protected items.
1. Bury ground ring not less than 600 mm 24 inches from building foundation.
 2. Bond ground terminals to the ground loop.
- N. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
- O. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

END OF SECTION

SECTION 26 43 13
SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Surge Suppression Devices, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 DESCRIPTION

- A. This specification includes surge protective devices that clamp transient voltage, diverts surge current and attenuates high-frequency electrical line noise.
- B. Surge protective devices shall be located at service entrance equipment and at downstream switchgear, switchboards, motor control centers, busway, distribution panelboards, and/or branch circuit panelboards where indicated on Drawings or Panelboard Schedules.
- C. Surge protective devices shall be internally mounted within the protected equipment enclosure.
- D. Surge protective devices shall be externally mounted in their own separate enclosure adjacent to the enclosure of the protected equipment.

1.3 REFERENCES

- A. Institute of Electrical and Electronic Engineers (IEEE):
 - 1. C62.41.1, Guide on the Surge Environment in Low Voltage (1000 V and less) AC Power Circuits.
 - 2. C62.41.2, Recommended Practice on Characterization of Surges in Low Voltage (1000 V and less) AC Power Circuits.
 - 3. C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits.
- B. Military Standards (MIL STD):
 - 1. 220C, Method of Insertion Loss Measurement.
- C. National Fire Protection Association (NFPA):
 - 1. 70, National Electrical Code (NEC) as amended by Authority Having Jurisdiction.
 - 2. 780, Lightning Protection Systems.
- D. Underwriters Laboratories (UL):
 - 1. 50, Enclosures for Electrical Equipment.
 - 2. 67, Panelboards.
 - 3. 96A, Lightning Protection Systems.
 - 4. 845, Motor Control Centers.
 - 5. 857, Busway.
 - 6. 891, Dead Front Switchboards.
 - 7. 1283, Electromagnetic Interference Filters.
 - 8. 1449, Fourth Edition, Surge Protective Devices.
 - 9. 1558, Metal Enclosed Low Voltage Power Circuit Breaker Switchgear.

1.4 SUBMITTALS

- A. Shop Drawings:

1. Submit unit dimensions, rated capacities, weights, mounting provisions, connection details, accessories, and layout diagrams of each SPD application.
 2. Indicate location with respect to protected bus and connection characteristics to bus including material type, length, and routing.
- B. Product Data:
1. Copy of UL 1449 Certification under Category VZCA or VZCA2 with applicable model numbers highlighted and indicating following information:
 - a. Model number.
 - b. Product Type.
 - c. Voltage.
 - d. Phase.
 - e. Voltage protection rating per mode.
 - f. Nominal discharge current rating per mode.
 - g. Maximum continuous operating voltage rating per mode.
 2. Standard catalog data sheets indicating:
 - a. Modes of protection.
 - b. Surge current capacity per mode.
 - c. Surge current capacity per phase.
 - d. Short circuit current rating.
 - e. Filter attenuation.
 - f. Diagnostics and monitoring features.
- C. Contract Closeout Information:
1. Operation and Maintenance Data.
 - a. See Section 01 78 23.
 2. Warranty.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
1. Engaged in design and manufacturer of specified system for a minimum of five (5) years.
 2. SPD manufacturer shall be same as manufacturer of protected equipment.
- A. Internally mounted SPD equipment shall be UL 1449 and UL 1283 Listed or shall be UL 1449 and UL 1283 component recognized as a surge protective device and electromagnetic interference filter. The protected equipment including the SPD shall be fully tested and certified to the applicable electrical power systems equipment (e.g., switchgear, switchboard, motor control center, busway, panelboard, etc.) UL Standard.
- B. Externally mounted SPD equipment shall be UL 1449 and UL 1283 listed as a surge protective device and electromagnetic interference filter.

1.6 WARRANTY

- A. Manufacturer's Limited Ten-Year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation, and maintenance instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Surge Suppression Devices:

1. Acceptable Manufacturers:
 - a. Eaton/Cutler-Hammer – SPD Series.
 - b. Schneider/Square D-Surgelogic IMA/EMA Series
 - c. Siemens Energy & Automation-Sentron TPS3 Series.
 - d. ABB/General Electric – TR7000 Series.
2. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

A. Environmental Requirements:

1. Operating temperature range shall be minus 40 deg F to plus 122 deg F minus 40 deg C to plus 50 deg C.
2. Relative humidity range shall be 5% to 95% non-condensing.
3. Capable of operation at altitudes up to 16,000 feet 5,000 m above sea level.
4. No audible noise.
5. No appreciable emissions of EMI/RFI fields.

B. General Electrical Requirements:

1. SPD shall be a combination of a solid state, parallel connected surge suppression device, and an electromagnetic interference filter.
2. The surge suppression elements shall be Metal Oxide Varistor (MOV).
3. Each MOV shall be provided with individual over-current and thermal over-temperature protection.
4. Surge current shall be equally distributed to all components to ensure equal stressing and maximum performance.
5. Nominal operating voltage: as indicated on the drawings or panelboard schedules.
6. Nominal operating frequency: 60 Hz.
7. Protection modes: provide directly connected suppression elements between line and neutral (L-N), line and ground (L-G), and neutral and ground (N-G).
8. Maximum Continuous Over Voltage (MCOV) shall equal or exceed the following:
 - a. 208Y/120 V systems:
 - 1) L-N: 150.
 - 2) L-G: 150.
 - 3) N-G: 150.
 - 4) L-L: 300.
 - b. 480Y/277 V systems:
 - 1) L-N: 320.
 - 2) L-G: 320.
 - 3) N-G: 320.
 - 4) L-L: 640.
9. Voltage Protection Rating (VPR) shall not exceed the following:
 - a. 208Y/120 V systems:
 - 1) L-N: 800.
 - 2) L-G: 800.
 - 3) N-G: 800.
 - 4) L-L: 1200.
 - b. 480Y/277 V systems:
 - 1) L-N: 1200.
 - 2) L-G: 1200.

- 3) N-G: 1200.
- 4) L-L: 2000.
- 10. Nominal discharge current rating: 20 kA.
- 11. Short circuit current rating (SCCR): 200 kA.
- 12. EMI/RFI filter shall provide minimum 50 dB noise attenuation at 100 kHz using MIL-STD-220A insertion loss test method.
- 13. Diagnostics and monitoring:
 - a. Solid state monitoring of each mode and power loss in any phase.
 - b. Externally visible green/red LED operational status indicator lights for each protection mode. Absence of a green light and presence of red light shall indicate which mode(s) or phase(s) have been damaged.
 - c. Audible alarm with silence switch shall sound if any fault condition occurs.
 - d. Form C dry contacts (1 NO/1 NC) for remote status monitoring. Contacts shall change state if any fault condition occurs.
 - e. Test switch shall test SPD's diagnostics and monitoring system.
- C. Specific Electrical Requirements by Application/Location:
 - 1. Internally mounted within service entrance equipment:
 - a. UL Labeled as Type 2, or Type 4 investigated by UL for use in Type 2 applications.
 - b. Tested and suitable for use in ANSI/IEEE C62.41 Category C environments.
 - c. Surge current capacity:
 - 1) Maximum surge current rating per phase shall be minimum 250 kA.
 - 2) Maximum surge current rating per mode shall be minimum 125 kA.
 - d. Factory installed.
 - 1) SPD equipment shall be located within the service entrance equipment enclosure and installed in the factory by the service entrance equipment manufacturer.
 - 2) SPD equipment shall be connected directly to the protected equipment bus on the load side of the service disconnect. If direct bus connection is not possible, conductor leads may be provided. Conductor leads shall be kept as short and straight as possible. Leads shall be minimum No. 8 AWG conductors and twisted with a minimum of three twists per foot (ten twists per meter) in the conductors to minimize impedance. Tie wrap twisted conductors at 4-inch 100 mm spacing.
 - 3) Provide a remote diagnostics panel mounted on the cover of the service entrance equipment enclosure and visible from outside the enclosure.
 - 2. Internally mounted within distribution equipment and/or panelboards serving rooftop equipment:
 - a. UL Labeled as Type 2, or Type 4 investigated by UL for use in Type 2 applications.
 - b. Tested and suitable for use in ANSI/IEEE C62.41 Category C or B environments.
 - c. Surge current capacity:
 - 1) Maximum surge current rating per phase shall be minimum 160 kA.
 - 2) Maximum surge current rating per mode shall be minimum 80 kA.
 - d. Factory installed.
 - 1) SPD equipment shall be located within the distribution equipment enclosure and installed in the factory of the distribution equipment manufacturer.
 - 2) SPD equipment shall be connected directly to the protected equipment bus on the load side of the main circuit breaker if provided. Neutral and ground leads shall be kept as short and straight as possible. Leads shall be minimum No. 8 AWG conductors and twisted with a minimum of three twists per foot (ten twists per meter) in the conductors to minimize impedance. Tie wrap twisted conductors at 4-inch 100 mm spacing.

- 3) Provide a window in the equipment to allow the diagnostics panels to be visible from outside the enclosure. If not, provide a remote diagnostics panel mounted on the cover of the distribution equipment enclosure and visible from outside the enclosure.
- e. SPD mounting shall not limit the use of through-feed lugs, sub-feed lugs, or sub-feed breakers.
- f. Panelboards shall be capable of being placed back in re-energized service upon removal of the SPD.
3. Internally mounted within branch circuit panelboards:
 - a. UL Labeled as Type 2, or Type 4 investigated by UL for use in Type 2 applications.
 - b. Tested and suitable for use in ANSI/IEEE C62.41 Category B environments.
 - c. Surge current capacity:
 - 1) Maximum surge current rating per phase shall be minimum 100 kA.
 - 2) Maximum surge current rating per mode shall be minimum 50 kA.
 - d. Factory installed.
 - 1) SPD equipment shall be located within the panelboard enclosure and installed in the factory of the panelboard manufacturer.
 - 2) SPD equipment shall be connected directly to the protected equipment bus on the load side of the main circuit breaker if provided. Neutral and ground leads shall be kept as short and straight as possible. Leads shall be minimum No. 8 AWG conductors and twisted with a minimum of three twists per foot (ten twists per meter) in the conductors to minimize impedance. Tie wrap twisted conductors at 4-inch 100 mm spacing.
 - 3) Provide a window in the panelboard cover to allow the diagnostics panels to be visible from outside the enclosure.
 - e. SPD mounting shall not limit the use of through-feed lugs, sub-feed lugs, or sub-feed breakers.
 - f. Panelboards shall be capable of being placed back in re-energized service upon removal of the SPD.
4. Externally mounted at service entrance equipment:
 - a. UL Labeled as Type 2.
 - b. Tested and suitable for use in ANSI/IEEE C62.41 Category C environments.
 - c. Surge current capacity:
 - 1) Maximum surge current rating per phase shall be minimum 250 kA.
 - 2) Maximum surge current rating per mode shall be minimum 125 kA.
 - d. Separately mounted in NEMA 1 enclosure. Diagnostics shall be visible from outside the enclosure.
5. Externally mounted adjacent to distribution equipment and/or panelboards serving rooftop equipment:
 - a. UL Labeled as Type 2.
 - b. Tested and suitable for use in ANSI/IEEE C62.41 Category C or B environments.
 - c. Surge current capacity:
 - 1) Maximum surge current rating per phase shall be minimum 160 kA.
 - 2) Maximum surge current rating per mode shall be minimum 80 kA.
 - d. Separately mounted in NEMA 1 enclosure. Diagnostics shall be visible from outside the enclosure.
6. Externally mounted adjacent to branch circuit panelboards:
 - a. UL Labeled as Type 2.
 - b. Tested and suitable for use in ANSI/IEEE C62.41 Category B environments.
 - c. Surge current capacity:

- 1) Maximum surge current rating per phase shall be minimum 100 kA.
 - 2) Maximum surge current rating per mode shall be minimum 50 kA.
 - d. Separately mounted in NEMA 1 enclosure. Diagnostics shall be visible from outside the enclosure.
- D. Factory-test SPD equipment prior to shipment, including but not be limited to:
1. Quality assurance checks.
 2. MCOV and let-through voltage verification tests.
 - a. MCOV testing shall consist of units burned-in at applicable MCOV for a minimum of one hour.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install SPD equipment per manufacturer's recommendations.
- B. Externally mounted SPD equipment:
1. Mount as close as practical to the protected bus. For panelboard applications, wall mount the SPD immediately adjacent to the circuit breaker serving it.
 2. Conductors shall be as short and straight as possible between SPD and circuit breaker. Do not exceed manufacturer's recommended circuit length.
 3. Conductor size shall be minimum No. 8 AWG in minimum 1 inch 25 mm conduit. Provide larger conductors and conduit as recommended by the manufacturer.
 4. Provide a minimum of three twists per foot (ten twists per meter) in the conductors to minimize impedance. Tie wrap twisted conductors at 4-inch 100 mm spacing.
 5. Seal conduit after placement of conductors.
 6. Provide multi-pole, overcurrent protective device as a dedicated disconnect means for the SPD, unless otherwise indicated.
 7. Provide externally mounted SPD's as indicated on approved Shop Drawings. Electrical Room layout and SPD installation shall maximize the ability to install additional equipment in rooms. Contractor to submit coordination drawings per section 26 00 10 indicating final layout of equipment with actual externally mounted SPD's submitted.
- C. Do not energize SPD's until distribution system has been energized, stabilized, and tested.
- D. Disconnect SPD's during distribution system insulation resistance testing.

3.2 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality control testing:
1. After installing surge protective devices but before electrical circuitry has been energized, test for compliance with requirements.
 2. Complete startup checks according to manufacturer's written instructions.
 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.
- B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION

SECTION 26 51 13

BUILDING LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Building Lighting, as indicated, in accordance with provisions of Contract Documents.
- B. Section includes interior luminaires and building mounted exterior luminaires, including luminaire accessories, lamps, LED modules, power supplies, and drivers.
- C. See Section 26 56 00 for exterior luminaires not mounted to building.
- D. Provide unit price for each piece of lighting equipment along with bid.
 - 1. List manufacturer and catalog number along with price.
 - 2. Fixed lot or packaged pricing and/or unidentified manufacturer are not acceptable reasons to obscure unit pricing.
 - 3. Unit pricing is used to assist Owner in making value management decisions, if necessary.
 - a. Provided pricing shall not serve as the basis for change order pricing.
- E. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI C62.41.2 IEEE Recommended Practice on Characterization of Surges in Low Voltage (1000 V and less) AC Power Circuits.
 - 2. ANSI C78.377: Specifications for the Chromaticity of Solid State Lighting Products.
 - 3. ANSI C82.77: Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment.
- B. Federal Communications Commission (FCC):
 - 1. Code of Federal Regulations (CFR), Title 47, Part 18, Industrial, Scientific, and Medical Equipment.
 - 2. Code of Federal Regulations (CFR), Title 47, Part 15 Class B: Radio Frequency Devices, Commercial Rated.
- C. International Electrotechnical Commission (IEC):
 - 1. IEC 61000-3-2: Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)
 - 2. IEC 61347-1: General and Safety Requirements for Lamp Control Gear.
 - 3. IEC 61347-2-13: Particular Requirements for DC or AC. Supplied Electronic Control gear for LED Modules.
 - 4. IEC 61547: Equipment for general lighting purposes - EMC Immunity Requirements.
 - 5. IEC 62384: DC or AC Supplied Electronic Control Gear for LED Modules - Performance Requirements.
 - 6. IEC 62386-101: Digital Addressable Lighting Interface - Part 101: General Requirements - System.
 - 7. IEC 62386-102: Digital Addressable Lighting Interface - Part 102: General Requirements - Control Gear.
 - 8. IEC 62386-207: Digital Addressable Lighting Interface - Part 207: Particular Requirements for Control Gear - LED Modules (Device Type 6).
- D. Institute of Electrical and Electronic Engineers (IEEE):

1. IEEE C62.41-91: Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits.
 2. IEEE 1789: Recommended Practice for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers.
- E. Illuminating Engineering Society of North America (IESNA):
1. IES LM-28: Approved Method: Guide for the Selection, Care and Use of Electrical Instruments in the Photometric Laboratory.
 2. IES LM-37: Approved Method: Guide for Determination of Average Luminance (Calculated) for Indoor Luminaires
 3. ANSI/IES LM-48: Testing Calibration of Locking Type Photoelectric Control Devices
 4. ANSI/IES LM-58: Approved Method: Spectroradiometric Measurement Methods for Light Sources.
 5. ANSI/IES LM-63: ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information.
 6. ANSI/IES LM-72: Approved Method: Directional Positioning of Photometric Data.
 7. ANSI/IES LM-75: Approved Method: Goniophotometer Types and Photometric Coordinates.
 8. ANSI/IES LM-77: Approved Method: Intensity Distribution Measurement of Luminaires and Lamps Using Digital Screen Imaging Photometry.
 9. ANSI/IES LM-78: Approved Method: Total Luminous Flux Measurement of Lamps using an Integrating Sphere Photometer.
 10. ANSI/IES LM-79: Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
 11. ANSI/IES LM-80: Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
 12. ANSI/IES LM-82: Approved Method: Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature.
 13. ANSI/IES LM-84: Approved Method: Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines and Luminaires.
 14. ANSI/IES LM-85: Approved Method: Electrical and Photometric Measurements of High-Powered LEDs.
 15. ANSI/IES LM-88: Approved Method: Optical and Electrical Measurements of AC-LED Packages and Arrays or Modules.
 16. ANSI/IES LM-90: Approved Method: Measuring Luminous Flux Waveforms for Use in Temporal Light Artifact (TLA) Calculations.
 17. ANSI/IES TM-15: Luminaire Classification System for Outdoor Luminaires.
 18. ANSI/IES TM-21: Technical Memorandum: Projecting Long Term Lumen Maintenance of LED Light Sources.
 19. ANSI/IES TM-25: Technical Memorandum: Ray File Format for the Description of the Emission Properties of Light Sources.
 20. ANSI/IES TM-26: Technical Memorandum: Projecting Catastrophic Failure Rate of LED Packages.
 21. ANSI/IES TM-27: Technical Memorandum: Standard Format for the Electronic Transfer of Spectral Data.
 22. ANSI/IES TM-28: Technical Memorandum: Projecting Long-Term Luminous Flux Maintenance of LED Lamps and Luminaires.
 23. ANSI/IES TM-30: IES Method for Evaluating Light Source Color Rendition.
 24. ANSI/IES TM-31: Technical Memorandum: Measurement Uncertainty for Lighting Equipment Calibration Using Integrating Spheres.
 25. ANSI/IES TM-33: Standard File Format for the Electronic Transfer of Luminaire Optical Data.

26. ANSI/IES TM-35: Technical Memorandum: Projecting Long-Term Chromaticity Coordinate Shift of LED Packages, Arrays, and Modules.
 27. ANSI/IES TM-38: Technical Memorandum: Photometric and Electrical Measurements of Tunable-White Solid-State Lighting Products.
 28. ANSI/IES LS-2: Lighting Science: Concepts and Language of Lighting.
 29. ANSI/IES RP-27: Recommended Practice: Photobiological Safety for Lighting Systems.
- F. National Electrical Manufacturer's Association (NEMA):
1. NEMA SSL1: Electronic Drivers for LED Devices, Arrays, or Systems.
 2. NEMA SSL3: High-Power White LED Binning for General Illumination.
 3. NEMA SSL7A: Phase Cut Dimming for Solid State Lighting: Basic Compatibility.
 4. NEMA 410: Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
- G. National Fire Protection Association (NFPA):
1. NFPA 70: National Electrical Code (NEC).
 2. NFPA 101: Life Safety Code.
- H. UL International (UL):
1. UL 1310 Standard for Class 2 Power Units.
 2. UL 8750 Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.3 SUBMITTALS

- A. Allow adequate time for the sample procurement, submittal review and ordering process of all products. (Some luminaires may require 12 to 16 weeks of lead time or more to arrive at the job site after ordering.) Substitutions will not be accepted on the basis that arrival of the specified luminaires will delay the Contractor's timeline.
- B. Shop Drawings:
1. For continuous pattern luminaires, indicate layout, individual section lengths, and LED/driver module quantities.
 - a. Show details of connections, emergency driver and module placement, corners and extensions, end plates, and mounting. Include pendant or bracket locations and show remote transformers/power supplies/drivers.
 - b. Provide field-measured overall dimensions in wall-to-wall and wall-to-corner applications.
 2. Details of luminaire flange, special construction, accessories, and finishes.
- C. Product Data:
1. Identify luminaires by Lighting Equipment Schedule designation.
 - a. For each luminaire, provide cut sheets indicating following information:
 - 1) Name of manufacturer, model, and complete catalog number.
 - a) Include product data details for catalog number references to explain special construction, accessory or finish, and photometric data.
 - 2) Photometric Data:
 - a) Collected by an independent testing laboratory.
 - b) Indicate optical performance developed using methods of Illuminating Engineering Society of North America (IESNA) as follows:
 - (1) Candlepower data presented graphically and numerically, in maximum 10 degree increments.
 - (2) Develop data for up and down quadrants that are normal, parallel, and at 45 degrees to lamp if light output is asymmetric.

- (3) Zonal lumens stated numerically in 10 degree increments as above.
 - (4) Fixture efficiency.
- 2. Solid state Luminaires:
 - a. LED Luminaires:
 - 1) Total input wattage.
 - 2) Luminaire voltage.
 - 3) Delivered lumens.
 - 4) Color temperature.
 - 5) Color rendering index (CRI), color fidelity (Rf), color gamut (Rg), and where requested, individual R-values measured in accordance with ANSI/IES TM 30 standards.
 - 6) Rated life, measured in accordance with IES standards.
 - 7) Total harmonic distortion (THD).
 - 8) Submit in tabular format the characteristics of submitted fixture per the technical information categories of the Lighting Equipment Schedule. Deviations from specified criteria shall be identified by a plus or minus percentage.
 - 9) Submit the rated lumen maintenance life of LED luminaires. Life shall be reported based upon the light source's L70 rating in accordance with IES standards.
 - b. LED Drivers:
 - 1) Driver manufacturer and model number.
 - 2) Driver rated life.
 - 3) Driver dimensions.
 - 4) Driver type (0-10V, constant voltage, constant current).
 - 5) If applicable, include lumen management protocols.
 - 6) Dimming range and control device compatibility list.
 - 7) Wiring Diagrams – as needed for special operation or interaction with other systems.
- 3. Coordinate ballasts/drivers used with lamping/LED modules, lamp sockets, and control devices prior to submitting Shop Drawings.
- 4. For product substitutions, provide calculations performed in AGI32 in specific spaces as identified by Lighting Designer where product is used.
- 5. Coordinate luminaires with ceiling construction.
 - a. Confirm clearances and fixture flange compatibility with construction.
- D. Samples:
 - 1. Luminaire samples for specified products only where required in Lighting Equipment Schedule.
 - 2. Provide with 120V cord and plug, fully operational.
 - 3. Provide with pre-paid return shipping packaging and instructions.
 - 4. Luminaire substitution requests shall require the submittal of a working sample upon request of Lighting Designer.
 - 5. Provide finish samples as indicated in Lighting Equipment Schedule. Submit a minimum of two 4 inches by 6 inches finish samples on the metal housing to be used.
- E. Project Information:
 - 1. Manufacturer's installation instructions.
 - 2. Warranties.
- F. Refer to Section 01 81 33 - Cyber Security Requirements for required cyber security related submittals for luminaires with integral wireless and cloud-based controls.

G. Contract Closeout Information:

1. Inventory of driver/module replacement stocks.
2. At time of Substantial Completion as defined by the Architect, submit all installation and maintenance tools received from various luminaire vendors clearly and permanently tagged with Manufacturer's name and relevant luminaire type(s) to the Owner's Representative.
3. Maintenance and Operating Manuals.
 - a. See Section 01 78 23.

H. Review of shop drawings and product data does not waive the Contractor of their obligations.

1.4 QUALITY ASSURANCE

- A. Where the Lighting Equipment Schedule identifies multiple fixture types using the same manufacturer and product family, the manufacturer and product family shall remain consistent for all fixture types. Final installation shall consist of same design standard or alternate manufacturer's equipment across groupings for consistency of color and quality of light, finishes, aesthetics, and similarity of maintenance procedures.
1. Mixing/matching across groups is unacceptable except where manufacturers do not offer products compliant with specifications for all luminaire types.
- B. Advise Architect of discrepancies between luminaire catalog references shown or specified and actual ceiling construction, prior to submission of shop drawings.
1. Failure to do so will require correction at no additional cost.
- C. Coordinate ballasts/drivers used with lamping/LED modules, lamp sockets, and control devices prior to submitting shop drawings.
- D. Provide luminaires bearing UL labels, and tested by a nationally recognized testing facility under UL1598 and UL 8750, and manufactured in accordance with NEC.
- E. Each luminaire shall be listed with nationally recognized testing laboratory including but not limited to, UL, CSA, ETL, under UL 1598 and UL 8750, or an equivalent standard from recognized testing laboratory, and manufactured in accordance with NEC.
- F. Materials and installations shall be in accordance with latest revision of National Electrical Code and any applicable Federal, State, and local codes and regulations.
- G. Luminaires shall comply with relevant and current ANSI, CBM, ESTA, FCC, IEC, IEEE, IESNA, NEMA, NFPA, and UL standards and practices.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Protect fixtures from damage using appropriate material, cartons, plastic wrapping, and protective means
- B. See Section 01 77 00:

1.6 WARRANTIES

- A. Manufacturer warranties shall be from the date of Substantial Completion and include labor allowance for field servicing of equipment.
1. Warrant the luminaire and all components to be free from defect in operation or finish for a minimum of five years.
 2. Warrant the driver for a minimum of five years.
 3. LED warranty shall include all modules without a percentage fail threshold.
 4. LED warranty shall include color consistency, lumen maintenance.
- B. Contractor is responsible for cost of materials and labor necessary to repair or replace luminaires within one year of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Luminaires:
 - 1. Base:
 - a. As indicated on Lighting Equipment Schedule.
 - 2. Optional:
 - a. As indicated on Lighting Equipment Schedule.
 - 3. Use catalog numbers listed as a guide only. Follow modifications and other requirements shown or specified.
- B. Lamps/LED Modules:
 - 1. GE Lighting.
 - 2. Osram Sylvania.
 - 3. Philips Lighting.
 - 4. Cree.
 - 5. Soraa.
 - 6. Xicato.
- C. Power Supply/Drivers:
 - 1. Osram Sylvania.
 - 2. Philips Advance.
 - 3. Mean Well.
 - 4. eldoLED.
 - 5. Hatch.
 - 6. Lutron.
 - 7. Moons.
- D. Emergency LED Drivers:
 - 1. Philips Bodine.
 - 2. Iota.
- E. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
- B. Luminaires:
 - 1. Resistant to corrosion and thermal and mechanical stresses encountered in normal application. Provide accessory equipment such as starters, sockets and lampholders, approved by UL and ETL, unless otherwise noted.
 - 2. Electrical components of recessed luminaires shall be accessible and removable through luminaire without having to remove luminaire from ceiling.
 - 3. Thermally protect luminaire.
 - 4. Housings:
 - a. Troffer luminaires: Minimum 22 GA 0.76 mm sheet steel; integral end plates and trim flanges to suit ceiling construction. Provide wire way covers with captive retainers to allow access to electrical components without use of tools.

- b. Downlight luminaires: Minimum 22 GA 0.76 mm sheet steel, or minimum 0.0508 inches 1.29 mm sheet aluminum, unless noted otherwise. Provide auxiliary junction box secured to mounting frame.
 - c. Extruded aluminum housings, where scheduled, shall be at least 1/8 inches 3 mm thick.
 - d. Punch and form housings prior to finishing (post-paint).
 - e. Power Supply/Driver surface shall be in complete contact with housing, having the mounting method designed for efficient conduction of heat.
 - f. Fixture shall be properly heat-sinked to assure LED junction temperature ratings are not exceeded. Manufacturer shall provide ambient operating temperature range for which product is warranted.
5. Trim:
- a. For square and rectangular luminaires, miter and continuously weld corners.
 - b. Miter perimeter inverted T-Bar angles at corners.
 - c. Do not butt or overlap squared ends.
 - d. Finish joints smooth.
6. Castings:
- a. Uniform quality, free from imperfections affecting strength and appearance. Exterior surfaces, if not receiving a finish coat, shall be smooth and match adjacent surfaces. At least one coat of clear methacrylate lacquer shall be applied unless a painted finish is specified.
7. Fasteners:
- a. For aluminum or steel luminaires, fastening hardware shall be zinc-nickel plated, stainless steel, or equivalent.
 - b. For stainless steel luminaires, fastening hardware shall be stainless steel.
 - c. For bronze luminaires, fastening hardware shall be bronze or stainless steel.
8. Finishes: As selected from manufacturer's standards unless scheduled otherwise.
- a. Painted surfaces, except as scheduled otherwise:
 - 1) Manufacturer's standard metal pretreatment and baked or air-dried, light-stabilized enamel finish: acrylic, alkyd, epoxy, polyester, or polyurethane.
 - 2) White finishes shall have minimum 85 percent reflectance.
 - b. Unpainted aluminum surfaces:
 - 1) Interior luminaires: Clear anodic coating, satin finish, except as scheduled otherwise.
 - 2) Exterior luminaires: Clear anodic coating.
9. Lens/Louver Frames:
- a. Extruded aluminum with mitered corners unless scheduled otherwise.
 - b. Hinging or other normal motion shall not cause lens or louver to drop out.
 - c. When installed, any exposed fixture housing surface, trim frame, door frame and lens frame shall be free of light leaks; lens doors shall close in a light tight manner.
10. Lenses:
- a. 100 percent virgin, UV stabilized acrylic.
 - b. The lenses shall be held securely in place but must also be removable to clean and service the luminaire.
 - 1) Luminaires with a spread lens shall also include a lens orientation device to ensure that it is not affected during cleaning or relamping.
 - c. There shall be no light leaks between the lens and the luminaire.
 - d. Acrylic lenses and diffusers shall be properly cast, molded, or extruded to meet the intent of the specified optics, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for the period of the Manufacturer's warranty.

11. Reflectors:
 - a. High-purity No. 12 aluminum reflector sheet, 0.047 inches 1.45 mm or heavier if specified, free from fabrication or assembly damages. No exposed rivets, springs, or other hardware after installation. Shape reflectors in modified elliptical or parabolic contour to produce no apparent brightness.
 - b. Downlights: Any direct image of the light source shall not be visible in 45 degree zone from nadir.
 - c. Downlight reflector and baffle finishes: First-quality Alzak anodized specular or semi-specular finish of color as specified, unless otherwise noted in Lighting Fixture Schedule.
 - 1) Downlight reflectors shall be securely fastened but also removable for cleaning and relamping.
 - d. Troffer reflector finish: integral reflectors shall be painted white after fabrication and shall have a minimum reflectance value of 90 percent.
12. Gaskets: Provide gaskets at face plates or frames of recessed luminaires which serve as ceiling trim, and which allow interior access. Provide moisture seal gaskets at exterior locations and in other areas designated. Secure frames to luminaire bodies with screws or other means, to result in tight installation, without light leaks. See Lighting Equipment Schedule for other types of seals and gaskets.
13. Ventilation: Provide ventilation openings of adequate size and quantity to permit operation of lamps/LED modules and power supply/driver without affecting rated output or life expectancy.
14. Lamp Holders:
 - a. Position holders so that lamps are in optically correct relation to luminaire components.
 - b. LED Module/Array Mountings:
 - 1) Dedicated quick-connect wiring accessories for field replaceable LED modules and arrays.
 - 2) LED modules and arrays shall be secured by screws or clips to assure proper connection to heat sink while permitting field replacement.
15. Wiring:
 - a. Factory wire luminaire to be compatible with project electrical and controls systems.
 - b. Luminaires shall comply with NEC requirements and be supplied with a disconnecting means accessible to qualified persons before servicing or maintaining.
 - c. Power supplies and LED modules, unless otherwise specified, shall be field replaceable and shall be serviceable while the fixture is in its normally installed position.
16. Mounting Accessories:
 - a. Provide appropriate mounting accessories for each luminaire, compatible with various structural conditions encountered. Provide fastening clips (seismic clips) for luminaires supported from framing members of suspended ceilings.
 - b. Luminaires with adjustable beam angles shall have a locking device to ensure that the beam distribution is not affected during relamping or cleaning.
 - c. Recessed Luminaires:
 - 1) Plaster frames: Provide frames for luminaires installed in gypsum board and concealed suspension system ceiling tile. Make frames of non-ferrous metal or suitably rustproof after fabrication.
 - 2) Baffles and gaskets: As required to prevent light leakage.
 - 3) Flanged luminaires are required in all ceiling systems unless otherwise noted in Lighting Equipment Schedule.
 - 4) Coordinate fixture flange with ceiling system and ceiling grid contractor.
 - d. Luminaire Suspension Material:

- 1) Unfinished spaces: 13 mm 1/2 inches minimum diameter pendant, unless otherwise noted.
- 2) Finished spaces: Unless otherwise noted, provide manufactured cable or stem and outlet box canopy; contemporary design with swivel self-aligning features; size canopy to cover outlet box; finished to match luminaire. Coordinate pendant location with ceiling tiles/ceiling grid and submit coordinated mounting accessories as part of Product Data submission.
 - a) Provide luminaires mounted on suspended ceiling grids with outlet box designed for grid mounting with direct cord entry.
- e. Mechanical Safety: Unless otherwise specified, retain luminaire closures (lens doors, trim frame, hinged housings, etc.) in secure manner by captive screws, chains, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
- f. LED luminaires shall be manufactured specifically for their respective light source with dedicated electrical connections and with power supplies integral to the fixture, except where remote devices are specified. Assemblies designed to retrofit incandescent luminaires are prohibited except when specifically indicated for use in decorative luminaires designed for LED retrofit lamps.
- g. Design luminaires for lamps specified.
- h. Fit trims, canopies, and escutcheons snugly and securely to the ceiling and/or wall so that no light leaks occur and so that no gaps or uneven waves are evident.

C. LED Modules:

1. Color temperature measurement shall have a maximum MacAdam Ellipse boundary of 3 SDCM unless otherwise specified in the Lighting Equipment Schedule.
2. LED light output and efficacy shall be measured in accordance with the following standards:
 - a. IES LM-79
 - b. IES LM-85
 - c. IES LM-88
 - d. IES TM-38
3. LED life and lumen maintenance shall be measured in accordance with the following standards:
 - a. IES LM-80
 - b. IES LM-84
 - c. IES TM-21
 - d. IES TM-26
 - e. IES TM-28
 - f. IES TM-35
4. Rated minimum L70 life of 50,000 hours at 25 deg C.
5. The individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in a light output loss of the entire luminaire.

D. Power Supplies and Drivers:

1. General:
 - a. Comply with UL and ANSI specifications. Enclosure shall display approval label for compliance with UL standards.
 - b. Contractor shall verify required voltage, frequency, and power factors.
 - c. Comply with US Federal Efficiency Laws.
 - d. Equipment shall not contain PCBs.
 - e. Manufacturer shall have a ten year history of producing electronic ballasts and/or drivers for the North American market.

2. LED Drivers:

a. LED Driver types.

- 1) 4-Wire (0V to 10V DC Voltage Controlled) Dimming Driver.
- 2) 2-Wire Switched Driver.

b. General.

- 1) LED dimming shall be equal in range and light quality to a commercial grade incandescent dimmer.
 - a) Free from perceived flicker or visible stroboscopic flicker.
 - b) Smooth and continuous change in level (no visible steps in transitions).
 - c) Stable when input voltage conditions fluctuate.
 - d) Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
- 2) Driver shall operate from 60 Hz input source of 120V through 277V with sustained variations of +/- 10 percent (voltage and frequency) with no visible change in light output.
- 3) Total Harmonic Distortion less than 20 percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
- 4) Driver shall have a Power Factor greater than 0.90.
- 5) Driver output shall be regulated to +/- 5 percent across published load range.
- 6) Driver shall have a Class A sound rating.
- 7) Driver shall have a minimum operating temperature of -20 deg C -4 deg F.
- 8) Driver shall tolerate sustained open circuit and short circuit output conditions without fail and auto-resetting without need for external fuses or trip devices.
- 9) Driver output ripple current shall be less than 15 percent measured peak-to-average, with ripple frequency greater than 100 Hz.
- 10) Driver must limit inrush current and meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps² – seconds.
- 11) Driver shall withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A for Transient protection.
- 12) Driver shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
- 13) Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements to maintain or deliver improved performance:
 - a) Adjustment of forward LED voltage, supporting 3V through 55V.
 - b) Adjustment of LED current from 200 mA to 1.05A at the 100 percent control input point in increments of 1 mA.
 - c) Adjustment for operating hours in lumen-maintenance drivers to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the luminaire and deliver up to 20 percent energy savings early in the life cycle.
- 14) Driver: UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
- 15) Drivers shall have a rated life greater than or equal to 150,000 hours.
- 16) LED engine must be compatible with type of driver and perform within the dimming range specified in the Lighting Equipment Schedule. Coordinate prior to submission of shop drawings.
- 17) If driver is remote-mounted, provide maximum allowable distances for secondary wire runs to luminaires. Driver shall be housed in NEMA enclosures so rated for the power supply and located in code-compliant, sound-isolated, well-ventilated,

easily accessible areas. Size wire according to run length and LED Manufacturer's size and distance-of-run requirements and in accordance with code requirements.

18) LED power supplies shall be suitably sized to accommodate the LED array consistent with industry standards, including IEC standard 60929 Annex E.

19) Driver shall be available in an all metal-can construction for optimal thermal performance.

20) Driver shall be provided with integral color-coded connectors.

21) Provide with mounting hardware as required.

c. Light Quality.

1) Over the entire range of available drive currents, driver shall provide step-free, continuous dimming. Driver shall respond similarly when raising.

a) The luminaire shall be capable of continuous dimming over a range of 100 percent to 10 percent of rated lumen output unless otherwise noted on Lighting Equipment Schedule.

(1) Driver must be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.

2) Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels.

3) Drivers to track evenly across multiple fixtures at all light levels and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.

4) Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index. At all points within the dimming range from 100 to 0.1 percent, luminaire shall have:

a) LED dimming driver shall provide continuous step-free, flicker-free dimming similar to incandescent source.

b) Flicker index shall be less than 5 percent at all frequencies below 800 Hz.

d. Control Input.

1) 4-Wire (0V to 10V DC Voltage Controlled) Dimming Drivers.

a) Must meet IEC 60929 Annex E for General White Lighting LED drivers.

b) Connect to devices compatible with 0V to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each control output based on voltage drop and control capacity.

c) Must meet ESTA E1.3 for RGBW LED drivers.

d) Driver shall utilize fully isolated 0V to 10V control inputs. Input shall be protected from line voltage miswire and shall be immune and output-unresponsive to induced AC voltage on the control leads.

E. Branch Circuit Emergency Lighting Transfer Switch:

1. Shall work in conjunction with an auxiliary generator or central inverter system to power designated lighting loads up to 20 A regardless of local switch position.

2. UL 1008 Listed to transfer a single 20 A circuit at 120V or 277V.

3. Switch can be used to:

a. Transfer a lighting load from normal power to generator or central inverter system power when normal power is lost.

b. Bypass a wall switch to allow generator- or central inverter system-supplied lighting loads to energize when normal power is lost.

c. Bypass a dimming panel and prevent backfeed to allow lighting to energize at full brightness when normal power is lost.

d. Bypass most dimming controls using an auxiliary relay contact.

4. Automatically transfers load back to normal power upon restoration of power.

5. Switch shall consist of relay switching circuitry, a test switch, a normal power indicator light and an alternate power indicator light contained in a single enclosure.
6. Provide ETC Model No. SC1008 or equal.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate luminaire mounting and trim type with architectural reflected ceiling plans, suspended ceiling grid and ceiling tile specification, and room finish schedules prior to submission of shop drawings.
 1. Advise Architect of any discrepancies. Failure to do so will result in correction at no additional cost to Owner.
- B. Coordinate required above-ceiling clearances of recessed luminaires with ductwork and piping.
 1. In exposed ceiling areas, coordinate luminaire locations, mounting heights, and supports with other trades.
- C. Coordinate, review, and approve fixture locations shown on acoustical ceiling shop drawings prior to submission.
 1. Notify Architect of any discrepancies with lighting plans and review coordinated ceiling shop drawing review comments.
- D. Coordinate lighting control devices with fixture power supplies and drivers. Advise Architect of discrepancies prior to submission of shop drawings. Failure to do so will result in correction at no additional cost to Owner.

3.2 INSTALLATION

- A. Strictly follow the manufacturer's directions for installation and assembly of lighting equipment. Luminaire installation shall include suitable lamps and required equipment, materials, parts, attachments, devices, hardware, cables, supports, frames, and brackets necessary for complete and fully operating installation.
- B. Locate luminaires in accordance with architectural reflected ceiling plans.
 1. Where field conflicts exist, coordinate relocation of equipment with Lighting Designer.
- C. Mount luminaires at heights indicated in Section 26 00 10 and as indicated on drawings. Where field conflicts exist, or mounting height is not stated, coordinate with Lighting Designer.
- D. Verify structural support to ensure luminaires are supported to maintain level and alignment.
- E. Support luminaires weighing more than 55 pounds directly from structure with approved hangers.
- F. Ground luminaires per NEC Article 410.
- G. Provide exit sign at exit locations, with mounting type, number of single or double faces, and directional arrows as required for exiting.
 1. Where exit signs are pendant mounted, provide manufacturers pendant mount stem kit.
 2. Provide proper structural support for junction box and exit sign.
- H. Align horizontally positioned fluorescent lamps or LED circuit boards of luminaires within a single room in same direction unless indicated otherwise. Align the luminaires so that the horizontal bar or element within the luminaire is parallel to the long axis of the space unless otherwise noted. Orientation of luminaires within similar spaces shall remain consistent.
- I. Seal luminaires for wet locations (i.e., knock-outs, pipe, and wire entrances) to prevent water wicking.
- J. Luminaire finishes which are disturbed in any way during construction shall be touched up or refinished in a manner satisfactory to the Architect and which does not void warranty.

- K. Install reflector cones, louvers, baffles, lenses, trims, and other decorative elements after completion of ceiling tile installation, plastering, painting, and general cleanup.
- L. Recessed Luminaires:
1. Provide mounting accessories as required for field conditions. Coordinate above ceiling conditions with other trades.
 2. Verify mounting details for each space; provide correct luminaire flange type and finish for each installed ceiling system.
 3. Support luminaire independently from ceiling system so there is no deflection of ceiling system caused by luminaires.
 4. Suspended Grid Ceilings:
 - a. Fasten luminaires attached to suspended ceiling systems with earthquake clips, each capable of supporting the weight of the luminaire and supported with 12 GA minimum steel wires connected to structure.
 - b. Luminaires attached to suspended ceiling systems for alignment only shall have a minimum of two 12 GA minimum steel wires connected on diagonal opposite corners connected to structure.
 - c. Additional seismic requirements:
 - 1) For installations located in seismic design categories C, D, E or F, provide the following supplementary supports based on the weight of the individual luminaire:
 - a) Less than 10 pounds: provide one 12 GA minimum slack steel wire connected from the luminaire housing to structure.
 - b) Between 10 and 55 pounds: provide two 12 GA minimum slack steel wires connected from opposite, diagonal corners of the luminaire housing to structure.
 - c) Greater than 55 pounds: provide an independent support directly connection to structure (no slack wires are required).
 - 2) These requirements are in addition to the supplementary hanger wires connected to the ceiling suspension system within 3 inches of each corner of each light fixture installed in categories D, E, or F.
 - d. Locate luminaires in exact center of tile and align linear luminaires with edge of ceiling grid unless indicated otherwise. Relocate misplaced luminaires and replace damaged ceiling materials.
 - e. Support downlights and exit signs with rails spanning between runners of suspension system.
 5. Gypsum Wallboard Ceilings:
 - a. Support troffers in gypsum board ceilings from structural framed openings with adjustable lugs on side of luminaire or yoke mounting as recommended by luminaire manufacturer.
 - 1) Where structural framed openings are not provided, luminaires must be independently supported from structure.
 - 2) Additional seismic requirements:
 - a) For installations located in seismic design categories C, D, E or F, provide the following supplementary supports based on the weight of the individual luminaire:
 - (1) Less than 10 pounds: provide one 12 GA minimum slack steel wire connected from the luminaire housing to structure.
 - (2) Between 10 and 55 pounds: provide two 12 GA minimum slack steel wires connected from opposite corners of the luminaire housing to structure.
 - (3) Greater than 55 pounds: provide an independent support directly connection to structure (no slack wires are required).

- 3) Suspended grid systems for gypsum board ceilings are not approved structural support systems for luminaires. Refer to mounting requirements for luminaires in suspended grid systems.
 - b. Support downlights and troffers in metal pan and gypsum board ceilings from plaster frames.
 - c. Provide access panels for recessed luminaires that require access for maintenance when such access is not provided for in design of luminaire.
 - 1) See Section 26 00 10.
 - d. Coordinate trimless or flangeless luminaires with other trades to achieve a trimless or flangeless installation.
 - 1) Provide a level 5 finish at drywall or plaster ceilings and walls unless otherwise directed by Architect.
 6. Use unwired or pre-wired luminaires as required.
 - a. Do not use pre-wired luminaires for through-wiring unless UL approved for the purpose.
 7. Wherever recessed luminaires are installed in insulated ceiling systems, it is the responsibility of the Contractor to construct above-ceiling enclosures around non-insulation-contact-rated equipment to provide at least 3 inches of airspace on each side of the luminaire.
 8. Trims shall fit plumb and flush with ceiling or wall surface.
 9. There shall be no light leak around interface between lens door or holder trim flanges and ceiling or wall.
 10. Field-apply silicone sealant between luminaire housing flange and hard ceiling. Application of sealant shall not prohibit opening of door frame or servicing of luminaire.
- M. Surface-Mounted and Pendant-Hung Luminaires:
1. Attach surface-mounted lighting luminaires to ceiling system with positive clamping devices that completely surround supporting members.
 - a. Attach safety wires between clamping device and adjacent ceiling hanger or to structure above.
 - b. Do not exceed design carrying capacity of supporting member for luminaire load.
 - c. Additional seismic requirements:
 - 1) For installations located in seismic design categories C, D, E or F, provide the following supplementary supports:
 - a) Support pendant-hung lighting luminaires directly from structure above, using 9 GA steel wire, without relying on ceiling suspension system for support.
 2. Pierce ceiling material for hangers and outlet boxes as required.
 3. Do not remove ceiling material above surface-mounted luminaires.
 4. Hang luminaires plumb with continuous rows in alignment.
 5. Unless otherwise noted, suspend luminaires in each room or area at same height regardless of varying clear height conditions.
 - a. Provide stem lengths as required.
 - b. The canopy portion of a pendant-hung luminaire installed in a finished space with an exposed-to-structure ceiling shall be installed directly to the bottom of the structural deck unless otherwise noted on the plans. Extending Unistrut, all-thread or similar means from the exposed deck down to a lower mounting height in order to suspend the box/canopy is not acceptable. Notify Engineer immediately if on-site conditions will result in a mounting conflict.
 6. Cord of pendant-hung fixtures must enter directly into approved wiring box without passing through plenum, in accordance with NEC.
 7. Provide suspended luminaires with flexible cord.
 - a. Flexible cord shall connect to a junction box located directly above luminaire feed point.

- b. Flexible metal conduit and luminaire whips are not allowed for suspended luminaires.
 - c. Trim cords to length and attach to suspension cable at regular intervals.
 - d. Do not coil flexible connections.
 - 8. Surface or pendant luminaires mounted end-to-end shall have flat end caps to assure flush alignment and shall be UL listed for through wiring.
 - 9. In exposed ceiling areas, install drivers and auxiliary equipment non-integral to luminaire in accessible, permanently installed NEMA-rated metal cabinets or housings. Field paint exposed cabinets or housings to match adjacent surfaces.
 - 10. Provide pendant-hung cylinder luminaires with swivel hangers which allow luminaire to swing in any direction but not permit stem to rotate.
 - 11. In mechanical, electrical and storage spaces, pendant-mounted luminaires, not in continuous rows, shall be supported by conduit or metal channel, similar to Unistrut, and All Thread.
 - a. Pendant-mounted luminaires in continuous rows shall be fastened to each other or mounted on continuous metal channel.
 - b. Provide alignment clips on linear luminaires mounted in continuous rows.
 - 12. Contractor shall provide and/or coordinate additional bracing in wall or above ceiling as required to support fixture in accordance with manufacturer's recommendations.
- N. Continuous Luminaire Patterns:
- 1. Fasten sections together for continuously aligned appearance, with no dimpling or light leakage.
 - a. Provide end extensions where required.
 - 2. Where luminaires run continuously around inside or outside corners, provide prefabricated illuminated corner pieces.
 - a. Run luminaire lenses, baffles, or louvers continuously with luminaire.
 - b. Miter or fan at corners as directed.
 - 3. Where lenses are used, open gaps shall not be visible.
 - a. Solid-state luminaires shall utilize mitered or rabbited lenses to prevent direct view of modules.
 - b. Maximum visible gap between the edge of lens and the end of luminaire trim is 1/16 inches 1.6 mm, and not allow direct view of solid state modules.
 - 4. Only where continuous runs do not end at a wall or fascia, provide a finished end plate, with no visible holes and concealed fasteners.
 - 5. Provide a continuous light appearance over total length of assembly.
 - a. The luminaire shall run continuously wall-to-wall or wall-to-corner without a gap at either end of the fixture when located adjacent to a wall or corner. The maximum permitted non-illuminated length at either end shall not exceed 6 inches.
 - 6. It is the responsibility of the Contractor to provide field held dimensions to the luminaire manufacturer. Field held dimensions shall be used to produce shop drawings. The contractor is responsible for the accuracy of the dimensions used.
 - 7. Cove luminaires in architectural coves shall be installed continuously with no visible gaps between luminaires.
 - 8. Coordinate installation and requirements of undercabinet luminaires with casework installation.
 - a. Provide separate segments of luminaires if luminaires cannot run continuously beneath cabinet.
 - b. Conceal wiring and conduit to luminaires.

3.3 COMMISSIONING

- A. Coordinate lighting operations, including support from Luminaire and Controls Manufacturers, with commissioning and controls.

- B. Synchronize fully functional lighting and lighting controls systems to address lighting operation in complete and code compliant manner.
- C. Provide documentation related to commissioning, including record drawings identifying luminaire control loops and addresses with respect to specific luminaire types and Initial Preset Schedule Spreadsheet.

3.4 ADJUSTABLE FIXTURES

- A. Aiming shall occur upon Substantial Completion of project including, but not limited to, installation of artwork, millwork, furniture, and plantings.
- B. Aim adjustable fixtures as directed. Make final adjustments in presence of Lighting Designer.
- C. Perform this work at night, outside of normal working hours, with no light from stray sources.
- D. Use light meter to obtain as even a distribution as possible.
- E. Aiming shall occur upon substantial completion of project including, but not limited to, installation of artwork, millwork, furniture, and plantings.
- F. Coordinate a time with Architect and Owner, to make final adjustments to aiming.
- G. Provide ladders, scaffolding, lifts, and tools required for accessing and aiming fixtures, and coordinate this activity based on site availability of Lighting Designer.

3.5 ADJUSTING, RELAMPING AND CLEANING

- A. Perform final focusing of adjustable luminaires in presence of Owner's Representative, including times outside regular working hours. Furnish ladders scaffolding and rigging, as required, for focusing and adjustment of luminaires.
- B. Replace inoperable luminaires prior to final acceptance.
- C. Replace LED modules and LED arrays if any individual module is not properly functioning.
- D. Replace noisy and malfunctioning luminaires prior to final acceptance.
- E. Replace luminaires, drivers, or control devices where necessary to eliminate strobing and flicker.
- F. Align luminaires and remove paint splatters, dirt, and debris.
- G. Touch up any visible damages to luminaire finish.
- H. Wipe clean luminaire reflectors, lenses, and housings after installation.
- I. Install luminaires with caution to avoid fingerprints or smudges on surfaces of louvers and downlight reflectors.
 - 1. Use cleaning materials and methods that will not damage finish.
 - 2. Where fingerprints or smudges cannot be adequately removed, replace affected luminaire.
- J. Install architectural cove luminaires after cove has been painted.
 - 1. Vacuum construction debris from cove to ensure a dust-free reflector surface prior to date of Substantial Completion.

3.6 SPECIAL PROTECTION

- A. Remove protective covers immediately prior to date of Substantial Completion.

3.7 CLOSEOUT ACTIVITIES

- A. Refer to Section 01 81 33 - Cyber-Security Requirements for cyber security related closeout requirements.

3.8 FIELD MODIFICATIONS STOCK

- A. To facilitate the addition of extra exit signs due to unforeseen deficiencies in satisfying life safety egress requirements, provide the following:

1. 5 percent of each exit sign type.

END OF SECTION

SECTION 26 56 00
SITE LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Exterior Lighting, as indicated, in accordance with provisions of Contract Documents.
- B. Section includes exterior luminaires, drivers, poles, concrete bases, accessories, and grounding.
- C. See Section 26 51 13 for building-mounted luminaires and accessories.

1.2 SUBMITTALS

- A. Specifier reserves the right to reject submitted product(s) for any reason.
- B. Shop drawing submittals shall allow sufficient time for potential disapprovals, re-submittals, ordering, fabrication, delivery, and installation in compliance with overall Project Schedule.
- C. Review of shop drawings and product data does not waive the Contractor of their obligations.
- D. Pre-Approval:
 - 1. Prior to submitting Shop Drawings and Product Data, submit manufacturer and model number proposed for each luminaire specified.
 - 2. Submittals must be received by A/E at least 30 calendar days before scheduled ordering of luminaires.
 - 3. Actual date of pre-approval submittals shall be determined by C/M and shall allow sufficient time for potential disapprovals, re-submittal for pre-approval, ordering, Shop Drawing and Product Data preparation, submittal for A/E review(s), fabrication, delivery, and installation, all in compliance with overall Project Schedule.
 - 4. Shop Drawings and Product Data, if submitted without pre-approval, or not compliant with pre-approval comments, will be returned without review.
- E. For the purpose of the evaluation of the entire lighting package, the unit price for every piece of lighting equipment shall be provided along with the bid. Manufacturer and catalog number shall be listed along with the price. Fixed lot or packaged pricing and/or unidentified Manufacturer(s) are not acceptable reasons to obscure unit pricing.
 - 1. The unit pricing provided shall not serve as the basis for change order pricing, but shall be used to assist the Owner in making value management decisions, if necessary.
- F. Provide a copy of this entire Building Lighting Specification Section, Lighting Equipment Schedule, Lighting Plans, Lighting Details, and Lighting Controls information to the listed and optional manufacturers as well as the manufacturers' local representatives for use in preparing their bid.
- G. Shop Drawings:
 - 1. Details of special construction, accessories, and/or finishes.
 - 2. Details for poles and pole bases.
- H. Product Data:
 - 1. Identify luminaires by Lighting Equipment Schedule designation. For each luminaire, provide the following:
 - a. Name of manufacturer, cutsheet, catalog number, clearly indicating delivered lumens, color temperature, input wattage, color rendering index (CRI), and rated life.
 - b. LED Driver:
 - 1) Driver manufacturer and model number

- 2) Rated life
 - 3) Product dimensions
 - 4) Driver type (0-10v, constant current, constant voltage, etc.)
 - 5) If applicable include lumen management protocols.
 - 6) Dimming range and control compatibility list.
 - 7) Wiring diagrams.
 - c. Photometric data submitted collected by an independent testing laboratory. Indicate optical performance developed using methods of the Illuminating Engineering Society (IES) as follows:
 - 1) Candlepower data presented graphically and numerically, in 10 degree (or smaller) increments.
 - 2) Develop data for up and down quadrants normal, parallel, and at 45 degrees to lamp if light output is asymmetric.
 - 3) Zonal lumens stated numerically in 10 degree increments as above.
 - 4) Fixture efficiency.
 - d. Where color quality is important for luminaires with CRI greater than or equal to 90, include Color fidelity (R_f) and Color Gamut (R_g).
 - e. Total Harmonic Distortion (THD).
 - f. Transient Surge suppression.
 - g. Upon request, provide calculations performed in AGi32, utilizing Light Loss Factor approved by Lighting Designer, for submitted substitution evaluations.
- I. Samples:
1. Submit a minimum of two 4 by 6 inches samples of each type of finish specified, on metal to be used.
 2. Fixture Samples:
 - a. Fixture samples are required for products not identified as design standard or as an acceptable substitution.
 - b. Samples shall be complete working units with 120V cord and plug, and other accessories, ready for operation.
 - c. After review and approval, transfer sample luminaires to job site for comparison with luminaires delivered for installation.
- J. Project Information:
1. Manufacturer's installation instructions.
- K. Contract Closeout Information:
1. Warrant LED drivers for five years from Date of Substantial Completion. Include labor allowance for full cost of ballast installation.
 2. Warrant the luminaire's LED modules to be free from defect in operation for five years from the date of Date of Substantial Completion.
 3. As long as the luminaire has been operated within the rated voltage range, the Contractor is responsible for the cost of the materials and labor necessary to repair or replace the luminaire within one year from substantial completion.
 4. Warrant the luminaire's finish for three years from the date of Substantial Completion.
 5. It is the responsibility of the contractor to manage all warranty issues that may arise.
 6. Operating and Maintenance Manuals.
 - a. See Section 01 78 23

1.3 QUALITY ASSURANCE

- A. Luminaires shall be listed with nationally recognized testing laboratory, including but not limited to UL, CSA, ETL, compliant with UL 1598 and UL 8750 standards.

- B. Materials and installations shall be in accordance with the latest revision of the National Electrical Code and any applicable Federal, State, and local codes and regulations.
- C. Luminaires shall comply with current ANSI, CBM, ESTA, FCC, IEC, IEEE, IESNA, NEMA, NFPA, and UL standards and practices.
- D. Where the Lighting Equipment Schedule identifies multiple fixture types using the same manufacturer and product family, the manufacturer and product family shall remain consistent for all fixture types. Consistency is required for color and quality of light, finishes, aesthetics, and maintenance needs.
 - 1. Mixing and matching manufacturers for the same product family is not acceptable.
 - 2. Mixing and matching manufacturers across multi-phased projects is unacceptable, except where products have subsequently been discontinued or redesigned in performance, appearance, or size.

1.4 WARRANTIES

- A. Manufacturer warranties shall be from the date of Substantial Completion and include labor allowance for field servicing of equipment.
 - 1. Warrant the luminaire and all components to be free from defect in operation or finish for a minimum of five years.
 - 2. Warrant the driver for a minimum of five years.
 - 3. LED warranty shall include all modules without a percentage fail threshold.
 - 4. LED warranty shall include color consistency, lumen maintenance.
- B. Contractor is responsible for cost of materials and labor necessary to repair or replace luminaires within one year of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Luminaires and Poles:
 - 1. Base:
 - a. As indicated on Lighting Equipment Schedule.
 - 2. Optional:
 - a. As indicated on Lighting Equipment Schedule.
 - 3. Use catalog numbers listed as a guide only. Follow modifications and other requirements shown or specified.
- B. Drivers:
 - 1. Osram Sylvania.
 - 2. Philips Advance.
 - 3. Mean Well.
 - 4. eldoLED.
 - 5. Hatch.
 - 6. Moons.
- C. Other manufacturers desiring approval comply with Section 01 61 00.
- D. Provide unit price for every piece of lighting equipment with bid.

2.2 MATERIALS MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Luminaire Housings:

1. Resistant to corrosion and thermal and mechanical stresses encountered in normal application.
 2. Provide accessory equipment such as starters, transformers, sockets and lampholders, approved by UL and ETL, unless otherwise noted.
 3. Enclosures:
 - a. Complete with closed cell neoprene gaskets to form weatherproof assembly with IP65 rating unless specified otherwise in Lighting Equipment Schedule.
 - b. Baffles and gaskets: as required to prevent light leakage.
 4. Castings:
 - a. Uniform quality, free of imperfections affecting strength and appearance.
 - b. Exterior surfaces not receiving a finish coating shall be smooth and shall match adjacent surfaces.
 - c. Apply at least one coat of clear methacrylate lacquer unless a factory painted finish is specified.
 5. Housing:
 - a. Weatherproof; hinged and gasketed access door with catch; slip-fitter with set screws.
 6. Hardware:
 - a. Stainless steel or hot dip galvanized steel, except as noted otherwise.
 7. Mounting Accessories for Recessed Housings:
 - a. Coordinate mounting accessories and housing flange with ceiling system.
 - b. Provide seismic clips and mounting accessories as required.
 - c. Provide non-ferrous or rust-proof frames.
- B. Poles and Accessories:
1. Metal Poles:
 - a. Round, seamless aluminum continuously welded to base; with 2 inches by 4 inches 50 mm by 100 mm grounding stud in shoe-base model.
 2. Shoe Base:
 - a. Bolt covers with tamper-proof stainless steel hardware.
 - b. Shoe base finish shall match pole finish.
 3. Assembly:
 - a. Designed to withstand wind loading of 100 MPH, with luminaires and brackets mounted.
 4. Anchor Bolts:
 - a. As recommended by pole manufacturer.
 - b. Provide anchor bolt templates, flat washers, lock washers, leveling shims, and hex nuts.
 5. Metal Pole Finish:
 - a. As specified on schedule.
 - b. Steel poles.
 - 1) Surface preparation.
 - a) The exterior steel surface shall be blast-cleaned to Steel Structures Painting Council Surface Preparation Specification No. 6 (SSPC-SP6).
 - 2) Interior coating.
 - a) Interior surfaces (pole shafts only) at the base end for a length of approximately 2.0 FT shall be coated with the same coating applied to the exterior.
 - 3) Prime coat.
 - a) High build epoxy powder. Prime coat shall be applied to an average dry film thickness (DFT) of 5 mils on the bottom 8 FT of the pole. The average dry film thickness shall be 3 mils above 8 FT and on the arms.
 - 4) Exterior coating.

- a) TGIC or urethane polyester powder, applied to an average dry film thickness of 3 mils.
 - c. Aluminum poles.
 - 1) Constructed of marine-grade aluminum alloy 6063.
 - a) Satin aluminum finish.
 - b) Thermoset powder coat finish.
 - (1) Pre-treatment: Chromate conversion coating.
 - (2) Primer: Epoxy powder primer, minimum 2.0 mils dry film thickness.
 - (3) Topcoat: Weather-resistant triglycidyl isocyanurate (TGIC) polyester thermoset powders that are electrostatically applied, oven cured and bonded to a minimum dry film thickness of 2.0 mils. Must pass a 1000 hour salt spray test.
 - (4) AAMA (American Architectural Manufacturers Association) 2604 super-durable coatings.
 - c) Anodized finish.
 - (1) Three year adhesion and corrosion warranty.
 - 6. Fuse Holders:
 - a. In-line waterproof fuse holder rated at 30 A, 600V, Bussman Limitron type, size rating 3-times load current.
 - 7. Ground Rods:
 - a. Copper, 8 FT length x 3/4 inches diameter.
 - 8. Circuit Identification:
 - a. Provide 3 inches by 1 inches 75 mm by 25 mm aluminum tag riveted to pole identifying building name, electrical distribution panel name, and circuit number.
- C. LEDs:
- 1. Quick-connect wiring for LED modules and arrays.
 - a. NEC compliant disconnecting means accessible to qualified persons servicing luminaire.
 - b. Field replaceable components.
 - 2. Color temperature specified shall be uniform for all LED products. Utilize 3000K color temperature, unless otherwise noted in Lighting Equipment Schedule.
 - a. Color temperature measurement shall have a maximum 4 SDCM on the MacAdam Ellipse for pole mounted luminaires.
 - b. Color temperature measurement shall have a maximum 3 SDCM on the MacAdam Ellipse for building mounted luminaires.
 - 3. Minimum color rendering index (CRI) of 80, unless otherwise noted in Lighting Equipment Schedule.
 - 4. LED light output and efficacy shall be measured in accordance with IES LM-79 standards.
 - 5. LED life and lumen maintenance shall be measured in accordance with IES LM-80 standards.
 - a. Rated minimum L70 life of 50,000 HRS.
 - 6. Individual LEDs shall be connected such that catastrophic loss or the failure of one LED will not result in light output loss of entire luminaire.
- D. Drivers:
- 1. LED Drivers.
 - a. Driver shall operate from 60 Hz input source of 120V through 277V with sustained variations of +/- 10 percent (voltage and frequency).
 - b. Driver output shall be regulated to +/- 50 percent across published load range.

- c. Driver input current shall have Total Harmonic Distortion (THD) of less than 20 percent when operated at nominal line voltage.
 - d. Driver shall have a Power Factor greater than 0.90.
 - e. Driver shall have a Class A sound rating.
 - f. Driver shall have an operating temperature of -40 deg C -40 deg F to +60 deg C +140 deg F.
 - g. Driver shall tolerate sustained open circuit and short circuit output conditions without fail and auto-resetting without need for external fuses or trip devices.
 - h. Driver output ripple current shall be less than 15 percent measured peak-to-average, with ripple frequency greater than 100 Hz.
 - i. Driver shall have integral common mode and differential mode surge protection of 3 kV.
 - j. Driver shall have integral thermal foldback to reduce driver power above rated case temperature to protect the driver if temperatures reach unacceptable levels.
 - k. Driver shall comply with NEMA 410 for in-rush current limits.
 - l. Driver shall incorporate an integral means of limiting surges to the LED's.
 - m. Driver shall not contain any Polychlorinated Biphenyls (PCB's).
 - n. Driver shall be Underwriter's Laboratories (UL) recognized Class 2 per UL 1310 or non-class 2 per UL 1012, as applicable.
 - o. Driver shall comply with ANSI C62.41 Category A for Transient protection.
 - p. Driver shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
 - q. The luminaire shall be capable of continuous dimming over a range of 100 percent to 5 percent of rated lumen output. Dimming shall be controlled by a 0-10VDC signal.
 - r. Control device must be compatible with type of driver and coordinated prior to submission of shop drawings.
 - s. If driver is remote-mounted, provide maximum allowable distances for secondary wire runs to luminaires.
 - t. Driver shall be provided with integral color-coded leads.
 - u. Driver shall be available in an all metal-can construction for optimal heat performance.
 - v. Provide with mounting hardware as required.
2. Coordinate drivers and control devices prior to submitting shop drawings.
- E. Luminaire shall be properly heat-sinked to assure LED junction temperature ratings are not exceeded. Manufacturer shall identify ambient operating temperature range for which product is warranted.
- 1. Secure LED modules and arrays with screws or clips to assure proper connection to heat sink while permitting field replacement.
- F. Luminaire shall include surge protection with a minimum rating of 6kV.
- G. Luminaires with adjustable beam angles shall have locking device to ensure aiming is not impacted by relamping or cleaning.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's directions for lighting equipment.
 - 1. Assemble and wire luminaires, with lamps, in such a manner to ensure correct operation and maintain integrity of sealed compartments.
 - 2. Do not expose interior of luminaire housings to precipitation or high humidity conditions that may trap moisture in housings.

B. Pole Luminaires:

1. Provide complete assembly consisting of luminaire, pole, and concrete base.
2. Install rigid steel conduit elbow in concrete base to lead wiring into pole base. Splice wires in base of pole, and train leads up pole to luminaire. Provide encapsulated splice kits for wiring in handholes, manholes and underground junction boxes.
3. Follow Section 26 00 10 for installation and coordination of concrete base and anchor bolts. Set poles plumb and secure. Face access door away from traffic. Install ground rod adjacent to pole base.
4. Coordinate pole height with luminaire mounting height and raised concrete base height to assure luminaire mounting height specified.
5. Install a fuse holder in each phase conductor feeding outdoor pole mounted lighting fixtures. Locate fuse holders in handholes of poles if applicable. Provide fuse holders to isolate overhead fixtures from total circuit if trouble should occur.
6. Install an in-line surge protector in pole-mounted luminaires without a 10 kA Maximum Peak Current Rating.
 - a. Clamping voltage: 320V.
 - b. Maximum energy: 430 Joules.
 - c. Maximum peak current: 10 kA (8/20 us standard wave).
 - d. Thermal protection: thermally protected transient over-voltage circuit.

C. In-grade Luminaires:

1. Follow manufacturer's written installation instructions exactly.
2. Document installation steps photographically.
 - a. Photographs shall be submitted to the Lighting Designer upon request.
3. Provide complete assembly consisting of luminaire and, if detailed on Drawings, a concrete base.
4. Wiring connections within below-grade wiring compartments shall be 100 percent waterproof. Utilize waterproof wire nuts and epoxy conductor penetrations as they exit underground conduits.
5. Provide pea gravel underneath housing for drainage as detailed within manufacturer's installation instructions or on Drawings.
6. Prior to sealing lens to luminaire housing, operate luminaire for a minimum of one hour without lens to create a vapor-free environment within the lamp compartment.
 - a. Any droplets of condensation observed on interior of lens once lens is affixed and sealed to housing will require entire installation sequence to be redone.

D. Install marking tape over each buried conduit.

1. See Section 26 05 33.

3.2 ADJUSTABLE FIXTURES

- A.** Aim adjustable fixtures as directed. Use light meter to obtain even distribution.
- B.** Make final adjustments in presence of Lighting Designer.
1. In general, perform this work at night with no light from stray sources.
 2. Isolate control zones during aiming.
- C.** Aiming shall occur upon substantial completion of project including, but not limited to, installation of paving and landscaping.
1. Provide ladders, scaffolding, or lifts required for accessing fixtures, and coordinate activity based on on-site availability of Lighting Designer.
- D.** Coordinate placement of landscape, hardscape, and artwork accent lighting with respective features.

E. Aiming shall occur at night, outside hours of daylight.

3.3 RELAMPING AND CLEANING

A. Replace inoperable LED modules and lamps with new prior to date of Substantial Completion.

B. Replace noisy and malfunctioning components/drivers prior to date of Substantial Completion.

C. Remove paint splatters, dirt, and debris.

1. Touch up any visible damages to luminaire finish.

D. Wipe clean luminaire reflectors, lenses, lamps, and trims, after installation.

1. Use cleaning materials and methods that will not damage finish.

3.4 SPECIAL PROTECTION

A. Retain protective covers throughout construction period and remove immediately prior to date of Substantial Completion.

END OF SECTION



DIVISION 27

COMMUNICATIONS



SECTION 27 05 01
COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. All labor, materials, tools, equipment, and services for Basic Materials and Methods for Communications Systems, as indicated, in accordance with provisions of Contract Documents to provide a full and operating communications system as described within Division 27 documents.
- B. Related Requirements: Include but are not necessarily limited to:
1. Section 07 84 00 - Fire Stopping
 2. Section 26 05 36 – Cable Trays
 3. Section 26 08 13 - Acceptance Testing
 4. Section 26 43 13 - Surge Protection Devices for Low-Voltage Electrical Power Circuits
 5. Section 27 10 00 - Structured Cabling

1.2 REFERENCES

- A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:
1. AMP NETCONNECT
 - a. Design Installer Agreement (ND&I).
 2. ASTM International:
 - a. A36/A36M - Standard Specification for Carbon Structural Steel.
 3. BICSI®
 - a. Telecommunications Distribution Methods Manual (TDMM).
 4. Code of Federal Regulations
 - a. Title 47 – Telecommunication.
 5. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
 - a. C2 – National Electrical Safety Code (NESC).
 6. ISO/IEC
 - a. 11801 Generic Cabling for Customer Premises.
 7. National Fire Protection Association® (NFPA)
 - a. 70 – National Electrical Code (NEC).
 8. TIA - Telecommunications Industry Association.
 - a. 526 - Standard Test Procedures for Fiber Optic Systems.
 - b. 526-7-A - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fiber-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement
 - c. 568.1 - Commercial Building Telecommunications Infrastructure Standard.
 - d. 568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 - e. 568.3 - Optical Fiber Cabling and Components Standard.
 - f. 569 – Telecommunications Pathways and Spaces.
 - g. 606 - Administration Standard for Telecommunications Infrastructure.

- h. 607 - Generic Telecommunications Bonding & Grounding (Earthing) for Customer Premises.
- 9. UL Solutions (UL).
 - a. 1863 - UL Standard for Safety Communications-Circuit Accessories.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Build-out of all telecommunications areas, entrance facility, building distribution, floor distribution and data/telecommunication outlets meeting the requirements of TIA.
- 2. Adherence to the design guidelines for installation of cabling in pathways and spaces as defined by TIA 569
- 3. All material, labor, tool, apparatus, and equipment to furnish completely working telecommunication cabling system.
- 4. Horizontal cables, backbone cables, cross connects, patch cords and data/telecommunication outlets.
- 5. Complete bonding of all systems components and cabinets to the telecommunications primary busbar and secondary busbar(s) in compliance with TIA 607.
- 6. Cable identification tags and system labeling shall match owners labeling conventions.
- 7. Coordination of the entire installation with all other divisions.

1.4 QUALITY ASSURANCE

A. Manufacturers:

- 1. Five continuous years, minimum, design and manufacture of the materials and equipment specified herein.
- 2. Products and equipment specified herein shall demonstrate that they have a quality assurance program in place to assure that the specifications are met. Include in the program, at a minimum, provisions for:
 - a. Incoming inspection of raw materials.
 - b. In-process inspection and final inspection of the cable product.
 - c. Calibration procedures of test equipment to be used in the qualifications of the product.
 - d. Recall procedures in the event that out of calibration equipment is identified.
 - e. Conform to government standards on quality assurance for applications within these specifications.
- 3. Material and equipment shall be new, and conform to grade, quality, and standards specified. Equipment and materials of the same type shall be a product of the same manufacturer throughout.
- 4. Equipment and materials of the type for which there are independent standard testing requirements, listings, and labels, shall be listed and labeled by the independent testing laboratory.

B. Installers:

- 1. The intent of these specifications is to ensure the systems described in this division are provided and installed by a technically experienced installer and, further, that the work is fully coordinated between the various systems by a single installer who is technically qualified as described herein.
- 2. Provide one of the following warranties:
 - a. Panduit, 25-year warranty.
- 3. Contractor shall submit proof of good standings with the above cable manufacturer warranty provider for the area/region of the project site.
- 4. Company specializing in installation of structured data/telecom cabling systems networks for a minimum of five years. Experience shall include the following:

- a. List at least 10 facilities of equal size, complexity and technical requirements utilizing the equipment submitted.
- 5. For each facility, list:
 - a. Name and location of facility.
 - b. Date of occupancy by Owner.
 - c. Owner's representative to contact and telephone number.
 - d. Construction Manager or General Contractor.
 - e. Architect.
- C. The successful cabling contractor must meet the following requirement:
 - 1. Must have a BICSI® certified RCDD review the drawings and meet with the Engineer and Owner representatives to discuss the project and to ensure that a structured cabling system is installed that provides a comprehensive telecommunications infrastructure.
- D. Where the installer is a branch office or other division of a larger organization, the qualifications of the branch office or other division shall meet the requirements of the Contract Documents. The installer incorporated under the same name, shall have successfully completed a minimum of three similar communications construction projects, both in scope and system types.
- E. The work of this division shall be managed and supervised by a full-time site communications superintendent who shall have the following qualifications:
 - 1. Experience in the applications engineering, installation, and supervision of similar construction projects both in scope and system type for a minimum of five years.
 - 2. Full time employee of the installer.
 - 3. Have a working knowledge of all systems installed under this division.
- F. Project superintendent shall be on site full time through duration of construction.

1.5 SUBMITTALS

- A. General:
 - 1. Provide complete submittal package (shop drawings/product data) per individual Division 27 specification section. Information contained within each submittal package shall only pertain to the referenced specification section.
 - 2. All submittal documents shall be submitted as pdf files. Drawings shall be produced on 30 inch x 42 inch format and product data shall be produced on 8.5 inch x 11 inch format.
- B. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. General:
 - 1) Drawing comparison:
 - a) Copy of drawing annotated where proposed system layout differs from designed system. Any differences to be explained.
 - b. Equipment enclosure wiring diagrams:
 - 1) Show a pictorial illustration of each equipment enclosure and/or terminal cabinet.
 - 2) Show the device nomenclatures exactly as shown on the single-line diagrams.
 - 3) Show the terminations including the wire numbers as shown on the single-line diagrams.
 - 4) Show wire colors for each terminal.
 - 5) For each wire exiting the enclosure, show the destination of the wire by floor, room number and the drawing number of the panel where the wire terminates.
 - c. Custom assembly diagrams:

- 1) For each custom assembly such as a receptacle assembly, control panel or the like, provide an assembly drawing illustrating the appearance of the assembled device including dimensions, assembly components and functional attributes.
- d. Drawing comparison:
 - 1) Copy of drawing annotated where proposed system layout differs from designed system. Any differences to be explained.

C. Product Data:

1. Cover page: Each product shall have a cover page with the following information:
 - a. Submitting Contractor's Logo.
 - b. Specification Section.
 - c. Specification Reference.
 - d. Manufacturer Name.
 - e. Manufacturer Part Number.
 - f. Brief Description.
2. Product Information: Include manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary) to clearly describe the product's characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements. Clearly indicate by highlighting, arrows or brackets precisely what is being submitted on and those optional accessories, which are included and those which are excluded. At a minimum, include products listed in Division 27. Include relevant products that will be provided, which are not listed in the specifications.
 - a. Do not include sheets that are not relevant to the product data or the project.
3. Specification comparison:
 - a. Copy of specification annotated on a line-by-line basis where proposed product or system differs from specified product or system. Any differences to be explained.
4. Product list for Division 27 equipment per specified system.
5. Description of system operation indicating overall system operation and purpose and capabilities of each component within system.
6. Cross reference data sheets to components shown on shop drawings.
7. Samples:
 - a. As indicated in each Division 27 section.
8. Testing Plans, Procedures, and Testing Limitations:
 - a. Testing procedure, apparatus, and limitations of apparatus and procedure, for:
 - 1) Source quality control activities indicated in each Division 27 section.
 - 2) Field quality control activities indicated in each Division 27 section.

D. Informational Submittals: Submit the following:

1. Certificates.
2. Manufacturer Instructions:
 - a. Serial numbers of items furnished, equipment nameplate information, and similar information for all items furnished.
 - b. Instructions for handling, installation, startup.

E. Qualifications Statements:

1. Manufacturer.
2. Installer.

F. Contract closeout information:

1. As indicated in each Division 27 section.

- 2. Operation and Maintenance Data
 - a. Contract closeout information:
 - 1) Refer to Section 01 78 23 - Operation and Maintenance Data.
- G. Maintenance Material Submittals: Furnish the items and submit documentation of delivery to and acceptance of such items by Owner or facility manager (as applicable) as defined in each Division 27 section.
- H. Cable performance test reports for each Category 6, Category 6A and fiber optic cable installed.
- I. Record Drawings: Refer to Section 01 78 39 - Project Record Documents.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to section 01 65 00 - Product Delivery Requirements and section 01 66 00 - Product Storage and Handling Requirements.

1.7 WARRANTY

- A. Manufacturer's Special or Extended Warranty:
 - 1. In addition to manufacturer's general, standard printed warranty, furnish any manufacturer's special warranty coverage. Special warranty shall remain in effect as indicated commencing on the date of Substantial Completion for the associated Work.

1.8 DEFINITIONS

- A. Work Area Outlet (WAO): Connecting device for termination of horizontal media outside of the telecommunications room.
- B. Pathway: Cable distribution systems consisting of but not limited to: raceways, racks, ladders, cable trays, conduits, j-hooks, distribution rings.
- C. Telecommunications Cables: Outside plant copper and fiber optic cabling, horizontal and backbone copper and fiber optic cabling, CATV/MATV coaxial cabling, copper and fiber optic audiovisual (AV) cabling, CCTV cabling, building environmental, building automation systems cabling, and security systems cabling.

1.9 OWNER'S PERSONNEL TRAINING

- A. Refer to Section 01 79 23 - Instruction of Operation and Maintenance Personnel
- B. Training
 - 1. Refer to Section 01 79 23 - Instruction of Operation and Maintenance Personnel

PART 2 - PRODUCTS

2.1 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Acceptable manufacturers:
 - 1. As noted in each Division 27 section.
 - 2. Other manufacturers desiring approval, Refer to section 01 62 00 - Product Options.
- B. Use UL labeled electrical materials where listing has been established for materials or devices in question.
- C. Structural steel for supports: ASTM-A36/A36M.
 - 1. Stainless steel members installed in all corrosive areas, including locations less than 10 miles from a saltwater source.
 - 2. Galvanize members installed in areas of high humidity or condensation.
 - 3. Furnish other members with shop coat of rust inhibiting primer.
 - 4. Shop fabricate for field assembly using bolts.

5. Minimize field welding.
6. Retouch primer and galvanizing after field welding.

2.2 EXTRA MATERIALS

- A. Furnish spare parts required in each Division 27 section.
- B. All spare parts shall be new and in original packaging from manufacturer.
- C. Ensure parts are packaged to protect from damage and to allow for easy storage.
- D. Provide inventory of all spare parts.

2.3 EQUIPMENT ENCLOSURE RATING

- A. Use equipment enclosures suitable for the environment.

PART 3 - EXECUTION

3.1 INSTALLATION OF COMMUNICATIONS INFRASTRUCTURE

- A. Provide access panels in any area where equipment is located which requires accessibility for service and/or maintenance.
- B. Do not change indicated sizes or configuration without written approval of Architect/Engineer.
- C. Conduit verification:
 1. Verify that all conduit is clear of foreign matter and substances prior to pulling of wire or cable.
 2. Apply a chemically inert conduit lubricant to all wire and cable prior to pulling. Do not subject wire and cable to tension greater than recommended by the manufacturer. Under no circumstances shall wire or cable be attached to any mechanical pulling device which exerts excessive force, shear or tensile.
 3. Secure all wire and cable runs vertically in conduit for continuous distances greater than thirty (30) feet at the vertical run terminations. Non-coaxial cables shall be secured by screw-flange nylon cable ties or similar devices. Symmetrical clamping devices with split, circular or other wire conforming, non-metallic bushings shall be provided for all other cables.
- D. Structured cabling systems shall not occupy the same conduit/raceway with any other system or power cables.
- E. Provide installation, including electrical connections, cable pulling, testing and interfacing of systems.
- F. Deliver materials and equipment to project and store in original containers or cartons, properly protected from elements.
- G. Execute all work described in this specification and shown on drawings and all work dependent upon, and necessary to, complete finish of the work so described or shown, in a skillful manner using materials best adapted to purposes where such work or material is not specifically mentioned.
- H. Painted Cables:
 1. Protect cabling from direct painting, Indirect painting or over-spray. Coordinate the paint and cable installation schedule with respective subcontractors. Painted cables shall be replaced at contractor's expense.
- I. Labeling:
 1. All labeling shall be in accordance with TIA-606-D requirements and Owner's labeling convention.

3.2 INSTALLATION OF EQUIPMENT

- A. Install all equipment and infrastructure in accord with manufacturer's recommendations.

- B. Provide all necessary anchoring devices and supports.
 - 1. Use structural supports suitable for equipment.
 - 2. Check loadings and dimensions of equipment with shop drawings.
 - 3. Do not cut, or weld to, building structural members.
- C. Verify that equipment will fit support layouts indicated.
 - 1. Where substitute equipment is used, revise indicated supports to fit at no additional expense.
- D. Arrange for necessary openings to allow entry of equipment.
 - 1. Where equipment cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves or other devices to allow later installation.
- E. Installation of communications equipment shall not proceed until the progress of construction has reached the following status in the area of installation:
 - 1. Temperature and humidity are controlled.
 - 2. Finished ceiling is installed.
 - 3. Walls are finish coated with final paint treatment.
 - 4. Floors are finished and sealed.
 - 5. Millwork is completely installed, approved and signed off.
- F. Equipment installed in areas where the previously described conditions have not been met and maintained after equipment installation shall be removed and either cleaned or replaced at the Architect/Engineer's discretion.
- G. Install equipment to permit easy access for normal maintenance.
 - 1. Maintain easy access to switches, pull boxes, panels, receptacles, etc.
 - 2. Relocate items which interfere with access.

3.3 CUTTING AND PATCHING

- A. Refer to section 01 73 29 - Cutting and Patching.

3.4 COORDINATION

- A. General:
 - 1. Coordinate the work with the other trades to assure that where this work interfaces to other trades, those interfaces are provided, complete and functional.
 - 2. Verify all field conditions.
 - 3. Positioning Members: Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Architect or Owner without additional expense.
 - 4. Interface Devices: Provide all items necessary to complete this work in conformance with the Contract Documents or the satisfaction of the Owner without any additional expense.

3.5 FINISHES (SEE DIVISION 09)

3.6 WIRING

- A. Cable and wire:
 - 1. Standard type available from more than one cable manufacturer.
 - 2. Manufacturer and installer are responsible for system performance.
- B. All cabling, wiring, conduits/raceways and equipment housings: In strict accordance with recommendations of equipment manufacturer; finish and color of all face plates as directed by Architect/Engineer.

- C. Furnish and install all wiring and cable for communications systems and perform all connections and equipment terminations.
 - 1. Check each cabling system run thoroughly for opens, shorts, faults, and other discontinuities.
 - 2. Test each system receptacle for continuity, ground condition, and voltage level prior to allowing plug-in of system equipment.
 - 3. All conductors from outgoing terminal blocks in control consoles, panels and/or systems equipment cabinets to devices controlled to be continuous.
 - a. No splicing of cabling allowed.
 - 4. Field device terminations to be per manufacturer's requirements.
 - a. Conductor to conductor connections to be fully insulated crimp on male/female tab type or pin and sleeve type.
 - b. No conical spring connectors to be used.
- D. Install communications systems cable in conduit 1 inch minimum, unless otherwise indicated.
- E. Boxes: Provide a 6-inch loop for all wire and cable routed through pull boxes or distribution panels. Cable loops and bends shall not be at a radius smaller than that recommended by the manufacturer. Enlarge pull boxes as necessary to accommodate this requirement.

3.7 FIELD QUALITY CONTROL

- A. Perform indicated tests to demonstrate workmanship, operation, and performance.
 - 1. Conduct tests in presence of Architect/Engineer, Owner and, if required inspectors of agencies having jurisdiction.
 - 2. Arrange date of tests in advance with Architect/Engineer, manufacturer and installer.
 - 3. Give minimum of 1 week notice to all inspectors.
 - 4. Furnish or arrange for use of electrical energy, steam, water, diesel fuel, or gas required for tests.
- B. Repair or replace equipment and systems found inoperative or defective and retest.
 - 1. If equipment or system fails retest, replace it with products conforming to Contract Documents.
 - 2. Continue remedial measures and retests until satisfactory results are obtained.
- C. Test equipment and systems as indicated for each item, unless otherwise recommended by manufacturer.

3.8 SYSTEMS OPERATIONAL TESTS

- A. Prior to the time of substantial completion, an operational test, witnessed by a representative of the Architect/Engineer and Owner, shall be held of each system comprising the total communications systems to determine full compliance with the contract drawings. Provide all personnel, equipment, instrumentation, and communication equipment and include all costs of testing in the contract.
- B. The installer shall certify in writing that the systems are installed in compliance with the manufacturer's recommendations, Refer to the requirements of the contract documents and are operating correctly. These written certifications shall be submitted to the Architect/Engineer and shall signify that the total communications system is operationally tested and ready for final acceptance testing by the Architect/Engineer.
- C. Final acceptance tests of the total communications systems shall be conducted as directed by the Architect/Engineer.
- D. It shall be the responsibility of the Installer to submit for the Architect/Engineer's approval, a proposed systems check list for use in final acceptance testing. This checklist shall consist of a list of individual tasks on a device-by-device basis, organized into logical groups per system being supplied. The checklist shall be submitted not later than 90 days prior to the scheduled

start of acceptance testing. Acceptance testing may not begin until the Architect/Engineer has approved the form and content of the acceptance checklist.

3.9 ADJUST AND CLEAN

- A. Inspect all equipment and put in good working order.
- B. Clean all exposed and concealed items.
- C. All equipment shall be clean and dust free.

3.10 PUTTING SYSTEMS IN OPERATION - START UP

- A. All systems shall be in satisfactory operation prior to final acceptance, at time agreed to by Owner and Architect/Engineer.
- B. Operate all systems in good working order for period of 10 working days prior to final acceptance testing.

3.11 DEVICE MOUNTING

- A. Dimensions are to center of device unless otherwise indicated.

END OF SECTION

SECTION 27 10 00

STRUCTURED CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for the structural cabling system such as:
 - a. Service entrance protection.
 - b. Cabinets, racks, frames, and enclosures.
 - c. Termination blocks and patch panels.
 - d. Cable management.
 - e. Rack mounted power protection and power strips.
 - f. Backbone cabling.
 - g. Horizontal cabling.
 - h. Patch cords.

B. Related Sections include but are not necessarily limited to:

1. Section 07 84 00 - Firestopping.
2. Section 10 14 06 - Identification Devices.
3. Section 27 05 01 - Basic Materials and Methods for Communications Systems.

1.2 REFERENCES

A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:

1. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
2. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
 - a. TIA 526-7 – Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
 - b. TIA 526-14-C – Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant.
 - c. TIA 568-0-E – Generic Telecommunications Cabling for Customer Premises.
 - d. TIA 568-1-E – Commercial Building Telecommunications Cabling Standard Part 1: General Requirements.
 - e. TIA 568-2-D – Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
 - f. TIA 568-3-D – Optical Fiber Cabling Components Standard.
 - g. TIA 569-E – Telecommunications Pathways and Spaces.
 - h. TIA-606-D Administration Standard for the Telecommunications Infrastructure.
 - i. TIA/EIA 604-2 – FOCIS 2 Fiber Optic Connector Intermateability Standard, Type ST.
 - j. TIA/EIA 604-3 – FOCIS 3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC.
 - k. TIA/EIA 604-10 – FOCIS 10 Fiber Optic Connector Intermateability Standard, Type LC.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers:

- a. See Specification Section 27 05 01 for additional requirements.
- 2. Installers:
 - a. Comply with TIA-569E Standard and the BICSI Telecommunications Distribution Methods Manual (TDMM) for the installation of Communication cabling.
 - b. See Specification Section 27 05 01 for additional requirements.
- B. Qualifications:
 - 1. Telecommunications Contractor:
 - a. Shall be regularly and professionally engaged in the business of the applications, installation, and testing of telecommunications systems and equipment.
 - b. Include three references of similar scope jobs completed in the last two years.
 - c. Supervisors and Installers shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level.
 - d. In lieu of BICSI Certification, Supervisors and Installers assigned to the installation of this system or any of its components shall have:
 - 1) A minimum of five years of experience in the installation of the specified copper and fiber optic cable and components.
 - 2) Factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products.
 - 2. Manufacturer:
 - a. Company specializing in manufacturing products specified in this Section with minimum 10 years documented experience in the manufacturing, assembly, and factory testing of components which comply with TIA-568-1-E, TIA-568-2-D, and TIA-568-3-D.

1.4 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Fabrication and/or layout drawings, sealed and approved by a Registered Communications Distribution Designer (RCDD):
 - 1) Layout of complete building per floor:
 - a) Building area boundaries, backbone systems and horizontal pathways.
 - 2) Building area drawings:
 - a) Drop locations and cable identifications in accordance with TIA-606-D.
 - 3) Telecommunications space drawings:
 - a) Telecommunication rooms plan views, pathway layout, mechanical/electrical layout, and cabinet, rack, backboard, and wall elevations.
 - 4) Typical detail drawings:
 - a) Faceplate labeling, faceplate types, and firestopping.
 - 2. Product Data:
 - a. Submittal data for all products specified in PART 2 of this Specification.
 - b. See Specification Section 27 05 01 for additional requirements.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Telecommunications Contractor and Installers qualifications.
 - b. Key Personnel qualifications.
 - c. Manufacturer qualifications.
 - 2. Test reports:
 - a. Testing plan and procedures.
 - b. Telecommunications cabling test results for all horizontal and backbone links.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. See Specification Section 27 05 01 for additional requirements.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. All Materials and equipment shall be:
 - 1. Appropriate for the intended use.
 - 2. Recognized as such by a Nationally Recognized Testing Laboratory (NRTL) such as Underwriters Laboratories (UL), ETL SEMCO (ETL), the Canadian Standards Association (CSA) or the American National Standards Institute (ANSI).
 - 3. NFPA 70 Compliant.
 - 4. Permitted by the Authority Having Jurisdiction (AHJ).
- B. All products shall be new, of the latest version at time of bid, and brought to the job site in original manufacturer's packaging. Used equipment and damaged materials will be rejected.
- C. Cable lubricants specifically designed for installing communications cable may be used as needed to reduce pulling tension when pulling cable into conduit.
- D. All copper products shall be from a single manufacturer so that a single performance warranty covers all applications on horizontal links/channel.
- E. See Specification Section 27 05 01 for additional requirements.

2.2 SUBSTITUTION POLICY

- A. This specification design is based on Panduit Copper Cable. As such, substitution of specified products must be submitted to, and approved by, Engineer of Record (EOR) in accordance with section 01 61 00 - Product Options. Any substitutions shall meet or exceed performance specified.

2.3 EQUIPMENT RACKS

- A. Floor mounted 2-post equipment racks shall be welded steel or aluminum relay racks with uprights to mount industry standard 19 inches components and equipment.
 - 1. Uprights shall be 3 inches deep channel, 1-1/4 inches wide, drilled and tapped 12 - 24 inches standard EIA pattern.
 - 2. Racks shall be provided with a standard top cross member, and predrilled base plate to allow floor fastening.
 - 3. Open frame equipment racks shall be 7 feet tall, 45U capacity.
 - 4. UL Listed.
 - 5. Load Capacity: 1500 pounds.
 - 6. Equipment mounting positions marked and numbered.
 - 7. Equipment racks shall be black powder coated.
 - 8. Panduit R2P or approved equivalent.
- B. Cable Management:
 - 1. Cable management shall be specifically manufactured for the purpose of routing cables, wires, and patch cords horizontally across 19 inches equipment racks.
 - a. Horizontal Cable Manager, Front Only, 1U x 3.5 inches deep: Panduit WMPFSE or equal.
 - b. Horizontal Cable Manager, Front Only, 2U x 3.5 inches deep: Panduit WMPFS1E or equal.

2. Cable management shall be specifically manufactured for the purpose of routing cables, wires, and patch cords vertically adjacent to equipment racks.
 - a. Vertical Cable Manager, PatchRunner, Front/Rear, 45U, 6 x 6 inch, Panduit PE2VD06 or equal.
 3. Cable management shall consist of ring or bracket-like devices with removable covers.
 4. Cable management shall mount to racks by screws and/or nuts and lock washers.
- C. Wall mounted rack
1. Front locking perforated door.
 2. 18U capacity.
 3. UL listed,
 4. Load Capacity: 300 pounds.
 5. Equipment mounting positions marked and numbered.
 6. Equipment racks shall be black powder coated.
 7. Panduit PZWMC18P.
- D. Rack Mount UPS
1. 1000VA monitored UPS
 2. Provide with APC Smart-Connect ethernet port
 - a. 8' input cord
 - b. Rack mounted
 - c. APC Part# SRT1000RMXLA-NC
- E. Relay Rack Grounding Strip.
1. Provide Vertical Grounding Strip on the rear of the Relay Rack (right vertical rail).
 2. Grounding Strip shall be same Rack Unit height as Relay Rack.
 3. Panduit RGS134-1Y or approved equivalent.

2.4 EQUIPMENT MOUNTING BACKBOARD

- A. Plywood backboards shall be provided on three adjacent walls of telecommunications spaces. (See drawings for details).
1. Void-free, interior grade A-C plywood, A-side mounted facing out, 3/4 inches thick, 4 FT x 8FT sheets.
 2. Plywood shall be painted on all 6 sides, including cut outs for outlets, with TWO coats of Fire-Retardant Paint, (White Color)
 - a. Coordinate painting of walls around plywood and ceiling before installation of telecommunications equipment and cabling.
 - b. Fire Retardant Paint: A premium quality intumescent fire-retardant paint; white in color.
 - 1) Manufacturers:
 - a) PPG; Speedhide Interior Fire Retardant Flat Latex.
 - b) Benjamin Moore & Co.; INSL-X Fire Retardant Paint 210.
 3. Mount Plywood 12 inches AFF.
 4. Bolts supporting Plywood to wall must be countersunk into wood, so that equipment can utilize all space of plywood.

2.5 COPPER PATCH PANELS

- A. Patch panels mounted in equipment racks with sufficient ports to accommodate all installed cable plus 25% spare:
1. Copper IDC Punchdown Patch Panel:

- a. 48-port modular jack (2U maximum) and 24-port modular jack (1U maximum), with rear mounted type 110 insulation displacement connectors.
- b. Panel shall have incoming cable strain relief and cable management guides.
- c. Jack pin/pair configuration shall be T568B.
- d. Jacks shall be unkeyed.
- e. Flat Patch Panels:
 - 1) Category 6, 48 Port 2U Flat: PANDUIT – DP48688TGY or equal.
 - 2) Category 6A, 48 Port 2U Flat: PANDUIT – DP486X88TGY or equal.

2.6 FIBER OPTIC ENCLOSURES

A. Manufacturers:

- 1. Corning is Basis of Design.
- 2. Acceptable Alternates to match Copper Connectivity Manufacturer:
 - a. Panduit.
 - b. Systimax.

B. Rack Mount Fiber Optic Enclosure:

- 1. Enclosure sized to accommodate 2, 4, 6 or 12 Fiber Adapter Panels.
- 2. Each Fiber Adapter Panel shall accommodate up to 6 duplex connectors (12 fibers).
- 3. Adapters shall be duplex LC style.
- 4. Adapters shall be unkeyed.
- 5. Provide dust covers for unused adapters.
- 6. Housing shall have cable management tray, incoming cable strain relief and cable management guides.
- 7. Size Enclosure as shown on drawings, Part Numbers:
 - a. CCH-01U Closet Connector Housing, 1RU, holds two CCH connector panels.
 - b. CCH-02U Closet Connector Housing, 2RU holds four CCH connector panels.
- 8. Fiber Optic Adapter Panels, shall hold 12 fibers or less, duplex style, LC style, Part Numbers:
 - a. CCH-CP-12-XX Closet Connector Housing (CCH) 12 Fiber Panel. (XX = adapter code).
 - 1) A9 = LC Duplex Adapters, Single Mode (OS2).

C. Wall Mount Fiber Optic Enclosure:

- 1. Enclosure shall accommodate 2, 4 or 6 Fiber Adapter Panels.
- 2. Each Fiber Adapter Panel shall accommodate up to 6 duplex connectors (12 fibers).
- 3. Adapters shall be duplex LC style.
- 4. Adapters shall be unkeyed.
- 5. Provide dust covers for unused adapters.
- 6. Housing shall have cable management tray, incoming cable strain relief and cable management guides.
- 7. Size Enclosure as shown on drawings, Part Numbers:
 - a. WCH-04P Wall Mountable Closet Housing, holds four CCH connector panels/cassettes.
- 8. Fiber Optic Adapter Panels, shall hold 12 fibers or less, duplex style, LC style, Part Numbers:
 - a. CCH-CP-12-XX Closet Connector Housing (CCH) 12 Fiber Panel. (XX = adapter code).
 - b. A9 = LC Duplex Adapters, Single Mode (OS2).

2.7 BACKBONE CABLING SYSTEM

A. Fiber Optic Outside Plant Cable (OSP):

1. Optical fiber backbone cabling system shall provide connections between Entrance Facilities / Equipment Room of one building to another.
 2. Size and configuration of fiber optic cables shall be as shown on Drawings.
 3. The buffered fibers shall be grouped in subunits of 6 or 12 fibers.
 4. Install all cables in accordance with project Drawings.
 5. Provide pull-tape in unused conduits.
 6. Leave pull-tape in used conduits for future cables is needed.
 7. Leave a 10-meter-long maintenance loop at each end of the link, neatly managed in the room containing Fiber Distribution Enclosure.
 8. Install the fiber backbone in continuous length between Fiber Distribution Enclosure (no splices permitted).
 9. Corning Indoor / Outdoor Rated Cable (Plenum):
 - a. 024E8F-31131-29 FREEDM One Cable, OFNP, TB 24F, 9µm singlemode (OS2)
- B. Fiber Optic Connectors:
1. Optical Fiber Connector Intermateability Standards (FOCIS) compliant with TIA/EIA 604-10 (LC), TIA/EIA604-3(SC and SC-APC), TIA/EIA 604-2(ST), Comply with TIA/EIA 568-3-D.
 2. No Epoxy/No Polish fiber optic connector.
 3. Field installed, Mechanical splice technology.
 4. Ceramic ferrule.
 5. Fiber Optic Connectors to match Fiber grade installed.

2.8 HORIZONTAL UTP CABLING

- A. Category 6 Unshielded Twisted Pair Cable – All Work Areas.
1. Panduit TX6 Category 6 UTP Copper Cable.
 2. In addition, Category 6 UTP Copper Cable must meet the following mechanical and performance criteria:
 - a. Exceeds requirements for TIA-562.2-D Category 6 and ISO 11801 2nd Edition Class E channel standards.
 - b. Exceeds requirements of TIA-568.2-D and IEC 61156-5 Category 6 component standards.
 - c. Meets requirements of IEEE 802.3af, IEEE 802.at and IEEE 802.bt for PoE applications.
 - d. Third party tested to comply with TIA-568.2-D.
 - e. Installation temperature range: 32 to 122 degrees F (0 to 50 degrees C).
 - f. Operating temperature range: -4 to 194 degrees F (-20 to 90 degrees C).
 - g. Cable shall be UL listed "LP" Limited Power for 0.05A. – LP (0.5A) shall be identified on the cable.
 3. Environmental Space:
 - a. Plenum (CMP), Diameter .224 inches (6.2mm) nominal.
 4. Cable Color:
 - a. Work Area Outlet Data/Voice – Blue.
- B. Category 6A High Performance Unshielded Twisted Pair Cable – All Work Areas.
1. Panduit TX6A UTP Copper with Vari-MaTriX Technology.
 2. In addition, Category 6A UTP Copper Cable must meet the following mechanical and performance criteria:
 - a. The UTP cable must include an electrically discontinuous metallic barrier (Vari-MaTriX) to suppress the effect of alien cross talk allowing 10 Gb/s transmission. The metallic barrier is not bonded/grounded. The continuity of the metallic barrier is to be partitioned

along the cables length into segments of varying length such that EMI immunity is uncompromised.

- b. Exceeds requirements for TIA-562.2-D Category 6A and ISO 11801 Class EA channel standards in a 4-connector configuration up to 100 meters.
 - c. Exceeds requirements of TIA-568.2-D and IEC 61156-5 Category 6A component standards.
 - d. Meets requirements of IEEE 802.3af, IEEE 802.at and IEEE 802.bt for PoE applications.
 - e. Third party tested to comply with TIA-568.2-D.
 - f. Installation temperature range: 32 to 140 degrees F (0 to 60 degrees C).
 - g. Operating temperature range CMP: -4 to 194 degrees F (-20 to 90 degrees C).
 - h. Operating temperature range CMR: -4 to 167 degrees F (-20 to 75 degrees C).
 - i. Cable shall be UL listed and identified on the cable:
 - 1) "CMP-LP (0.7A)" Limited Power rating of (0.7A).
- 3. Environmental Space:
 - a. Plenum (CMP), Diameter .250 inches (6.4mm) nominal.
 - 4. Cable Color:
 - a. Wireless Access Point – Green.

2.9 TELECOMMUNICATIONS OUTLETS

A. Faceplates.

- 1. Faceplates shall have the following attributes:
 - a. Be single-gang or double-gang.
 - b. Made by the same manufacturer as the jacks.
 - c. Supplied in colors and finishes coordinated with the Division 26 27 26 Wiring Devices.
 - d. Have the capability for integral labeling and identification.
 - e. Provide capacity for a maximum of:
 - 1) Six individual jacks for single-gang applications.
 - 2) Up to 12 individual jacks for double-gang applications.
- 2. Manufacturer:
 - a. Panduit CFPL4SY Classic Faceplate, Single Gang with Label, 4-port.
 - b. Panduit KWPY Wall Phone Plate, Single Gang.

B. Copper Jacks.

- 1. Category 6 UTP Jacks.
 - a. Install category 6 jacks at each workstation location and match in the TR at the patch panel.
 - b. Category 6 jacks at the work area shall be color:
 - 1) PANDUIT – CJ688TGBU (Work Area Outlet Data/Voice – Blue).
 - c. In addition, Category 6 Copper Jacks must meet the following mechanical and performance criteria:
 - 1) Exceed TIA-568.2-D Category 6 and ISO 11801 2nd Edition Class EA standards.
 - 2) Meets requirements of IEEE 802.3af, IEEE 802.3at and IEEE 802.3bt for PoE applications.
 - 3) Be 100% tested to ensure NEXT and RL performance and be individually serialized for traceability.
 - 4) Color-coded, keyed jack modules mechanically and visually distinguish connections to prevent unintentional mating with unlike keyed or non-keyed modular plugs accommodating more discrete networks.

- 5) Utilize patented enhanced Giga-TX TMTechnology for jack terminations which optimizes performance by maintaining cable pair geometry and eliminating conductor untwist.
 - 6) Have contacts plated with 50 micro inches of gold for superior performance.
 - 7) 3rd party certified to meet the mechanical endurance to the standard requirement of IEC 60512-99-001 for support of remote power applications with test current of 2 Amperes per conductor (for future PoE++ applications).
 - 8) Have guaranteed ability to be re-terminated a minimum of twenty times without measurable degradation of performance.
 - 9) Have range to terminate 4-pair, 22 – 26 AWG, 100 Ohm, solid or stranded twisted pair cable.
 - 10) Accept 6 and 8-position modular plugs without damage to conductor pins.
 - 11) Identified options that include optional labels and icons.
 - 12) Be compatible with Mini-Com [®] Modular Patch Panels, Faceplates, and Surface Mount Boxes.
 - 13) Have available optional RJ45 block-out device that blocks out unauthorized access to jack modules and potentially harmful foreign objects, saving time and money associated with data security breaches, network downtime, repair, and hardware replacement.
2. Category 6A UTP Jacks.
- a. Install category 6A jacks at each workstation location and match in the TR at the patch panel.
 - b. Category 6A jacks at the work area shall be color:
 - 1) PANDUIT – CJ6X88TGGR (Wireless Access Points – Green).
 - c. In addition, Category 6A Copper Jacks must meet the following mechanical and performance criteria:
 - 1) Exceed TIA-568.2-D Category 6A and ISO 11801 Class EA standards.
 - 2) Meets requirements of IEEE 802.3af, IEEE 802.3at and IEEE 802.3bt for PoE applications.
 - 3) Be 100% tested to ensure NEXT and RL performance and be individually serialized for traceability.
 - 4) Include MaTriX split foil tape to suppress the effects of alien crosstalk, allowing 10 Gb/s transmission even in high density 48-port, 1RU patch panels.
 - 5) Utilize patented enhanced Giga-TX TMTechnology for jack terminations which optimizes performance by maintaining cable pair geometry and eliminating conductor untwist.
 - 6) Meets TIA-1096-A contacts plated with 50 microinches of gold for superior performance.
 - 7) 3rd party certified to meet the mechanical endurance to the standard requirement of IEC 60512-99-001 for support of remote power applications with test current of 2 Amperes per conductor (for future PoE++ applications).
 - 8) Have available a high-volume “gun-style” optional termination tool (TGJT) that reduces termination time by 25% and is ideal for high volume installations.
 - 9) Have guaranteed ability to be re-terminated a minimum of twenty times without measurable degradation of performance.
 - 10) Have range to terminate 4-pair, 22 – 26 AWG, 100 ohm, solid or stranded twisted pair cable.
 - 11) Utilize a universal termination cap is color-coded for T568A and T568B wiring schemes for flexibility across installations.
 - 12) Accept 6 and 8-position modular plugs without damage to conductor pins.
 - 13) Identified options that include optional labels and icons.

- 14) Be compatible with Mini-Com ® Modular Patch Panels, Faceplates, and Surface Mount Boxes.
- 15) Have available optional RJ45 block-out device that blocks out unauthorized access to jack modules and potentially harmful foreign objects, saving time and money associated with data security breaches, network downtime, repair, and hardware replacement.

2.10 PATCH CORDS

- A. Supply patch cords equal to 1.1 times the number of cables terminated in the communication room(s).
 1. Provide for installed copper and fiber-optic systems.
 2. Length: 50% 5 feet, 50% 7 feet.
- B. Patch Cords, Copper:
 1. Assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at each end.
 2. Cable shall be label-verified.
 3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
 4. Patch cords shall be wired straight through; pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring.
 5. Patch cords shall be unkeyed.
 6. Patch cords shall be factory assembled.
 7. Patch cords shall match the color of the installed system.
- C. Patch Cords, Single Mode Fiber:
 1. Assemblies consisting of flexible, 9um/125um OS2 rated cable with duplex LC connectors at each end.
 2. Cable shall be label-verified.
 3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
 4. Patch cords shall have crossover orientation.
 5. Patch cords shall be unkeyed.
 6. Patch cords shall be factory assembled.
 7. Patch cords shall be yellow.

2.11 DEVICE CABLES

- A. Work area outlet patch cords provided by owner.
- B. Provide 1 foot patch cords for camera locations.
- C. Device Category 6 Cables, Copper:
 1. Assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at each end.
 2. Category 6/Class E channel and component performance.
 3. Exceeds all TIE-568-2-D Category 6 and ISO 11801 Class E Edition 2.1 electrical performance requirements for all frequencies from 1 to 250 MHz.
 4. FCC and ANSI compliance: Meets TIA/EIA-1096-A; contacts plated with 50 micro inches of gold for superior performance.
 5. IEC compliance: Meets IEC 60603-7 c (UL) US listed: UL 1863, CSA standard C22.2.
 6. PoE compliance: Meets IEEE 802.3af and IEEE 802.3at for PoE application in bundle sizes up to 48 cables.

7. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
 8. Device cables shall be wired straight through; pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring.
 9. Device cables shall be unkeyed.
 10. Device cables shall be manufactured by the same connectivity manufacturer.
 11. Device cables shall match the color of the installed system.
 12. Panduit: UTP28SP15BL Cat 6 28 AWG UTP Patch Cord
- D. Device Category 6A Cables, Copper:
1. Assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at each end.
 2. Category 6A/Class EA channel and component performance.
 3. Exceeds all TIE-568-2-D Category 6A and ISO 11801 Class EA electrical performance requirements for all frequencies from 1 to 500 MHz.
 4. FCC and ANSI compliance: Meets TIA/EIA-1096-A; contacts plated with 50 micro inches of gold for superior performance.
 5. IEC compliance: Meets IEC 60603-7.
 6. PoE compliance: Meets IEEE 802.3af and IEEE 802.3 at for PoE application in bundle sizes up to 48 cables.
 7. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
 8. Device cables shall be wired straight through; pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring.
 9. Device cables shall be unkeyed.
 10. Device cables shall be manufactured by the same connectivity manufacturer.
 11. Device cables shall match the color of the installed system.
 12. Panduit: UTP28X15GR Cat 6 28 AWG UTP Patch Cord

2.12 LABELING AND COLOR CODING

- A. Labels shall be developed by the contractor and approved by the Owner.
1. Labels shall be machine printed on opaque or clear tape, stenciled onto adhesive labels.
 2. Handwritten labeling is unacceptable.
- B. Cable and Jacks:
1. Data: Blue.
 2. Wireless access point: Green

PART 3 - EXECUTION

3.1 INSTALLATION

- A. System components and appurtenances shall be installed in accordance with NFPA 70, manufacturer's instructions and as shown.
- B. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be coordinated with the local communications provider(s).
- C. Components shall be labeled in accordance with TIA 606-D.
- D. Penetrations in fire-rated construction shall be firestopped.
- E. Wiring shall be installed in accordance with TIA/EIA/ANSI Standards.
 1. Wiring, and terminal blocks and outlets shall be marked in accordance with TIA 606-D.

- F. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with AC power cables.
- G. Equipment Racks:
 - 1. Open frame equipment racks shall be bolted to the floor.
 - 2. Cable guides shall be bolted or screwed to racks.
 - 3. Racks shall be installed level.
 - 4. Bag and leave attached to the rack the spare hardware.
 - 5. Wall mounted racks shall be secured to the mounting surface to prevent fully loaded racks from separating from the mounting surface. Provide 3/4" A/C plywood backing same size as wall mounted rack paint with (2) coats fire retardant paint on all 6 sides.
- H. Rack Mounted Equipment: Equipment to be rack mounted shall be securely fastened to racks by means of the manufacturer's recommended fasteners.
- I. Terminal Blocks:
 - 1. Terminal blocks shall be mounted in orderly rows and columns.
 - 2. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks.
 - 3. Industry standard wire routing guides shall be utilized.
- J. Pathway System:
 - 1. Provide in accordance with TIA 569-E and NFPA 70.
 - 2. Provide conduits in accordance with 27 05 28 – Pathways for Communication Systems.
 - 3. Provide bonding of raceways and cable tray in accordance with TIA 607-D and NFPA 70.
- K. ENTRANCE FACILITIES
 - 1. Unlisted OSP cables entering building shall adhere to NEC Articles 770, 800, 820, 830 and 840 (or their successors') requirements for conduit if these cables extend beyond 50 feet from their point of entrance.
- L. Unshielded Twisted Pair Patch Panels:
 - 1. Patch panels shall be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 25% spares.
 - 2. Cable guides shall be provided above, below and between each panel.
- M. Fiber Optic Patch Panels:
 - 1. Patch panels shall be mounted in equipment racks with sufficient connectors to accommodate the installed cable plant plus 25% spares.
 - 2. Cable guides shall be provided above, below and between each panel.
- N. Backbone and Horizontal Distribution Cable:
 - 1. Cable pulling tension shall not be exceeded.
 - a. 110N (25 pounds-force) for copper cabling.
 - 2. Cable shall not be stressed such that twisting, stretching, or kinking occurs.
 - 3. Cable shall not be spliced.
 - 4. All backbone cable shall be installed in conduit or cable tray.
 - 5. All horizontal cable shall be installed in an appropriate telecommunications pathway.
 - 6. Cable shall not be run through structural members or in contact with conduits, pipes, ducts, or other potentially damaging items.
 - 7. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided.
 - 8. Cables shall be terminated; no cable shall contain unterminated elements.

9. Minimum bending radius shall not be exceeded during installation or once installed.
10. Only fabric hook and loop fasteners shall be used to wrap cables, 1/2 inches width minimum. Plastic or nylon cable ties shall not be used.

O. J-HOOK INSTALLATION

1. Provide velcro ties around J-hooks to secure cable.
2. Strategically place J-hooks to aid in routing at corners and at changes in height.
3. If cable tray is not used as a primary pathway, use 2-inch or larger J-hooks to support cable in primary pathways. Provide a second J-hook in a tiered or back to back configuration for each J-hook installed only when the quantity of outlets served from that primary pathway exceeds 40% of the manufacturer's rated capacity.
4. J-hooks used to support cable in secondary pathways can be 1-5/8 inches or larger. Provide a second J-hook for each J-hook installed only when the quantity of outlets served from that secondary pathway exceeds 40% of the manufacturer's rated capacity.
5. Provide J-hooks as required between discontinuous sections of cable tray.
6. Where multiple J-hooks are installed, place J-hooks back-to-back if possible; otherwise, stack J-hooks one above the other.
7. Install J-hooks at maximum of 5 foot intervals unless cable manufacturer requires different interval to maintain warranty. Unevenly space J-hooks to avoid standing waves on the cable.
8. Attach J-hooks to building structure.

P. Telecommunications Outlets:

1. Faceplates: As a minimum each jack shall be labeled as to its function and a unique number to identify cable link.
2. Cables:
 - a. Unshielded twisted pair cables shall have a minimum of 12 inches of slack cable loosely coiled into the telecommunications outlet boxes.
 - b. Minimum manufacturers bend radius for each type of cable shall not be exceeded.

3.2 TERMINATION

- A. Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles.**
1. Manufacturer's minimum bending radius shall not be exceeded.
 2. When there are multiple system type drops to individual workstations, relative position for each system shall be maintained on each system termination block or patch panel.
 3. Unshielded Twisted Pair Cable:
 - a. Each pair shall be terminated on appropriate outlets, terminal blocks, or patch panels.
 - b. No cable shall be unterminated or contain unterminated elements.
 - c. Pairs shall remain twisted together to within the proper distance from the termination as specified in the TIA/EIA/ANSI 568B Series.
 - d. Conductors shall not be damaged when removing insulation.
 - e. Wire insulation shall not be damaged when removing outer jacket.
 4. For cold weather installation bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating cable.
 5. Fiber Optic Cable:
 - a. Each pair shall be terminated with appropriate connectors.
 - b. No cable shall be unterminated or contain unterminated elements.
 - c. Armored fiber metallic sheathing shall extend from fiber enclosure to fiber enclosure. Terminate armor with armor connector using available enclosure knock-out.

- d. Ground armored fiber armor with grounding kit or MC connector suitable with manufacturer's recommendations.
- e. Provide a service loop of 20 feet at each end of each fiber optic cable. Place the location of the service loop such that the cable can be extended without interference of other systems such as mechanical systems, electrical piping, plumbing, racking, etc. Wind the loop such that the cable enters the rack and distribution hardware with minimal bends. Store the loop out-of-way and fasten to the wall with d-ring supports above cable tray

3.3 INNERDUCT INSTALLATION

- A. Provide innerduct for each non armored fiber optic backbone cables.
- B. Install innerduct prior to the installation of fiber optic cabling. Coordinate innerduct routing path through the pathway system.
- C. Provide innerduct for the entire length of the fiber optic cabling from termination enclosure to termination enclosure.
- D. Cut innerduct squarely using a saw or pipe cutters. De-burr cut ends.
- E. Replace damaged innerduct with new material

3.4 GROUNDING

- A. Signal distribution system ground shall be installed in the telecommunications entrance facility and in each telecommunication closet in accordance with TIA607-D.
 - 1. Equipment racks shall be connected to the electrical safety ground.

3.5 LABELING

- A. All cables will be labeled using color labels on both ends per TIA 606-D.
- B. All workstation and patch panel connections will be labeled using color coded labels per TIA 606-D.

3.6 TESTING

- A. Testing shall conform to the TIA/ANSI Standards for all test parameters.
 - 1. All test data sheets shall be downloaded from the tester, printed out and provided to the Owner.
 - 2. Provide Engineer and Owner with all test results as Electronic Documents (in portable document format, PDF files) by Electronic Means in accordance with Section 01 31 26 – Electronic Communication Protocols.
 - 3. Tester shall be capable of testing parameters for the warranted system.
- B. Materials and documentation to be furnished under this Specification are subject to inspections and tests.
 - 1. All components shall be terminated prior to testing.
 - 2. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.
- C. Unshielded Twisted Pair Tests:
 - 1. All metallic cable pairs shall be tested for proper identification and continuity.
 - 2. All opens, shorts, crosses, grounds, and reversals shall be corrected.
 - 3. Correct color coding and termination of each pair shall be verified in the communications closet and at the outlet.
 - 4. Horizontal wiring shall be tested from and including the termination device in the communications closet to and including the modular jack in each room.

5. These tests shall be completed, and all errors corrected before any other tests are started.
- D. Category 6 6A Circuits:
1. Perform Category 6 link tests in accordance with TIA-568-1-E and TIA-568-2-D. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.
 2. Cables which contain failed circuits shall be replaced and retested to verify the standard is met.
- E. Fiber Optic Cable:
1. Unless stated otherwise, tests shall be performed from both ends of each circuit per TIA-526-7 and TIA-526-14-C.
 2. All terminations shall be visually inspected for scratches, pits or chips and shall be reterminated if any of these conditions exist.
 3. Each link shall be tested for insertion loss using a light source similar to that used for the intended communications equipment.
 4. High-resolution Optical Time Domain Reflectometer (OTDR) tests shall be performed for each fiber.
 5. Scale of the OTDR trace shall be such that the entire circuit appears over a minimum of 80% of the X-axis.

END OF SECTION



DIVISION 28

ELECTRONIC SAFETY AND SECURITY



SECTION 28 05 01
COMMON WORK RESULTS FOR ELECTRONIC SECURITY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. All labor, materials, tools, equipment, and services for Basic Materials and Methods for Electronics Systems, as indicated, in accordance with provisions of Contract Documents to provide full and operating electronic security systems as described within the Division 28 documents.

B. Related Requirements: Include but are not necessarily limited to:

1. Section 01 81 33 - Cybersecurity
2. Section 03 30 00 – Cast-in-Place Concrete
3. Section 07 84 00 – Fire Stopping
4. Section 10 14 00 – Identifications Devices
5. Section 27 05 01 – Common Work Results for Communications Systems.
6. Section 28 10 01 - Access Control.
7. Section 28 20 01 – Video Surveillance System.

1.2 REFERENCES

A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:

1. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA).
 - a. ANSI/TIA-568.0-E - Generic Telecommunications Cabling for Customer Premises.
 - b. ANSI/TIA-568.1-E - Commercial Building Telecommunications Infrastructure Standard.
 - c. ANSI/TIA-568.2-D - Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 - d. ANSI/TIA-568.2-D-2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard Addendum 2: Power Delivery Over Balanced Twisted-Pair Cabling.
 - e. ANSI/TIA-568.3-D - Optical Fiber Cabling and Components Standard.
 - f. ANSI/TIA-568.3-D-1 - Optical Fiber Cabling and Components Standard Addendum 1: General Updates.
 - g. ANSI/TIA-569-E – Telecommunications Pathways and Spaces.
 - h. ANSI--607-D - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
 - i. ANSI/TIA-606-D Administration Standard for the Telecommunications Infrastructure.
 - j. ANSI/TIA-526 - Standard Test Procedures for Fiber Optic Systems.
 - k. ANSI/TIA-526-7-A – Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
2. BICSI®
 - a. Telecommunications Distribution Methods Manual (TDMM).
3. National Fire Protection Association (NFPA)
 - a. 70, National Electrical Code (NEC).

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Build-out of all security equipment areas and outlets meeting the requirements of ANSI/TIA+/EIA.
2. Adherence to the design guidelines for installation of cabling in pathways and spaces as defined by ANSI/TIA/EIA 569
3. All material, labor, tool, apparatus, and equipment to furnish completely working security cabling system.
4. Horizontal cables, backbone cables, cross connects, patch cords and security outlets.
5. Complete bonding of all systems components and cabinets to the telecommunications primary busbar and secondary busbar(s) in compliance with ANSI/TIA/EIA 607.
6. Cable identification tags and system labeling shall match owners labeling conventions.
7. Coordination of the entire installation with all other divisions.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers:

- a. Five continuous years, minimum, design and manufacture of the materials and equipment specified herein.
- b. Products and equipment specified herein shall demonstrate that they have a quality assurance program in place to assure that the specifications are met. Include in the program, at a minimum, provisions for:
 - 1) Incoming inspection of raw materials.
 - 2) In-process inspection and final inspection of the cable product.
 - 3) Calibration procedures of test equipment to be used in the qualifications of the product.
 - 4) Recall procedures in the event that out of calibration equipment is identified.
 - 5) Conform to government standards on quality assurance for applications within these specifications.
- c. Material and equipment shall be new, and conform to grade, quality, and standards specified. Equipment and materials of the same type shall be a product of the same manufacturer throughout.
- d. Equipment and materials of the type for which there are independent standard testing requirements, listings, and labels, shall be listed and labeled by the independent testing laboratory.

2. Installers:

- a. The intent of these specifications is to ensure the systems described in this division are provided and installed by a technically experienced installer and, further, that the work is fully coordinated between the various systems by a single installer who is technically qualified as described herein.
- b. Company specializing in installation of security systems and integration for a minimum of five years. Experience shall include the following:
 - 1) List at least 10 facilities of equal size, complexity and technical requirements utilizing the equipment submitted.
 - 2) For each facility, list:
 - a) Name and location of facility.
 - b) Date of occupancy by Owner.
 - c) Owner's representative to contact and telephone number.
 - d) Construction Manager or General Contractor.
 - e) Architect.
- c. Where the installer is a branch office or other division of a larger organization, the qualifications of the branch office or other division shall meet the requirements of the Contract Documents. The installer incorporated under the same name, shall have

successfully completed a minimum of three similar security construction projects, both in scope and system types.

- d. The work of this division shall be managed and supervised by a full-time site Electronic Security Systems superintendent who shall have the following qualifications:
 - 1) Experience in the applications engineering, installation, and supervision of similar construction projects both in scope and system type for a minimum of five years.
 - 2) Full time employee of the installer.
 - 3) Have a working knowledge of all systems installed under this division.
- e. Project superintendent shall be on site full time through duration of construction.

1.5 SUBMITTALS

A. General:

- 1. Provide complete submittal package (shop drawings/product data) per individual specification section. Information contained within each submittal package shall only pertain to the referenced specification section.
- 2. All submittal documents shall be submitted as pdf files. Drawings shall be produced on 30 inch x 42 inch format and product data shall be produced on 8.5 inch x 11 inch format.

B. Action Submittals: Submit the following:

1. Shop drawings:

a. General:

- 1) Drawing comparison:
 - a) Copy of drawing annotated where proposed system layout differs from designed system. Any differences to be explained.
- 2) All contractor provided equipment shall be identified in the shop drawing package by its associated room designation (i.e. PLC-A122, do not label equipment PLC-1, PLC-2, TS-1, TS-2, etc.).

b. "Point-to-Point" sheet and detail references shall be provided throughout the shop drawing set to specifically identify:

- 1) Field device location on floorplan to cable termination location.
- 2) Cable termination location to equipment cabinet elevation.
- 3) Equipment cabinet elevation to equipment component detail.
- 4) Equipment component detail to equipment wiring diagram.
- 5) Equipment wiring diagram to termination schedule.
- 6) Termination schedule including:
 - a) PLC input/output information.
 - b) Power supply information.
 - c) Field device wiring diagram.
 - d) Field device rough-in detail.
 - e) Programming information.
 - f) Functional information.
 - g) Interface to other system information (camera call-up to intercom/alarm, etc.)
 - h) Any pertinent or device specific special operational information.
- 7) The cross-references shall be backwards and forwards referencing throughout the shop drawings to the level that each field device can be referenced from its floorplan location to its specific termination location and associated wiring information.

c. Equipment enclosure wiring diagrams:

- 1) Show a pictorial illustration of each equipment enclosure and/or terminal cabinet.
- 2) Show the device nomenclatures exactly as shown on the single line diagrams.

- 3) Show the terminations including the wire numbers as shown on the single line diagrams.
 - 4) Show wire colors for each terminal.
 - 5) For each wire exiting the enclosure, show the destination of the wire by floor, room number and the drawing number of the panel where the wire terminates.
 - d. Field device wiring diagrams:
 - 1) For each field device, existing or new, provide a detailed wiring diagram.
 - 2) Show the termination connectors on the device.
 - 3) Show the wire numbers attached to the connectors, pigtails, or terminal blocks.
 - 4) Show the wire colors connected to the pins, pigtails, or terminal blocks on each device connector.
 - e. Freestanding device wiring diagrams:
 - 1) For each freestanding device, such as a computer, printer or the like, show the rear elevation of the device as a pictorial.
 - 2) Show the termination connectors on the device.
 - 3) Show the wire numbers attached to the connectors.
 - 4) Schedule the wire colors connected to the pins on each device connector.
 - f. Custom assembly diagrams:
 - 1) For each custom assembly such as a receptacle assembly, control panel or the like, provide an assembly drawing illustrating the appearance of the assembled device including dimensions, assembly components and functional attributes (momentary or alternate action switch, lens color, panel finish and the like).
 - g. Drawing comparison:
 - 1) Copy of drawing annotated where proposed system layout differs from designed system. Any differences to be explained.
2. Product data:
- a. Cover page: Each product shall have a cover page with the following information:
 - 1) Submitting Contractor's Logo.
 - 2) Specification Section.
 - 3) Specification Reference.
 - 4) Manufacturer Name.
 - 5) Manufacturer Part Number.
 - 6) Brief Description.
 - b. Product Information: Include manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary) to clearly describe the product's characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories, which are included and those which are excluded. At a minimum, include products listed in Division 28. Include relevant products that will be installed, which are not listed in the specifications.
 - 1) Do not include sheets that are not relevant to the product data or the project.
 - c. Specification comparison:
 - 1) Copy of specification annotated on a line-by-line basis where proposed product or system differs from specified product or system. Any differences to be explained.
 - d. Table of Contents in the form of the Bill of Materials provided as defined by each Division 28 section.

- e. Data sheets for each device as indicated in each Division 28 section and as indicated herein.
- f. Description of system operation indicating overall system operation and purpose and capabilities of each component within system.
- g. Cross reference data sheets to components shown on system/riser diagrams.
- 3. Security Electronics Control System (SECS) Graphic Maps:
 - a. Graphic maps shall be submitted for each control station for approval by Engineer and Owner.
 - b. Provide two PDF on USB colored, digitally tabbed, digital copies of each submission.
 - c. Submittal Review Meeting: After initial Graphic Map Review a meeting shall be arranged at the Owner's site to discuss operational and functional issues relating to the design of the Graphics prior to creating the final maps for the submittal process outlined below.
 - d. Graphic Map Shop drawings:
 - 1) Full size layout of each graphic map.
 - 2) List of system integrator suggested modifications to graphic maps.
 - 3) List of system integrator suggested system enhancement.
 - e. Testing Plans, Procedures, and Testing Limitations:
 - 1) Testing procedure, apparatus, and limitations of apparatus and procedure, for:
 - a) Source quality control activities indicated in each Division 28 section.
 - b) Field quality control activities indicated in each Division 28 section.
- 4. Samples:
 - a. As indicated in each Division 28 section.
- C. Informational Submittals: Submit the following:
 - 1. Certificates.
 - 2. Manufacturer Instructions:
 - a. Serial numbers of items furnished, equipment nameplate information, and similar information for all items furnished.
 - b. Instructions for handling, installation, startup.
 - 3. Qualification Statements:
 - a. Manufacturer
 - b. Installer
- D. Closeout Submittals:
 - 1. As indicated in each Division 28 section.
 - 2. Operation and Maintenance Data
 - a. Contract closeout information:
 - 1) Refer to Section 01 78 23 - Operation and Maintenance Data.
 - 3. Record Drawings: Refer to Section 01 78 39 - Project Record Documents.
- E. Maintenance Material Submittals: Furnish the items and submit documentation of delivery to and acceptance of such items by Owner or facility manager (as applicable) as defined in each Division 28 section.
- F. Refer to Section 01 81 33 - Cyber Security Requirements for required cyber security related submittals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to section 01 65 00 - Product Delivery Requirements and section 01 66 00 - Product Storage and Handling Requirements.

1.7 WARRANTY

A. Manufacturer's Special or Extended Warranty:

1. In addition to manufacturer's general, standard printed warranty, furnish any manufacturer's special warranty coverage. Special warranty shall remain in effect as indicated commencing on the date of Substantial Completion for the associated Work.

1.8 OWNER'S PERSONNEL TRAINING

A. Refer to Section 01 79 23 - Instruction of Operation and Maintenance Personnel

B. Training

1. Refer to Section 01 79 23 - Instruction of Operation and Maintenance Personnel

PART 2 - PRODUCTS

2.1 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.

B. Acceptable manufacturers:

1. As noted in each Division 28 section.
2. Other manufacturers desiring approval Refer to section 01 62 00 - Product Options.

C. Use UL labeled electrical materials where listing has been established for materials or devices in question.

D. Structural steel for supports: ASTM-A36/A36M.

1. Stainless steel members installed in all corrosive areas, including locations less than 10 miles from a saltwater source.
2. Galvanize members installed in areas of high humidity or condensation.
3. Furnish other members with shop coat of rust inhibiting primer.
4. Shop fabricates for field assembly using bolts.
5. Minimize field welding.
6. Retouch primer and galvanizing after field welding.

2.2 EXTRA MATERIALS

A. Furnish spare parts required in each Division 28 section.

B. All spare parts shall be new and in original packaging from manufacturer.

C. Ensure parts are packaged to protect from damage and to allow for easy storage.

D. Provide inventory of all spare parts.

2.3 EQUIPMENT ENCLOSURE RATING

A. Use equipment enclosures suitable for the environment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide access panels (detention and non-detention) in any area where equipment is located which requires accessibility for service and/or maintenance

B. Do not change indicated sizes or configuration without written approval of Architect/Engineer.

C. Conduit verification:

1. Verify that all conduit is clear of foreign matter and substances prior to pulling of wire or cable.
 2. Apply a chemically inert conduit lubricant to all wire and cable prior to pulling. Do not subject wire and cable to tension greater than recommended by the manufacturer. Under no circumstances shall wire or cable be "jerked", "yanked" or attached to any mechanical pulling device which exerts excessive force, shear, or tensile.
 3. Secure all wire and cable runs vertically in conduit for continuous distances greater than 30 meters at the vertical run terminations. Non-coaxial cables shall be secured by screw-flange nylon cable ties or similar devices. Symmetrical clamping devices with split, circular or other wire conforming, non-metallic bushings shall be provided for all other cables.
- D. Division 28 systems (i.e., communications, door control, CCTV, power) shall not occupy the same conduit/raceway, nor with any other system or power cables. All Class 1 and Class 2 circuits shall be routed within separate raceways and shall be portioned within all wireways.

3.2 COORDINATION

- A. General:
1. Coordinate the work with the Owner to assure that where this work interfaces to other trades, those interfaces are provided, complete and functional.
 2. Verify all field conditions.
 3. Positioning Members: Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Engineer or Owner without additional expense.
 4. Interface Devices: Provide all items necessary to complete this work in conformance with the Contract Documents or the satisfaction of the Engineer or Owner without any additional expense.

3.3 INSTALLATION OF EQUIPMENT

- A. Install all equipment in accord with manufacturer's recommendations.
- B. Provide all necessary anchoring devices and supports.
1. Use structural supports suitable for equipment.
 2. Check loadings and dimensions of equipment with shop drawings.
 3. Do not cut, or weld to, building structural members.
- C. Verify that equipment will fit support layouts indicated.
1. Where substitute equipment is used, revise indicated supports to fit at no additional expense.
- D. Arrange for necessary openings to allow entry of equipment.
1. Where equipment cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves or other devices to allow later installation.
- E. Installation of security electronics headend equipment shall not proceed until the progress of construction has reached the following status in the area of installation:
1. Temperature and humidity are controlled.
 2. Finished ceiling, if any, is installed.
 3. Walls are finish coated with final paint treatment.
 4. Floors are finished and sealed.
- F. Installation of security electronics control room equipment shall not proceed until the progress of construction has reached the following status in the area of installation:
1. Temperature and humidity are controlled.
 2. Finished ceiling, if any, is installed.

3. Walls are finish coated with final paint treatment.
 4. Floors are finished and sealed.
 5. Millwork is completely installed, approved, and signed off.
- G. Equipment installed in areas where the previously described conditions have not been met and maintained after equipment installation shall be removed and either cleaned or replaced at the Engineer's discretion.
- H. Install equipment to permit easy access for normal maintenance.
1. Maintain easy access to switches, pull boxes, panels, receptacles, etc.
 2. Relocate items which interfere with access.
- I. Provide tamper resistant security fasteners on all device plates, etc., and for all exposed fasteners, in inmate areas within secure detention perimeter. These areas include but are not limited to the following: all spaces within the vehicular sallyport, inmate sallyport, holding cells, visitation booths, movement corridors, movement elevators and court holding cell areas within secure perimeter and all other areas as directed.

3.4 WIRING

- A. Refer to section 27 10 00 Structured Cabling Systems.

3.5 FIELD QUALITY CONTROL

- A. Perform indicated tests to demonstrate workmanship, operation, and performance.
1. Conduct tests in presence of Engineer, Owner and, if required inspectors of agencies having jurisdiction.
 2. Arrange date of tests in advance with Engineer, manufacturer and installer.
 3. Schedule with the Engineer and Owner a minimum of 2 weeks prior to inspection.
 4. Furnish or arrange for use of electrical energy, steam, water, diesel fuel, or gas required for tests.
- B. Repair or replace equipment and systems found inoperative or defective and retest.
1. If equipment or system fails retest, replace it with products conforming with Contract Documents.
 2. Continue remedial measures and retests until satisfactory results are obtained.
- C. Test equipment and systems as indicated for each item, unless otherwise recommended by manufacturer.

3.6 SYSTEMS OPERATIONAL TESTS

- A. Prior to the time of substantial completion, an acceptance test, witnessed by a representative of the Engineer and Owner, shall be held of each system comprising the total electronic system to determine full compliance with the contract drawings. Provide all personnel, equipment, instrumentation, and communication equipment and include all costs of testing in the contract.
- B. It shall be the responsibility of the Integrator to submit for the Engineer's approval, a proposed "SECS Checklist" for use in final acceptance testing. This checklist shall consist of a list of individual tasks on a device-by-device basis, organized into logical groups per system being supplied; the checklist shall list each device and its associated function with a "comment" box for further description or clarification. The checklist shall be submitted not later than 90 days prior to the scheduled start of acceptance testing. Acceptance testing may not begin until the Engineer has approved the form and content of the acceptance checklist.
- C. Not less than 2 weeks prior to the scheduled acceptance test, the installer/integrator shall certify in writing that the systems are installed in compliance with the manufacturer's recommendations, Refer to the requirements of the contract documents and are operating correctly. The contractor shall completely fill out the Engineer approved SECS Checklist that all devices and equipment have been tested and are operating correctly. These written

certifications shall be submitted to the Engineer and shall signify that the total electronic system is operationally tested and ready for final acceptance testing by the Engineer.

- D. Final acceptance tests of the total electronic systems shall be conducted as directed by the Engineer but generally described as follows:
 - 1. Locking system shall be tested by operation of each individual locking device with status visual display observed.
 - 2. Remote control and emergency release of locking systems shall also be tested.
 - 3. Emergency lock-down shall be performed.
 - 4. Intercom system shall be tested by operation of all individual features and stations.
 - 5. Each individual alarm system and each group of alarm systems operating both individually and collectively shall be tested for alarm signal initiation, tamper signal initiation and loss of power signal initiation as directed by the Engineer.
- E. All expenses for the Engineer to re-test after initial punch-list and subsequent "final acceptance test" will be the responsibility of this contractor.

3.7 ADJUST AND CLEAN

- A. Inspect all equipment and put in good working order.
- B. Clean all exposed and concealed items.
- C. All equipment shall be clean and dust free.
- D. Provide all adjustments in accordance with the manufacturer's recommendations and Owner's requirements, such as scheduling.

3.8 PUTTING SYSTEMS IN OPERATION - START UP

- A. All systems shall be in satisfactory operation prior to final acceptance, at time agreed to by Owner and Engineer.
- B. Operate all systems in good working order for period of 10 working days prior to final acceptance testing by Engineer and Owner.

3.9 DEVICE MOUNTING

- A. Dimensions are to center of device unless otherwise indicated.

3.10 LABELING

- A. Labeling:
 - 1. Engraved phenolic nameplates for security equipment cabinets, and enclosures.
 - 2. Label all junction boxes using black permanent ink with type of system wiring installed in junction box, i.e., access control, detention door controls, intercom, CCTV, etc.

3.11 CLOSEOUT

- A. Refer to Section 01 81 33 - Cyber-Security Requirements for cyber security related closeout requirements.
- B. Training
 - 1. Refer to Section 01 79 23 - Instruction of Operation and Maintenance Personnel.
 - a. Allow a minimum 48 hours time for performing the prescribed operations and maintenance training.
 - b. Provide on-site hands-on training prior to system acceptance.

END OF SECTION

SECTION 28 10 01

ACCESS CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for a complete and fully functional access control system, to allow access to authorized personnel within pre-determined areas of the site, based on time and/or authority level.
 - 2. Specifications require that access control reader interface devices and field devices to be interfaced with other security systems outlined in the Division 28 Sections.
 - 3. Section 28 05 01 - Common Work Results for Electronic Safety and Security provides requirements that apply to the work of this section.
- B. Related Specification Sections but not necessarily limited to:
 - 1. Section 07 48 00 - Firestopping.
 - 2. Section 08 71 00 - Door Hardware.
 - 3. Section 14 24 24 - Hydraulic Elevators.
 - 4. Section 28 05 01 – Common Work Results for Electronic Security Systems
 - 5. Section 28 20 01 - Video Surveillance System

1.2 REFERENCES

- A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:
 - 1. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA).
 - a. ANSI/TIA--569-E – Telecommunications Pathways and Spaces.
 - 2. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 3. UL Solutions. (UL).

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
 - 1. Coordinate installation of readers and integrate into special assemblies for narrow jamb frames and pedestal mounts.
 - 2. Elevator Readers.
 - a. Coordinate the required types, sizes, and quantities of conductors for the traveling cable with elevator contractor.
 - b. Coordinate card reader interface from elevator cab to elevator equipment room demarcation interface.
 - c. Coordinate interfacing elevator equipment to card access equipment with elevator contractor.
 - d. Coordinate installation of readers and integrate into elevator call panels/cab.
 - e. Coordinate with the Owner and Vertical Transportation Contractor the output time duration requirements to activate call and floor buttons.
 - f. Security features shall not affect emergency firefighter's services.

1.4 QUALITY ASSURANCE

- A. Qualifications:

1. Manufacturers:
 - a. See Specification Section 28 05 01 for additional requirements.
2. Installers:
 - a. See Specification Section 28 05 01 for additional requirements.

1.5 SYSTEM ARCHITECTURE AND DESCRIPTION

- A. Provide a microprocessor-based networked security access control and alarm monitoring system. System components shall have as a minimum, Access Control System Servers and Workstations, required software and licenses, field devices, remote I/O modules, readers, printer and all the required hardware and software for a complete and operational system.
- B. System.
 1. The alarm monitoring client workstation shall communicate with, and monitor, access control hardware devices, such as access control readers and access control panels. Administrative tasks including defining credential holder information, access groups, time zones, intrusion detection devices, configuring digital video cameras and recording devices, generating reports, creating maps, floor plans, site plans etc. shall be provided from any licensed client workstation on the network.
 2. All system data shall reside on a single database on the server and be accessible in real time to all licensed system workstations connected to the network, to allow for automatic change propagation to all client workstations on the system, as well as to provide a common database to consolidate all information.
 3. System shall integrate into the Owners existing RS2 Technologies access control system.
- C. Access Control:
 1. The system shall be programmed to provide access granted or denied decisions, define access levels, and set time zones and holidays. An input/output linkage feature shall allow linking of monitor zone points to output control points within Access control panels.
- D. Alarm Monitoring:
 1. Alarms are to be prioritized. The main alarm window shall provide information to include the time and location of the alarm, along with its priority. The main alarm window shall be able to sort pending and/or insert new alarms based on any of the following attributes: priority, date/time, alarm description, Access control panel, Card Reader, Input Module or cardholder.
- E. Network Video Management:
 1. The system shall include a seamlessly integrated network-based video management module, to allow for the central administration, monitoring, and archiving of network based video and the associated cameras. The system shall support network based video servers from multiple manufacturers.
- F. Third Party Interfaces:
 1. The system shall integrate with a number of third-party hardware and software products. The system shall provide seamless integration with fire alarm systems, personal safety systems, video intercom systems, emergency assistance stations, elevator control interface and video systems.
- G. System Administration:
 1. System Administrative tasks such as defining client workstation & System Operator permissions set-up, access groups, time zones, reports, maps, etc. shall be provided from any client workstation on the network. Initial setup of the cardholder screen layout shall occur on the database server. The system shall support an unlimited number of access control readers, input points, video cameras, intrusion detection points, and relay outputs.
- H. Application Programming Interfaces:

1. The system shall provide a set of standard Application Programming Interfaces (API's) and supporting documentation that allows hardware manufacturers and software application developers to integrate their products into the system. The Application Programming Interfaces shall allow requests from the end user to integrate a third party hardware or software solution based on system open architecture and system device independence.
- I. Upgrades:
 1. All systems shall be upward compatible. Access control hardware shall be compatible with all systems. Access control hardware (Access control panels, Input Control Modules, Access Control Readers, etc.) shall not require replacement or upgrades as the Owner migrates from the existing system level to a newer version.

1.6 APPLICATION DESIGN

- A. Open Architecture:
 1. The system shall have an open architecture design to support industry standards for databases, networks, credential printers, and video cameras.
- B. Open Database Connectivity Compliance:
 1. The system shall be Open Database Connectivity (ODBC) compliant. The system shall support a relational database management system with the proper 32-bit ODBC drivers.
- C. Network Support:
 1. The system shall be designed to support industry standard network protocols TCP/IP. The system shall also support peer-to-peer and FTP server capabilities.

1.7 DESIGN REQUIREMENTS

- A. System shall consist of a server, one or more networked client workstations and access control and alarm monitoring processors, interfaced to the Owner's building network.
 1. System Software: 64-bit, latest version Windows operating system and application software. Software shall have the following capabilities:
 - a. Graphical user interface to show pull-down menus and a menu tree format that complies with interface guidelines of Microsoft Windows operating system.
 - b. System license shall be for the entire system and shall include capability for future additions that are within the indicated system size limits specified in this Section.
 - c. System shall have open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with Microsoft Windows operating system.
 - d. Password-protected operator login and access.
- B. Distributed Processing: System shall be a fully distributed processing system so that information, including time, date, valid codes, access levels, and similar data, is downloaded to access control processors to allow each access control processor to make access-control decisions for its location. Intermediate access control processors used to store access control information is not acceptable. In the event that communications to the server is lost, all access control and alarm monitoring processors shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the Server.
- C. Server/workstations shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Server shall control system networks to interconnect all system components, including workstations and field-installed access control and alarm monitoring processors.
- D. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of control panels, readers, sensors, etc.
- E. Coordinate color of devices and readers with Architect to blend with surrounding environment prior to procuring. If color options of device are not acceptable to Architect, furnish the devices

that have a paintable surface and coordinate with the painting contractor the requirements to paint the devices prior to installation.

F. Systems that require annual license renewal shall not be acceptable.

G. Communication.

1. Network connecting the Server and workstations shall be by the Owner.
2. Field equipment shall include access control/alarm monitoring processors, sensors, and controls. Access control/alarm monitoring processors shall serve as an interface between the Server and sensors and controls. Data exchange between the Server and the access control/alarm monitoring processors shall include down-line transmission of commands, software, and databases to access control/alarm monitoring processors. The up-line data exchange from the access control/alarm monitoring processor to the Server shall include status data such as intrusion alarms, status reports, and entry-control records. Access control/alarm monitoring processors are classified as alarm-annunciation or entry-control type.

H. Access Control/Alarm Monitoring Processors.

1. Access control field devices shall have an onboard UPS to allow for independent operation during power loss periods.
 - a. Provide battery back up to all access control/alarm monitoring processors and power supplies, where Division 26 UPS power is not available. Refer to the Division 26 plans and specifications for UPS power circuit schedules and locations.
2. Equipment enclosures in the field shall be key-lockable, and equipped with tamper switches, to annunciate at monitoring workstations.
3. Locate access control panels adjacent to power supplies and door hardware power supplies in dedicated equipment rooms or communications rooms. Locating the panels at the door location is unacceptable.

I. The system shall comply with Underwriters Laboratories (UL) standards and shall carry the UL labels for UL 294 Access Control System Units.

1. The access control system shall operate within the limits of Class 2 remote-control and signal circuits as defined by Article 725 of the National Electrical Code, NFPA 70.

J. Integration with other trades.

1. Interface Readers into Elevator Lobby Call Stations to provide elevator call authorization upon presentation of a valid credential.
2. Integrate Readers into Precast and Construction Walls, Door Frames, etc.
3. Door Hardware Interface: Coordinate with Division 08 Sections that specify door hardware required to be monitored or controlled by the security access system. The access control/alarm monitoring processors in this Section shall have electrical characteristics that match the signal and power requirements of door hardware. Integrate door hardware specified in Division 08 Sections to function with the hardware in this Section.
 - a. Provide interface to integral Request to Exit (REX) switch in the door hardware.
 - b. In Line Power/Continuous Duty Protection Devices.
 - 1) Provide protection devices with built-in surge protection and voltage regulation at each electric hardware device to protect the relays and sensitive electronics of the system from the electrical spike that occurs when electric hardware locks or unlocks. The equipment shall also provide protection to door which are programmed for continuous duty operation, reducing the output voltage by 25 percent to extend the life of the electric locks. Design Basis: HES model 2005 - SMART PAC II or approved equal.
4. Fire Alarm Interface. Provide interface from the fire alarm release directly to the hardware or hardware interface to release delayed egress equipment and locked doors in the path of egress in compliance with UL and Life Safety requirements. The fire alarm release shall not interface through security equipment.

- K. Request to Exit Motion Detectors (where indicated on drawings)
 - 1. Adjust request to exit motion detector timers to 1-2 seconds. The access control systems shall govern the duration time of door unlocks and door held opens.
 - 2. Request to exit motion detectors shall be programmed to shunt door position switches only, unless life safety codes require the affected door to be unlocked.
- L. Cable Requirements.
 - 1. Sensor and card reader cable shall be a minimum 22 AWG
 - 2. Lock cable shall be a minimum 18 AWG, however, shall be sized larger base on distance and current rating.

1.8 PERFORMANCE REQUIREMENTS

- A. System Response to Alarms: Field device network shall provide a system end-to-end response time of 1 second or less for every device connected to the system. Alarms shall be annunciated at the monitoring station within 1 second of the alarm occurring at an access control/alarm monitoring processor or device controlled by a local Access control panel, and within 100 ms if the alarm occurs at the Server. Alarm and status changes shall be displayed within 100 ms after receipt of data by the monitoring station. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within 5 seconds of alarm receipt at the security console. The response times shall be maintained during system heavy load.
- B. Acknowledgeable Events: Any user programmed alarm event shall cause the card access system workstation to provide an audible and visual alarm requiring the operator to acknowledge the event and enter via the keyboard a report of the event and cause.
- C. Handicap Entrances:
 - 1. Interface to electric locks and automatic door opening equipment at handicapped access locations. Presentation of a valid card shall unlock the door, and enable the door open button. The credential holder shall then have the option to press the door open button, or manually open the door. The card access system shall not disable the egress door-open button.
- D. Elevator Readers:
 - 1. Provide readers in elevator cars locations indicated. The system shall restrict the credential holder's access to areas on a per-floor basis. The floor selection buttons within the elevator car shall be disabled under normal conditions. The presentation of a valid card shall enable the floor buttons the credential holder is authorized to access. Floor restrictions per cardholder shall be modified through the programming in the access control system.
- E. ADA Accommodation.
 - 1. Cards designated for ADA access shall be programmed to an extended door unlock time to allow sufficient time for handicapped individuals to open the door.

1.9 SUBMITTALS

- A. Action Submittals
 - 1. Shop Drawings:
 - a. Fabrication and/or layout drawings:
 - 1) Routing, size, and fittings.
 - 2) Seismic location installation details.
 - 2. Product data.
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. See Specification Section 28 05 01 for additional requirements.
- B. Informational Submittals:
 - 1. Cable tray fill calculations.

2. Cable schedule of number and type of cables in cable trays.
 3. Project planning documents.
- C. Closeout Submittals
1. Operation and Maintenance Data
 - a. Contract closeout information:
 - 1) Provide schematic drawings depicting type and location of interface equipment/components, number of cables and conductors, types of connectors, circuit requirements and type and dimensions of enclosures.
- D. Maintenance Material Submittals:
1. Furnish the following items and submit documentation of delivery to and acceptance of such items by Owner:
 - a. One card reader of each type used as a spare.
 - b. One access control/alarm monitoring processor as a spare.
 - c. One reader interface module for each type used as a spare.
 - d. One power supply of each type used as a spare.
 - e. Backup software and database programs upon completion of the programming of all access control information. Demonstrate to the Owner that the copies provided can be accessed by the Owner and that the entire database is contained on the disks. Demonstrate to the Owner the procedure for restoring the system using the backup disks.
 - f. One factory box for each component, addressed to the manufacturer to facilitate factory return for repair authorizations.
 - g. Written procedures for obtaining return authorizations. (If not required, state so in writing.)

1.10 PROJECT DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 28 05 01.

1.11 WARRANTY

- A. Comply with the requirements of Section 28 05 01 - Warranty.
- B. User Cards shall be warranted for a period of five years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with Contract requirements, furnish products of one of the following listed manufacturers.
- B. Access Control Equipment:
1. RS2 Technologies
- C. Request to Exit Motion Equipment:
1. Interlogix - Model RCR-REX
 2. Securitron - Model XMS
 3. Visonic
 4. Or Equal.
- D. Card Reader:
1. HID Corp iCLASS.
- E. Motion Detection Equipment:

1. Interlogix
 2. Detection Systems
 3. Honeywell International
 4. Or Equal.
- F. Door Position Switches:
1. Magnasphere
 2. GRI, Inc
 3. Honeywell
 4. Aleph International
 5. Flair Electronics
 6. Or Equal.
- G. Power Supplies.
1. LifeSafety Power
 2. Alarm Saf
 3. Altronix.
 4. Or Equal.
- H. Enclosures:
1. Hoffman
 2. Rittal Corporation
 3. Hammond
 4. Middle Atlantic Products
 5. Stantron
 6. Bud
 7. Or Equal.

2.2 SYSTEM REQUIREMENTS

- A. Workstation Software:
1. The access control software shall operate with the latest Windows Server and client workstation operating system.
 2. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each location. Each user's access shall be partitioned to restrict access to only view and modify authorized files, database, remote servers, menus, screens, and individual fields within each screen.
 3. The system shall provide two-way communication with third party database on the building network for other database sharing applications. The relational database shall ODBC compliant.

2.3 ACCESS CONTROL SYSTEM SOFTWARE REQUIREMENTS

- A. General Requirements:
1. The system shall provide for password restricted operator access levels. This feature shall restrict access to sensitive programming functions to authorized personnel only. The highest-level password shall have access to all system databases and functions. Each password shall be individually programmable to restrict operator access to programming and operator functions, commands, database access, and alarm point and control point functions.
 2. The system shall provide an audit feature to maintain an historical record of what changes were made and who made them.
 3. Graphical Maps:

- a. The system shall provide for map graphics, floor plans, site plans that graphically depict system status. Icons placed on graphical backgrounds shall be used to indicate the real time status of each system connection including access control reader connections, alarm inputs, control point outputs, communication connections, etc.
 - b. The icon of the device in alarm shall be differentiated from other device symbols by enhancement, color change and/or flashing. Different enhancements shall indicate normal, alarm, trouble, time schedule shunt, manual shunt and other status conditions provided by the system.
 - c. The system shall be capable of being configured to automatically call up a graphical map upon system-generated alarms without an operator request.
 - d. The system shall provide for the import of graphics generated by other drawing programs.
4. The system shall provide for a status screen on the security monitoring screen. The status screen shall be manually displayed by an operator any time during a session with a mouse click. The operator shall be able to select any group to view in more detail. The status screen shall display the following:
 - a. A complete list of all alarm points displaying the status of each alarm point.
 - b. A complete list of all doors displaying the status of each door.
 - c. A complete list of all outputs displaying the status of each output.
 - d. A complete list of all Alarm Zones displaying the status of each Alarm Zone.
 5. The operator shall have the ability to display multiple alarms, queued in their order of priority.
 6. The system monitoring screen and event printer shall display and record the alarm message in real time including: the time, date location, point description, event type and point status of each point transaction.
 7. The operator shall be able to verify current status of any point in the system and change any of the programmable point descriptors via the Client Workstation.
 8. All software applications shall be specifically designed for security and access control. A current high-level language shall have been used to develop all application programs.
 9. The system shall include a schedule program that will allow the Owner to automatically schedule events such as report printing, output commands, door access, alarm access, etc. on a time/day programmable basis in advance.
- B. Access Control:
1. The system shall provide control point outputs for lock power control activated by access control reader, client workstation keyboard or time schedule.
 2. All alarm control points as well as access control reader inputs shall be capable of independent time schedule via software controls from the access control/security monitoring system.
 3. The system shall provide for controlled access through reader controlled doors based on the user's access levels. An access level shall define a door or group of doors accessible by authorized individuals during a certain time period(s). Time periods shall include both authorized days and hours. The system shall provide for controlled access through reader controlled doors based on the user's authorization. Users shall be allowed to add or remove selected doors within an access level for individual credential holders. This shall also include the ability to assign multiple access levels to credential holders.
 4. The system shall provide for automatic credential holder activation and expiration by specified time and date.
 5. The system shall store in memory every access transaction, describing the nature of the transaction, time, date, reader location, credential holder name and validity status.
 6. The system shall provide for alarm indication at the system monitoring station for unauthorized reader use attempts. Unauthorized reader use alarms shall be user selectable on a reader-by-reader basis. When configured in Card and PIN mode the

system shall automatically invalidate the badge after five consecutive invalid PIN attempts. The system shall not allow duplicate PIN numbers.

7. The system shall provide screen display and event printing of transactions (all transactions or violations only; by user and by reader).
8. The system shall provide momentary or maintained release of reader controlled door locks via the monitoring screen.
9. The system shall provide for user programming of the following data for each card:
 - a. Card number (internal and hot stamp).
 - b. Access Levels.
 - c. Authorized Areas.
 - d. Effective Date.
 - e. Expiration Date.
 - f. Credential holder Name.
 - g. Credential holder ID number.
 - h. Employee status (active, retired, temporary, etc.).
 - i. Credential holder department name.
 - j. Credential holder automotive license number.
 - k. Credential holder phone number.
 - l. Company name (if other than system owner).
 - m. User definable fields.

C. Database Queries, Editing and Printing:

1. The system shall provide for database queries, database editing and report printing via user definable parameters. The system shall be capable of printing requested queries and reports to the system monitoring screen or its associated report printer. In addition, the system shall be capable of conducting a file search by field or combination of user definable fields. Upon the users request, searched and sorted files shall be capable of being printed in the order dictated by the user, i.e. alphabetically by last name, numerically by badge number, alphabetically by department name, etc.
2. The system shall provide for report printing and/or display of any group of events within any selectable time period. The Report printer shall be capable of producing a hard copy of any report that the system may generate. Reports shall include historical events, defined by any combination of the following categories:
 - a. All Events.
 - b. Location.
 - c. Point Number.
 - d. Event Type (e.g. intrusion, door open, etc.)
 - e. Point Status (e.g. on, off, alarm, normal, shunted, etc.)
 - f. Management reports of transactions history by card number, cardholder data, reader number, time period, or invalid attempts.
 - g. Audit trail reports.
3. The system shall allow the exporting of report outputs directly to another database.

2.4 SECURITY APPLICATION SERVER AND WORKSTATIONS

- A. The Database Server for the Access Control & Alarm Monitoring Systems shall consist of the following minimum specifications:
 1. 2 RU TIA/EIA Rack Mountable.
 2. Operating System: Microsoft Windows, latest version.
 3. Processor: Intel Xeon processor E5-2600v4 Series.
 4. Chip Set: Intel C612 (or Latest)

5. Memory Specifications:
 - a. Quad channel memory 1TB 2400 MHz DDR4 ECC memory.
 - b. Dual CPU's.
6. Graphics:
 - a. 4 PCI Express x16 Gen 3 graphics cards - 675W
 - 1) Total 3 x 225W graphic cards in 3 slots.
7. Storage: 3.5 inches SATA (4) 4TB 5400 rpm drives.
8. Storage Controller:
 - a. Integrated: LSI SAS 3008 12Gb/s SAS (6Gb/s SATA) controller.
 - 1) RAID 0, 1, 10 capable of 8 drives.
 - 2) 2 integrated Intel controller (6Gb/s) SATA ports for optical drives.
9. Communications:
 - a. Integrated: Intel I217 & I 210 Gigabit Ethernet controllers.
 - 1) Intel Remote Wake Up.
 - 2) PXE and Jumbo frames support.
10. Audio Controller: Integrated Realtek ALC3220 High Definition Audio Codec (2 Channel).
11. I/O Ports:
 - a. 6 - USB 2.0
 - b. 4 - USB 3.0
 - c. 1 - Microphone.
 - d. 1 - Headphone.
 - e. 1- 2x5 USB 2.0 header.
 - f. 8 - SAS @ 12Gb/s (supports SATA @ 6 Gb/s as well)
 - g. 1 - Audio Line out.
 - h. 1 - Audio Line in/Microphone.
 - i. 1 - Serial port.
 - j. 2 - RJ45 Network ports.
12. Bays.
 - a. (1) External slimline optical bay.
 - b. (4) Internal 3.5 inches bays (support total of (4) 3.5 inches or 2.5 inches drives)
 - c. (1) External 5.25 inches bay.
13. Slots.
 - a. (2) PCIe x16 Gen 3
 - b. (1) PCIe x16 Gen 3 (wired as x4 - Slot 1)
 - c. (1) PCIe x16 Gen2 (wired as x4)
 - d. (1) PCI 32 Bit.
14. Power Supply:
 - a. 1300W (input voltage 120VAC-240VAC)
 - b. 90 percent efficient (80PLUS Gold Certified)
 - c. Externally accessible and removable.
15. Storage devices: Slimline DVD-ROM; DVD+/-RW
16. USB Keyboard.
17. USB Optical 3 button Mouse with scroll wheel.
18. User Interface: Remote operation via the security management operator workstation.
19. Surge Suppression Strip.
20. Server Software:

- a. Microsoft Server Operating System, latest edition.

- 1) Minimum of five (2) client licenses.

2.5 ACCESS CONTROL HARDWARE COMMUNICATIONS

- A. The system shall have the ability to communicate with the access control/alarm monitoring processors by either RS485 or LAN/WAN connections utilizing TCP/IP communications protocol. The system shall also have the ability to communicate with the access control panels through remote dial up capabilities.
- B. Downloading or database changes shall not interfere with any output control, access decisions, alarm monitoring, traces, or any other required function of the access control hardware and alarm monitoring client workstation. Communications between the system client workstation(s) and the access control/alarm monitoring processors shall be interleaving so that alarms will still report to their respective alarm monitoring client workstations while downloads are occurring.
- C. Upon losing and then restoring communications between the access control/alarm monitoring processors and the system database, database synchronization between the system database and the local database in each access control/alarm monitoring processor shall be fast and efficient.

2.6 ACCESS CONTROL/ALARM MONITORING PROCESSORS

- A. Access control/alarm monitoring processors shall operate as an autonomous intelligent processing unit. Access control/alarm monitoring processors shall make decisions about access control, alarm monitoring, linking functions, and door locking schedules for its operation, independent of other system components. Access control/alarm monitoring processors shall be part of a fully distributed processing control network. The portion of the database associated with access control/alarm monitoring processor and consisting of parameters, constraints, and the latest value or status of points connected to that access control/alarm monitoring processor, shall be maintained in the access control/alarm monitoring processor.
- B. Description overview:
 - 1. The access control/alarm monitoring processor shall communicate to the host computer in a single path configuration of Ethernet or RS485.
 - 2. The access control processor shall support a minimum of twenty readers, easily populated through the use of the following.
 - a. Distributed reader modules for support of:
 - 1) Biometric Gateways.
 - 2) Credential Readers.
 - b. Input Control Modules.
 - 1) Input module shall provide 8 fully supervised inputs and 4 non supervised inputs.
 - c. Output Control Modules.
 - 1) Each reader module shall have the additional capacity of 8 relay outputs.
 - 3. The access control processor shall have the following characteristics:
 - a. Shall store a minimum of [100,000] credential holders online.
 - b. Incorporate Flash upgradeable firmware.
 - c. Provide supervised alarm inputs to monitor the status of alarm circuits and report the status information to the monitoring screen.
 - d. Provide control relay outputs for controlling devices by remote command from the system, through time schedules or on alarm point activation.
 - e. Contain enough RAM to maintain a card database of [100,000]
 - f. Automatically disconnect from the communication loop upon a communication failure within the access control processor to prevent the communication to other access control processors in the loop from being interrupted.

- g. Upon loss of communication, the access control/alarm monitoring processor shall contain enough memory to operate normally. In addition, the access control/alarm monitoring processor shall store a minimum of [10,000] prioritized transactions or events and shall automatically transmit that data to the system as soon as communication is restored.
- h. Upon verification of credential authorization or request to exit, the processor shall activate a door control relay output and shunt the intrusion alarm. The lock control outputs shall be rated for a minimum of 1A @24 VDC. Relay activation time shall be adjustable from 0 to 49,999 seconds on an individual reader basis. The door shall automatically relock upon opening.
- i. Provide an intrusion alarm indication on the system if the reader controlled door is opened without an authorized credential use or request to exit.
- j. Shall provide a door prop alarm indication on the monitoring screen if the reader controlled door is held open past an adjustable time period after an authorized credential use or request to exit. The door prop alarm delay shall be adjustable from 0 to 99 seconds on an individual reader basis.
- k. Acceptable manufacturer for the access control/alarm monitoring processor shall be the same manufacturer of the software to insure control of quality and integrated performance capabilities.

C. Input Control Module.

- 1. The Input Control Module (ICM) shall monitor all system alarm inputs. The Input Modules shall be able to operate independently and in conjunction with Output Control Modules, which will send an output signal to a corresponding output device upon alarm input activation. System Administrators shall have the ability to set the following options for each input or output configured on the Input Control Modules in the system:
 - a. Alarm Masking:
 - 1) This feature shall allow System Administrators to mask the alarm input manually, or on a time zone basis.
 - b. Local Linkage:
 - 1) This feature shall allow System Administrators to locally link outputs with inputs that are attached to the same Input control module/Output Control Module. Inputs shall be linked to multiple outputs and outputs shall be triggered by multiple inputs.
 - c. Activate Output:
 - 1) This feature shall allow System Administrators to activate an output tied to the Input control module/output control module on a time zone basis.
 - d. Activate Output Always:
 - 1) This feature shall allow System Administrators to activate an output always.
 - e. Configuration of Debounce Times:
 - 1) Debounce time configuration allows System Administrators to control the amount of time that an input state change must remain consistent in order for it to be considered a real change of state, and shall prevent contact "flickers" from being reported up as changes of state.
 - f. Configuration of Hold Times:
 - 1) When configuring an Alarm Input, a hold time setting shall be settable from 0-15. When an input goes active and is restored, the hold time is the amount of time in seconds to wait until reporting the input activation as restored. This feature is used when there is no advantage to log the specific number of times a point is tripped after the initial event.

D. Individual Access Control/Alarm Monitoring Processor Operation:

- 1. Card-reader ports of an access control processor shall be custom configurable for a minimum of [120] different card-reader or keypad formats. Multiple reader or keypad

formats may be used simultaneously at different access control processors or within the same access control processor.

2. Access control processors shall provide a response to card-readers or keypad entries in less than 0.25 seconds, regardless of system size.
3. Access control processors that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to its proper working state. This shall happen without any operator intervention.
4. Initial Startup: When access control/alarm monitoring processors are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each access control/alarm monitoring processor.
5. Failure Mode: On failure for any reason, access control/alarm monitoring processors shall perform an orderly shutdown and force access control/alarm monitoring processor outputs to a predetermined failure mode state, consistent with the failure modes shown and the associated control device.
6. Startup after Power Failure: After power is restored, startup software shall initiate self-test diagnostic routines, after which access control/alarm monitoring processors shall resume normal operation.
7. Startup after Access Control/Alarm Monitoring Processor Failure: On failure, if the database and application software are no longer resident, access control/alarm monitoring processors shall not restart, but shall remain in the failure mode until repaired. If database and application programs are resident, access control/alarm monitoring processors shall immediately resume operation. If not, software shall be restored automatically from the Server.

E. Communications Monitoring:

1. System shall monitor and report status of communications of each location.
2. Missed polls indicate that messages had to be retransmitted and reflect the soundness or quality of the access control/alarm monitoring processor-to-access control/alarm monitoring processor network.
3. Communication status window shall display which access control/alarm monitoring processors are currently communicating, a total count of missed polls since midnight, and which access control/alarm monitoring processor last missed a poll.

- F. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central processing units a minimum of once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

2.7 OPERATIONS

- A. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.
- B. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
- C. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.
- D. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.
- E. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.

- F. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:
1. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
 2. Maps to provide real-time display animation and allow for control of points assigned to them.
 3. System to allow inputs, outputs, and override groups to be placed on different maps.
 4. Software to allow changing the order or priority in which maps will be displayed.
- G. Operator Commands:
1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
 2. Command inputs shall be acknowledged, and processing shall start in not less than 1 second.
 3. Tasks that are executed by operator's commands shall include the following:
 - a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
 - b. Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
 - c. Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.
 - d. System Test: Allows the operator to initiate a system-wide operational test.
 - e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
 - f. Print reports.
 - g. Change Operator: Used for changing operators.
 - h. Display Graphics: Used to display any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
 - i. Run system tests.
 - j. Generate and format reports.
- H. Alarms:
1. System Setup:
 - a. Assign manual and automatic responses to incoming point status change or alarms.
 2. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
 3. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.
 4. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
 5. Video Surveillance Alarm Interface: Allow commands to be sent to video surveillance systems during alarms (or input change of state).
 6. Camera Control: Provides operator ability to select and control cameras from graphic maps.
- I. Alarm Monitoring: Monitor sensors and access control panels, and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.

1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
 2. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
 3. Maps shall automatically display the alarm condition for each input assigned to that map, if that option is selected for that input location.
 4. Alarms initiate a status of "pending" and require the following two handling steps by operators:
 - a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
 - b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.
 5. Each workstation shall display the total pending alarms and total unresolved alarms.
 6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
 7. Alarms shall transmit to Server in real time.
 8. Alarms shall be displayed and managed from a minimum of four different windows.
 - a. Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.
 - b. History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
 - c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
 - d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.
 9. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
 10. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
 11. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
- J. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.
1. Color Code:
 - a. FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
 - b. STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged.
 - c. YELLOW: Advises operator that a zone is in access.
 - d. GREEN: Indicates that a zone is secure and that power is on.
 2. Graphics:
 - a. Support a minimum of 100 graphic display maps and allow import of maps from a minimum of 16 standard formats from a graphics program.
 - b. Allow I/O to be placed on graphic maps by the drag-and-drop method.
 - c. Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on graphic map.

- d. Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic map associated with inputs or outputs.
 - e. Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.
 - f. Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.
 - g. Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.
- K. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.
- 1. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
 - 2. The program shall provide means to disable the enrollment station when it is unattended to prevent unauthorized use.
 - 3. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
 - 4. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:
 - a. MASK: Determines a specific format that data must comply with.
 - b. REQUIRED: Operator is required to enter data into field before saving.
 - c. UNIQUE: Data entered must be unique.
 - d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
 - e. NAME ID: Data entered will be considered a unique ID for the cardholder.
 - 5. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
 - 6. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
 - 7. Default card data can be programmed to speed data entry for sites where most card data are similar.
 - 8. Enhanced ASCII File Import Utility: Allows the importing of cardholder data and images.
 - 9. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.
- L. Access control/alarm monitoring processors shall be capable of communicating with the host computer and other panels via RS232, RS485, fiberoptics and LAN/WAN - TCP/IP.

2.8 SYSTEM DATABASE

- A. Time Zones:
- 1. Each zone consists of a start and stop time for 7 days of the week and three holiday schedules. A time zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.

2. Four time zones may be assigned to inputs and outputs to allow four arm or disarm periods per day or four lock or unlock periods per day; three holiday override schedules may be assigned to a time zone.
 3. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.
- B. Holidays:
1. Three different holiday schedules may be assigned to a time zone. Holiday schedule consists of date in format MM/DD/YYYY and a description. When the holiday date matches the current date of the time zone, the holiday schedule replaces the time zone schedule for that 24-hour period.
 2. Three separate holiday schedules may be applied to a time zone.
 3. Holidays have an option to be designated as occurring on the designated date each year. The holidays remain in system and will not be purged.
 4. Holidays not designated to occur each year shall be automatically purged from database after the date expires.
- C. Access Levels:
1. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-passback.
 2. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
 3. System shall have the ability to create multiple door and time zone combinations under same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same Access control panel.
- D. User-Defined Fields:
1. System shall provide a minimum of 99 user-defined fields, each with 50 characters, for specific information about each credential holder.
 2. System shall accommodate a title for each field; field length shall be 20 characters.
 3. A "Required" option may be applied to each user-defined field that, when selected, forces the operator to enter data in the user-defined field before the credential can be saved.
 4. A "Unique" option may be applied to each user-defined field that, when selected, will not allow duplicate data from different credential holders to be entered.
 5. Data format option may be assigned to each user-defined field that will require the data to be entered with certain character types in specific spots in the field entry window.
 6. A user-defined field, if selected, will define the field as a deactivate date. The selection shall automatically cause the data to be formatted with the windows MM/DD/YYYY date format. The credential of the holder will be deactivated on that date.
 7. A search function shall allow any one user-defined field or combination of user-defined fields to be searched to find the appropriate cardholder. The search function shall include search for a character string.
 8. System shall have the ability to print cardholders based on and organized by the user-defined fields.
- E. Code Tracing:
1. System shall perform code tracing selectable by cardholder and by reader.
 2. Any code may be designated as a "traced code" with no limit to how many codes can be traced.
 3. Any reader may be designated as a "trace reader" with no limit to which or how many readers can be used for code tracing.
 4. When a traced code is used at a trace reader, the access-granted message that usually appears on the monitor window of the monitoring station shall be highlighted with a different

color than regular messages. A short singular beep shall occur at the same time the highlighted message is displayed on the window.

5. The traced cardholder image (if image exists) shall appear on workstations when used at a trace reader.

2.9 CARD READER FUNCTIONS

- A. The system shall support a variety of card readers that must encompass a wide functional range. The system may combine any compatible card readers for installations requiring multiple types of card reader capability (i.e., card only, card and/or PIN, supervised inputs, etc.). Card readers shall be available in Open Supervised Device Protocol (OSDP) output format and Wiegand. All card readers shall include card reader back boxes for conduit installations.

2.10 READERS

- A. Contactless SmartCard 13.56 MHz Technology.
- B. Exterior readers shall be weatherproof. Seal all openings and penetrations with manufacturer approved sealant.
- C. No special housing shall be required for those readers designated for outdoor use.
- D. Electrical connections and cabling from the reader assembly to the system interface shall be per manufacturer's specifications.
- E. All card readers shall be installed on an electrical include electrical back boxes for conduit installations.
- F. Card readers shall provide audible feedback to indicate access granted/denied decisions. Upon a card swipe, two beeps shall indicate access granted and three beeps shall indicate access denied. All keypad buttons shall provide tactile audible feedback.

2.11 CARDS / CREDENTIALS

- A. Owner provided

2.12 REQUEST TO EXIT MOTION DETECTOR

- A. The request to exit motion detector shall include as a minimum the following features:
 1. Dual technology passive infrared and microwave.
 2. Adjustable time delay.
 3. Tamper output.
 4. Microwave frequency: 5.8 GHz.
 5. Range, depth: 3 to 15 feet, adjustable.
 6. Range, width: 7.9 feet.
 7. Range, PIR: 15 feet (4.6 m), adjustable.
 8. Relay output - Form "C".
 9. Approximate dimensions (HxWxD): 1.76 x 7.395 x 1.85 inches.
 10. Provide a trim plate to mount between the request to exit motion and the mounting surface. The trim plate shall be approximately 1/8 inches in depth, and shall be sized approximately 1/2 inch - 3/4 inches larger than the motion detector mounting surface and large enough to cover the backbox opening. The trim plate shall be supplied by the manufacturer. If a trim plate is not available from the manufacturer, one shall be fabricated using ABS plastic. The trim plate color shall match the existing surface.

2.13 MOTION DETECTION SENSORS

- A. Ceiling Mounted.
 1. Dual optic technology.
 2. 60 feet diameter coverage.
 3. Ceiling mount.

4. 360 degree coverage.
5. Mask all unused curtain areas.
6. Utilize recessed mounting kit.
7. Powered by 7 to 18 volts DC.

B. Wall Mounted:

1. Dual Tech: (Honeywell DT7450 basis of design)
2. Passive infrared motion detector with self-contained microprocessor employing dual technology motion detection.
3. Integral bug guard.
4. Form C, 125mA max, 25VDC (minimum) alarm output.
5. Integral combination cover/ tamper switch.
6. Digitally adjust thresholds to account for room disturbances
7. Fresnel lens shall provide the same sensitivity for human targets at the edge of the pattern as exists directly in front of the sensor.
8. Continuous internal signal diagnostic supervision.
9. PIR supervision performed once every hour.
10. Temperature compensation monitored and updated every 30seconds.
11. Additional minimum requirements:
 - a. Range: 50 feet x 60 feet (short range - wall mounted), 100 inches x 25 feet (long range - wall mounted), 50 feet x 360 degree (ceiling mounted)
 - b. Alarm Relay: Energized Form C @125 mA, 25 VDC, w/20 Ohm series resistor.
 - c. Tamper: (NC) 50 mA, 24 VDC.
 - d. Power Requirements: 8.0 - 16 VDC.
 - e. Frequency: 24.125 GHz (K-Band).
 - f. PIR White Light Immunity: 6,500 lux typical.
 - g. Fluorescent Light Filter: 50 Hz or 60 Hz, selectable.
 - h. RFI Immunity: 30 V/m, 10 MHz - 1000 MHz.
 - i. Operating Temperature: 14 degrees to 131 degrees F @ 5 percent - 95 percent relative humidity (non-condensing)
 - j. PIR Fields of View: 22 long range edges, 12 intermediate edges, Six lower edges.
 - k. Four look-down edges.
 - l. Maximum Dimension: 4.685 inches x 2.795 inches x 1.654 inches.
 - m. Sensitivity: Standard: 3-4 steps Intermediate: 2-3 steps.

2.14 DOOR POSITION SWITCHES

- A. Magnetic door position switches - Recessed - Magnasphere model MSS Series used as Basis of Design, any/all substitution request shall meet the following criteria:**
1. Recessed mounted magnetic switches.
 2. 1 inches diameter self-locking.
 3. UL 634 Listed.
 4. Resistant to defeat by placing magnet against frame.
 5. Resistant to arcing and fusing from lighting and voltage spikes.
 6. Weatherproof, fully sealed.
 7. 0.25 Watt contact rating.
 8. Double Pole-Single Throw (DPST)
 9. Closed-loop configuration.
 10. Coordinate color to match door frame.

- B. Magnetic door position switches - Surface Mount - Magnasphere model MSS Series used as Basis of Design, any/all substitution request shall meet the following criteria:
1. Anodized aluminum housing.
 2. UL 634 Listed.
 3. Resistant to defeat by placing magnet against frame.
 4. Resistant to arcing and fusing from lighting and voltage spikes.
 5. Weatherproof, fully sealed.
 6. 0.25 Watt contact rating.
 7. Double Pole-Single Throw (DPST)
 8. 24 inches Armored Cable.
 9. Closed-loop configuration.
 10. Coordinate color to match door frame.

2.15 ACCESS CONTROL AND DOOR HARDWARE POWER SUPPLIES

- A. Power Supplies for door hardware and access control hardware shall be designed specifically for the system equipment installed. Power supplies shall be regulated, isolated versions for the access control panel, I/O Modules, Readers, Door Locking Hardware and the security monitoring peripheral equipment. Each version shall be available in UPS with battery back-up and non-UPS models. All power supplies shall be housed in locked enclosures that also allow mounting space for the access control panels, I/O Modules, single reader modules, dual interface modules or other device/panel required.
1. Provide separate power supplies for the access control equipment and door locking hardware.
 2. The power supplies shall be UL listed for use with the specified access control system.
 3. Electric lock power supplies shall be UL listed for use with the specified lock manufacturer.
 - a. Coordinate with Division 08 for electric lock manufacturer.
 - b. The Contractor has the option to combine more than one door on one power supply. Coordinate with Division 08, the power requirements for each lock to determine the size of power supply required.
 4. Power supplies for doors with high current electric latch retraction will be provided by Division 08.

2.16 SURGE AND TAMPER PROTECTION

- A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.
1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
- B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal at the security monitoring screen when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and submit as Project planning documents for review and approval by Owner and Architect.
 - 1. Record setup data for control station and workstations.
 - 2. For each location, record setup of Access control panel features and access requirements.
 - 3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
 - 4. Set up groups, facility codes, linking, and list inputs and outputs for each Access control panel.
 - 5. Assign action message names and compose messages.
 - 6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
 - 7. Prepare and install alarm graphic maps.
 - 8. Develop user-defined fields.
 - 9. Develop screen layout formats.
 - 10. Complete system diagnostics and operation verification.
 - 11. Prepare a specific plan for system testing, startup, and demonstration.
 - 12. Develop acceptance test concept and, on approval, develop specifics of the test.
 - 13. Develop cable and asset management system details; input data from construction documents. Include system schematics and Visio Technical Drawings.
- B. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.2 INSTALLATION

- A. Comply with the requirements of Section 28 05 01.
- B. Coordinate all work with the Owner prior to the commencement of the scope of work as specified herein.
- C. Apply for, and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.
- D. Install and terminate all security circuits to the door hardware supplied and installed by Division 08. Coordinate with the Division 08 contractor the installation and termination of all cabling and security devices.
- E. Coordinate the conduit/raceway installation with the Division 26 contractor. Conduit to be provided beyond what is shown on the [EY] series project drawings shall be the responsibility of the Security Contractor.
- F. Install equipment and devices in accordance with manufacturer's specifications.
- G. Coordinate with the Owner the complete system configuration requirements of the Owner.
 - 1. The installer/contractor shall be responsible for configuring/programming the system to meet the operational requirements of the Owner.
- H. Install readers and integrate into special assemblies as may be required for elevator call panels, narrow jamb frames and pedestal mounts.

3.3 FIELD QUALITY CONTROL

- A. Field Tests and Inspections

1. Test and inspect all system components and cabling to assure compliance with manufacturer's requirements for operation in accordance with the requirements in Section 28 05 01.

3.4 SYSTEM STARTUP

- A. Coordinate requirements of this Section with Section 01 75 00 – Checkout and Startup Procedures when applicable.
- B. Coordinate with the manufacturer's services and requirements.

3.5 DEMONSTRATION AND TRAINING

- A. Comply with requirements in Section 28 05 01.

END OF SECTION

SECTION 28 20 01
VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements include system expandability to accommodate the addition of multiple monitors, as well as multiple cameras and increased coverage areas and integration of the system with the access control system to allow automatic camera call-up during alarm events. The system allows for the surveillance/viewing of remote areas from one or more local and remote-control stations.
- B. Related Specification Sections but not necessarily limited to:
 - 1. Section 07 48 00 - Firestopping.
 - 2. Section 28 05 01 - Common Work Results for Electronic Security Systems.
 - 3. Section 28 10 01 - Access Control

1.2 REFERENCES

- A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:
 - 1. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA).
 - a. ANSI/TIA--569-E – Telecommunications Pathways and Spaces.
 - 2. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 3. UL Solutions. (UL).

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturers:
 - a. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
 - b. See Specification Section 28 05 01 for additional requirements.
 - 2. Installers:
 - a. Comply with ANSI/NFPA 70 – National Electric Code.
 - b. Comply with ANSI/TIA-569E Standard and the BICSI Telecommunications Distribution Methods Manual (TDMM) for the installation of Communication Pathways.
 - c. See Specification Section 28 05 01 for additional requirements.

1.4 SYSTEM DESCRIPTION

- A. The system specified herein shall include all components necessary for a complete and operating video system, interfaced to the Owner's building network. The hardware shall include but not limited to, encoders, decoders, servers, workstations, display monitors, video storage units, and management software. The system shall include an intuitive computerized graphical user interface for system configuration, diagnostics, and video surveillance.
- B. Include all programming and configuration, for the complete set up, operation and administration of the system.
- C. Include all programming for graphical map representation of each camera location. The graphical maps, floor/site plans, shall be the same as used by the card access control system.

D. Design Requirements:

1. Provide an interface from the video management system to the access control system for alarm assessment camera call up, and review of video events prior and during the alarm.
2. Visit the project site prior to the bid date to verify the existing site conditions.

E. Performance Requirements:

1. All cameras shall be environmentally rated for its intended installed location. The Security Contractor shall be responsible for visiting the project site prior to bid to evaluate each camera location to verify the environmental camera housing requirement.
2. All cameras shall be continuously recorded on the network video recorders.
3. Provide network video storage for each camera installed on the project.
 - a. Network video storage shall include the storage of each video signal at a minimum frame rate of 15 images per second at 2-megapixel resolution for 30 days.

1.5 SUBMITTALS

A. Action Submittals

1. Shop Drawings:
 - a. Fabrication and/or layout drawings:
 - 1) Routing, size, and fittings.
 - 2) Seismic location installation details.
2. Product technical data.
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. See Specification Section 28 05 01 for additional requirements.
3. Testing Plans, Procedures, and Testing Limitations:
 - a. Project planning document: Submit 2 weeks prior to the Project planning document review meeting.

B. Informational Submittals:

1. Cable tray fill calculations.
2. Cable schedule of number and type of cables in cable trays.

C. Maintenance Material Submittals:

1. Furnish the following items and submit documentation of delivery to and acceptance of such items by Owner, in accordance with Section 01 78 43 - Spare Parts and Extra Materials:
 - a. One camera housing for each type utilized on the project as spares.
 - b. One power supply for each type utilized on the project as spares.
 - c. Two cameras for each type utilized on the project as spares.
 - d. Two lenses for each type utilized on the project as spares.
 - e. One factory box for each component, addressed to the manufacturer to facilitate factory returns for repair.
 - f. Written procedures for obtaining return authorizations (If not required, state so in writing).

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Project planning documents review meeting: Met with Owner and Engineer to review project planning document.

1.7 PROJECT DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 28 05 01

1.8 WARRANTY

- A. Comply with the requirements of 28 05 01.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers of Integrated Dome Camera Systems:
 - 1. Avigilon.
- B. Manufacturers of Camera System Mounting Adapters.
 - 1. Avigilon.
- C. Manufacturers of Network Video Recorders:
 - 1. Hanwha Techwin.
 - 2. Axis.
 - 3. OnSSI.
 - 4. Or equal.
- D. Manufacturers of Camera Power Supplies:
 - 1. Hirschmann.
 - 2. Or equal.

2.2 VIDEO SURVEILLANCE CAMERAS

- A. Interior 360 Fisheye Camera
 - 1. 12 Megapixel resolution.
 - 2. Image Sensor: Progressive Scan CMOS 1/1.8-inch.
 - 3. Video Compression: H.265 and H.264 Baseline and Main Profile, MJPEG.
 - 4. Frame Rate: 60fps H.265 and H.264, 30fps MJPEG.
 - 5. Resolution: Adjustable to 3840x2160 maximum.
 - 6. Casing: Tamper-resistant polycarbonate transparent cover and casing, Aluminum inner camera module with encapsulated electronics.
 - 7. Color: White.
 - 8. Memory: 512GB Micro SD/SDHC/SDXC card slot.
 - 9. Power: Power over Ethernet IEEE 802.3af/802.3at Type 1, Class 2, max. 5.9 Watts., 12VDC, 24VAC.
 - 10. Connectors: RJ45 10BASE-T/100BASE-TX PoE.
 - 11. Operating Conditions: -40 degrees F to 131 degrees F, Humidity 10-100% RH (condensing).
 - 12. Built-in microphone – enable audio recording for each camera.
 - 13. Furnish Pendant kit, ceiling bracket, wall mount, or pole adapter with each camera.
 - 14. Design basis: Avigilon, H6A Fisheeye Camera
- B. High Definition Mini Dome Camera.
 - 1. 8 Megapixel resolution.
 - 2. Image Sensor: Progressive Scan CMOS 1/2.8-inch.
 - 3. Lens: Varifocal, Remote focus and zoom, P-Iris Control, IR corrected.
 - 4. Focal Length: 2.8 ~ 12 mm.
 - a. Angle of view: H: 119.5 degrees ~ 27.9 degrees / V: 62.8 degrees ~ 15.7 degrees / D: 142.1 degrees ~ 32.0 degrees
 - 5. Day and Night: Automatically removable infrared-cut filter.
 - 6. Minimum Illumination:
 - a. Color: 0.015 lux, F1.4, 30IRE.
 - b. B&W: 0.0015 lux, F1.4, 30 IRE

7. Camera Angle Adjustment: Pan 360 degrees, tilt 160 degrees, rotation 340 degrees.
8. Video Compression: H.265 and H.264 Baseline and Main Profile, MJPEG.
9. Frame Rate: 60fps H.265 and H.264, 30fps MJPEG.
10. Resolution: Adjustable to 1920x1080 maximum.
11. Casing: Tamper-resistant polycarbonate transparent cover and casing, Aluminum inner camera module with encapsulated electronics.
12. Color: White.
13. Memory: 512GB Micro SD/SDHC/SDXC card slot.
14. Power: Power over Ethernet IEEE 802.3af/802.3at Type 1, Class 2, max. 5.9 Watts., 12VDC, 24VAC.
15. Connectors: RJ45 10BASE-T/100BASE-TX PoE.
16. Operating Conditions: -40 degrees F to 131 degrees F, Humidity 10-100% RH (condensing).
17. Built-in microphone – enable audio recording for each camera.
18. Furnish Pendant kit, wall mount, and pole adapter with each camera.
19. Design basis: Avigilon H6A Dome Camera

C. High Definition Multisensor Dome Camera.

1. 8 Megapixel resolution.
2. Image Sensor: 4x Progressive Scan CMOS 1/2.8-inch.
3. Lens: Varifocal, Remote focus and zoom, P-Iris Control, IR corrected.
4. Focal Length: 2.8 ~ 12 mm.
 - a. Angle of view: H: 119.5 degrees ~ 27.9 degrees / V: 62.8 degrees ~ 15.7 degrees / D: 142.1 degrees ~ 32.0 degrees
5. Day and Night: Automatically removable infrared-cut filter.
6. Minimum Illumination:
 - a. Color: 0.015 lux, F1.4, 30IRE.
 - b. B&W: 0.0015 lux, F1.4, 30 IRE
7. Video Compression: H.265 and H.264 Baseline and Main Profile, MJPEG.
8. Frame Rate: 60fps H.265 and H.264, 30fps MJPEG.
9. Resolution: Adjustable to 3840x2160 maximum.
10. Casing: Tamper-resistant polycarbonate transparent cover and casing, Aluminum inner camera module with encapsulated electronics.
11. Color: White.
12. Memory: 512GB Micro SD/SDHC/SDXC card slot.
13. Power: Power over Ethernet IEEE 802.3af/802.3at Type 1, Class 2, max. 5.9 Watts., 12VDC, 24VAC.
14. Connectors: RJ45 10BASE-T/100BASE-TX PoE.
15. Provide Avigilon ACMICR-1001 microphone for interior installations – enable audio recording for each camera.
16. Operating Conditions: -40 degrees F to 131 degrees F, Humidity 10-100% RH (condensing).
17. Furnish Pendant kit, parapet mount, or pole adapter with each camera.
18. Design basis: Avigilon Alta H5A Multisensor Camera

2.3 NETWORK VIDEO RECORDER

- A. Capable of 32 channels, 32MP resolution camera support.
- B. Capable of 400Mbps network camera recording.

- C. Provide with 30 days or storage capacity at full resolution 20 fps
- D. Dual HDMI display video out.
- E. Dynamic Event support.
- F. Bookmark management for easy retrieval and protection of video clips (Up to 100 bookmarks)
- G. H.265, H.264, MJPEG compression support.
- H. Supports 16 SATA HDDs, up to 10Tb each (Maximum capacity 160TB)
- I. External iSCSI storage.
- J. RAID 5
- K. Compression - H.265, H.264, MJPEG
- L. Fisheye De-warping.
- M. Web viewer.
- N. Local viewing with manufacturer's software.
- O. Resolution - 32MP (15fps, H.265 Only), 12MP(30fps, H.265 Only), 8.3MP(120fps), 1080p(480fps), 720P(960fps), D1(960fps)
- P. Basis of Design: Wisenet WRN-3210B4 - 32 channel

2.4 POWER SUPPLIES

- A. Power Over Ethernet Midspan.
 - 1. Design Basis: L-Com, BTD-CAT5-P4J
 - 2. Quad Port Passive PoE Midspan with integral Surge Protection.
 - 3. Extended Temperature Range.
 - 4. Operating Temperature: -40 degrees C to +70 degrees C.
 - 5. Operating voltage: +/- 55V, Maximum current 1 Amp.
 - 6. Enclosure Dimensions: 2.5 inches H x 4.5 inches W x 1.5 inches D Nominal.
 - 7. Cast aluminum enclosure with Din Rail Mounting clip.
 - 8. 8 RJ45 Ports.
 - 9. Grounding Lug.
- B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal at the security monitoring screen when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

2.5 CAMERA SYSTEM MOUNTING ADAPTERS

- A. Wall Mount Arm.
 - 1. The mounting adapter shall consist of a rugged wall mount arm designed specifically for use with the integrated positioning system pan & tilt units.
 - 2. The mounting adapter shall consist of a rugged wall mount arm designed specifically for use with the integrated dome camera system pan & tilt units.
 - a. The integrated dome camera mounting adapter shall be equipped with 1-1/2 inch NPT adapter to facilitate the mounting of pendant mount dome housings.
 - 3. The adapter shall be capable of handling a load of up to 100 pounds.
 - 4. The adapter shall be constructed of an aluminum casting and flat plate and shall be finished in a polyester powder coating.
 - 5. The adapter shall weigh a maximum of 9 pounds.
 - 6. The adapter shall be mounted via four user supplied 5/16 inches fasteners suitable for the mounting surface.

B. Pole Mount Adapter.

1. The pole mount shall facilitate the mounting of the integrated positioning system and integrated dome system to a pole with a minimum diameter of 3.00 inches.
2. The pole mount shall support up to 100 pounds.
3. The pole mount shall feature three mounting slots for the attachment of stainless steel straps for strapping to the pole.
4. The pole mount adapter shall be constructed of 5052H32 aluminum, .190 inches thick.
5. The pole mount adapter shall be finished in gray polyester powder coat.
6. The pole mount adapter shall weigh a maximum of 3 pounds.
7. Furnish the following hardware with each adapter.
 - a. Two, 5 feet stainless steel straps.
 - b. Two banding clips.
 - c. Six hex head cap screws.
 - d. Six flat and lock washers.
 - e. Six hex nuts.

C. Parapet Mounting Adapter.

1. Provide aluminum alloy construction.
2. The parapet mount shall facilitate the mounting of the integrated positioning system to the inside of a parapet wall or to the top of the parapet or roof top.
3. The parapet mount shall be capable of supporting up to 100 pounds.
4. The parapet mount shall require a minimum of 18 inches of inside wall height for mounting.
5. The parapet mount shall utilize four 5/16 inches mounting studs for attaching the Wall Arm.
6. The parapet mount for the inside wall application shall be secured to the wall with sixteen fasteners of 1/4 inches minimum diameter suitable for the mounting surface.
7. The parapet mount for the top of the parapet shall be secured to the horizontal surface with a minimum of eight 3/8 inches fasteners suitable for the mounting surface.
8. The parapet mount vertical tube for inside wall mounting shall measure 24 inches L and the width of the mount shall be 15 inches W and shall weigh a maximum of 10 pounds.
9. The parapet mount vertical tube for top surface mounting shall measure 48 inches L with a mounting base which is 18 inches square and shall weigh a maximum of 30 lbs.
10. The parapet mount shall be finished in a Corrosion-resistant white polyester powder coat.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Obtain detailed Project planning forms from manufacturer of surveillance system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval by Owner and Engineer.
1. Record setup data for control station and workstations.
 2. For each location, record setup of camera features and view requirements.
 3. Assign action message names and compose messages.
 4. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
 5. Prepare and install camera graphic maps.
 6. Develop user-defined fields.
 7. Develop screen layout formats.
 8. Complete system diagnostics and operation verification.
 9. Prepare a specific plan for system testing, startup, and demonstration.

10. Develop acceptance test concept and, on approval, develop specifics of the test.
 11. Develop cable and asset management system details, input data from construction documents. Include system schematics and Visio Technical Drawings.
- B. In meetings with Engineer and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.2 INSTALLATION

- A. Comply with the requirements of Section 28 05 01.
- B. Coordinate all work with the Owner prior to the commencement of the scope of work as specified herein.
- C. Apply for, and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.
- D. Install and terminate all security circuits to the cameras supplied and installed by this section.
- E. Coordinate the conduit/raceway installation with the Section 27 05 28.
- F. Install equipment and devices in accordance with manufacturer's specifications.
- G. Coordinate with the Owner the complete system configuration requirements of the Owner.
 1. The installer/contractor shall be responsible for configuring/programming the system to meet the operational requirements of the Owner.

3.3 FIELD QUALITY CONTROL

- A. Field Tests and Inspections
 1. Test and inspect all system components and cabling to assure compliance with manufacturer's requirements for operation in accordance with the requirements in Section 28 05 01.

3.4 SYSTEM STARTUP

- A. Coordinate requirements of this Section with Section 01 75 00 – Checkout and Startup Procedures when applicable.
- B. Coordinate with the manufacturer's services and requirements.

3.5 ADJUSTING

- A. Provide all adjustments in accordance with the manufacturer's recommendations and Owner's requirements, such as camera views.

3.6 DEMONSTRATION AND TRAINING

- A. Comply with requirements in Section 28 05 01.

END OF SECTION

SECTION 28 31 00
FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Fire Alarm System, as indicated, in accordance with provisions of Contract Documents.
- B. System:
 - 1. Provide complete, non-coded addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on drawings and as specified herein.
 - 2. Activate system into alarm mode by actuation of any alarm-initiating device.
 - a. System shall remain in alarm mode until initiating device is reset and fire alarm control panel is reset and restored to normal.
 - 3. Use terms fire alarm control panel (FACP) and fire alarm control unit (FACU) interchangeably.
- C. Software:
 - 1. Fire alarm system shall allow for loading and editing instructions and operating sequences as necessary.
 - 2. System shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation.
 - 3. Store software operations in non-volatile programmable memory within fire alarm control unit.
 - a. Loss of primary and secondary power shall not erase instructions stored in memory.
 - 4. System shall provide storing dual configuration programs with one active and one in reserve.
 - 5. Provide panel full system operation during new configuration download.
- D. History Logs:
 - 1. System shall provide means to recall alarms and trouble conditions in chronological order for purpose of recreating event history.
 - a. Provide separate alarm and trouble log.
- E. Wiring/Signal Transmission:
 - 1. Hard wire transmission using addressable signal transmission, dedicated to fire alarm service only.
 - 2. System connections for initiating device circuits: Class B.
 - 3. Signaling line circuits and notification appliance circuits: Class B.
 - 4. Circuit supervision:
 - a. Circuit faults shall be indicated by trouble signal at FACP.
 - b. Provide distinctive indicating audible tone and alphanumeric annunciation.
 - 5. Constant supervision audio:
 - a. When provided, supervise audio notification appliance circuits during standby by monitoring for DC continuity to end of line resistors.
- F. Remote Access:
 - 1. Personal computer or technician's laptop, configured with terminal emulation software shall have ability to access FACP for diagnostics, maintenance reporting and information gathering.

G. Required Functions:

1. Priority of signals:
 - a. Fire alarm events have highest priority.
 - 1) Subsequent alarm events are queued in order received and do not affect existing alarm conditions.
 - b. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority:
 - 1) Signals of higher-level priority take precedence over signals of lower priority even though lower priority condition occurs first.
 - 2) Annunciate events regardless of priority or order received.
2. Non-interfering:
 - a. Activation of addressable device does not prevent receipt of signals from subsequent addressable device activations.
3. Transmission to approved supervising station:
 - a. Automatically route alarm, supervisory, and trouble signals to approved supervising station service provider.
4. Annunciation:
 - a. Annunciate operation of alarm and supervisory initiating devices at FACP and remote annunciator, indicating type of device, operational state of device, i.e. alarm, trouble or supervisory and display custom label associated with device.
5. Selective Alarm System, include:
 - a. Indication of alarm condition at FACP and annunciator.
 - b. Identification of device /zone that is source of alarm at FACP and annunciator.
 - c. Operation of audible and visible notification appliances until silenced at FACP.
 - d. Control Heat Pumps and ERV fans as specified.
 - e. Transmission of signal to supervising station.
 - f. Initiation of elevator Phase I functions (recall, shunt trip, illumination of indicator in cab) in accordance with ASME/ANSI A17.1, when detectors or sensors are activated.
6. Supervisory operations:
 - a. Upon activation of supervisory device such as Fire Sprinkler system switch or tamper switch, generator status, elevator shunt trip power supervision shall operate as follows:
 - 1) Activate system supervisory service audible signal and illuminate LED at FACP and remote annunciators.
 - 2) Pressing supervisory acknowledge key will silence supervisory audible signal while maintaining Supervisory LED "on" indicating off-normal condition.
 - 3) Record event in FACP historical log.
 - 4) Transmission of supervisory signal to supervising station.
 - 5) Restoring condition shall cause Supervisory LED to clear and restore system to normal.
7. Alarm silencing:
 - a. If Alarm Silence button is pressed, cease visual and audible alarm signal operation.
8. System reset:
 - a. Use System Reset button to return system to normal state.
 - b. Display messages shall provide operator assurance of sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur.
 - c. System shall verify circuits or devices are restored prior to resetting system to avoid potential for re-alarmed system.
 - d. Display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
 - e. Should an alarm condition continue, system will remain in an alarmed state.

9. Manual evacuation switch:
 - a. Provide to operate the notification appliances without causing other control circuits to be activated.
10. Walktest:
 - a. System shall have capacity of 8 programmable passcode protected one person testing groups, such that only portion of system need be disabled during testing.
 - b. Actuation of "enable one person test" program at FACP shall activate "One Person Testing" mode of system as follows:
 - 1) Bypass remote station signaling circuit connection and suppression release circuits for testing group.
 - 2) Bypass control relay functions associated with one of 8 testing groups.
 - 3) FACP shall indicate trouble condition.
 - 4) Alarm activation of initiating device in testing group shall cause audible notification appliances assigned only to that group to sound code to identify device or zone.
 - 5) Automatic reset after signaling is complete.
 - 6) Opening of initiating device or notification appliance circuit wiring shall cause audible signals to sound for 4 seconds indicating trouble condition.
- H. Performance Requirements
 1. Premises protection shall be suitable for type IIB – Non-Combustible building construction and occupancy type Group A-3/B.
- I. Provide components and features including but not limited to following.
 1. FACP.
 2. Remote annunciator.
 3. Manual station.
 4. Heat detectors.
 5. Smoke detector.
 6. Sprinkler flow switch and main waterflow detector circuits.
 7. Main, post indicator valve and O, S & Y sprinkler valve tamper switch circuits.
 8. Visual and audible notification appliances.
 9. Manual paging microphone and switches.
 - a. Building Speakers
 - b. Stairwell Speakers
 10. Fire alarm system conduit and wire.
 11. Elevator control functions.
 12. Generator supervision.
- J. Initiating, notification, and control devices, and wiring, riser diagrams shall be labeled on the building plan to support programming.
- K. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Complete conduit and wiring required for installation of fire alarm system and electrical work covered under Division 26 and Division 28 by Class A Journeymen electricians or Class A Master electricians, licensed in State of Nebraska.
- B. System Standards:
 1. NFPA 72 series bulletins as applicable.
 2. NFPA 90A.

3. Control Panel shall be listed under UL Standard 864 (Control Units and Accessories for Fire Alarm Systems).
 4. NFPA 101.
 5. National Electrical Code Article 760.
 6. ADA Standards for Accessible Design
 7. International Building Code (IBC).
- C. Design Criteria:
1. Manufacturer must have local service organization.
 2. Comply with system standards.
 3. Meet requirements of fire authorities having jurisdiction (AHJ).
 4. Complete fire detection and alarm system design, wiring diagrams, interphase wiring diagrams, and operational details by system manufacturer or authorized technical representative.
- D. Service Organization Qualifications:
1. Offer an annual maintenance contract including complete service and equipment costs for maintenance of complete system.
 2. Ten years experience minimum serving fire alarm systems.
 3. Provide for 24 HR emergency service.
 4. Factory trained NICET Level III certified technicians.
- E. Field Quality Control:
1. Manufacturer's field services: Provide services of factory-authorized certified service representative to supervise field assembly and connection of components and pretesting, testing, and adjustment of system.
 2. Service personnel shall be qualified and experienced in inspection, testing, and maintenance of fire alarm systems.
 - a. Examples of qualified personnel shall include but not be limited to individuals with following qualifications:
 - 1) Factory trained and certified.
 - 2) National Institute for Certification in Engineering Technologies (NICET Level III) fire alarm certified.
 - 3) International Municipal Signal Association (IMSA) fire alarm certified.
 - 4) Certified by state or local authority.
 - 5) Trained and qualified personnel employed by organization listed by national recognized testing laboratory for servicing of fire alarm systems.
 3. Pretesting:
 - a. Determine, through pre-testing, conformance of system to requirements of drawings and specifications.
 - b. Correct deficiencies observed in pre-testing.
 - c. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
 4. Inspection:
 - a. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
 - b. Verify that units and controls are properly installed, connected, and labeled and interconnecting wires and terminals are identified.
- F. Authority Having Jurisdiction (AHJ) Review:
1. Concurrent or prior to submission to Architect, submit shop drawing and product data to Authority Having Jurisdiction (AHJ).

2. Upon receipt of comments from AHJ, make resubmissions, if required, to make clarifications or revisions to obtain approval.

1.3 SUBMITTALS

A. Shop Drawings:

1. Scaled floor plans indicating final device locations, routing of raceway connections, and including room names and numbers corresponding to project Contract Documents.
 - a. Submit system approved by City of Lincoln. (AHJ).
2. Wiring diagrams and riser diagram:
 - a. Point-to-point wiring diagram:
 - 1) Include diagrams for equipment and for system with terminals and interconnections identified.
 - 2) Color-code schedule for fire alarm system wiring.
 - 3) Color-coding shall be reviewed and approved by owner.
 - 4) System riser diagram with device addresses, conduit sizes, and cable/wire types and sizes.
 - a) Provide clarification on drawings for each size and type of fire alarm cable to be used on Project.
 - b) Coordinate text identifier descriptions of each addressable device with owner prior to programming Fire Alarm Control Panel (FACP).
 - (1) Descriptions annunciated at FACP must include as-built room numbers to assist Fire Department during emergency response.
 - (2) Add as-built room numbers to as-built shop drawings for record purposes.
3. System power and battery charts with performance graphs and voltage drop calculations to assure that system will operate in accordance with prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
4. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs.
5. Provide list of input and output points in system with label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.
6. Equipment design considerations for future expansion when indicated.
 - a. Provide a minimum of 25 PCT spare capacity on fire alarm circuits and battery loading.
7. Operating instructions for FACP.

B. Product Data:

1. Provide exact types and quantity of fire alarm devices.
 - a. Identify specific components on technical data sheets.
2. Name of local service organization.

C. Contract Closeout Information:

1. Completion Documents and Permanent Records in accordance with NFPA 72.
 - a. Include final device address list after programming system.
2. Test report in accordance with NFPA 72.
3. Operation and maintenance manuals:
 - a. Provide shop drawings and product data in PDF format.
 - b. Provide three (3) copies of Operation and Maintenance Manuals outlining step-by-step procedures required for system startup, operation, and shutdown.
 - c. Provide routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide.

- d. Provide manufacturer's name, model number, service manual, parts list, and a complete description of equipment and their basic operating features.
- e. Provide printout of addressable device list in O&M Manual.
- f. Provide copy of fire alarm system program and associated password in O&M Manual.
- g. O&M Manuals shall be approved prior to training.
- 4. Owner instruction report.
- 5. Sequence of operation:
 - a. Provide sequence of operation input and output matrix.
 - 1) See NFPA 72.
 - 2) Indicate input/output actions for all fire alarm functions and ancillary systems associated with the fire alarm system to include, but not be limited to, elevator safety functions, fire sprinkler, and public address.
 - 3) Indicate specific ID's for mechanical air handling equipment, elevator systems, and similar items that need to be included for commissioning purposes as well as future reference.
 - 4) After new fire detection and alarm system is commissioned and acceptance testing has been completed, revise Sequence of Operations matrix to accurately reflect as-built conditions.
 - 5) Performance testing of Sequence of Operations must be witnessed and approved by AHJ.
 - a) Contractor shall make advance arrangements and schedule with AHJ prior to performance testing.
- 6. Compile Closeout documentation on electronic format media approved by Owner and Architect.

1.4 STORAGE DELIVERY AND HANDLING

- A. Contractor shall provide necessary means to properly stage and store materials and equipment until time of use or installation on the Project.
 - 1. Contractor shall be solely responsible for materials and equipment stored on the Site; type and extent of security provided to be at Contractor's discretion.
 - 2. Coordinate all requirements with Owner.
- B. Contractor shall be responsible for proper handling, rigging, and installing of materials and equipment for the Project.
- C. Owner reserves the right to reject any materials or equipment that is not properly stored in accordance with these specifications or the Manufacturers' requirements.

1.5 SPARE PARTS

- A. Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:
 - 1. Break Rods for Manual Stations: Furnish quantity equal to 15 PCT of number of manual stations installed but no less than 6 rods.
 - 2. Notification Appliances: Furnish quantity equal to 5 PCT of each type and number of units installed, but not less than one of each type.
 - 3. Automatic initiation devices including but not limited to smoke sensors and heat sensors: Furnish quantity equal to 5 PCT of each type and number of units installed but not less than one of each type.
 - a. Detector or Sensor Bases: Furnish quantity equal to 2 PCT of each type and number of units installed but not less than one of each type.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fire Alarm System:

1. Edwards.
2. Siemens.
3. Notifier/ NESCO (Notifier Engineered Systems Company).
4. Johnson Controls.
5. Autocall.
6. Gamewell.

B. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

A. Fire Alarm System:

1. UL listed as a product of a single manufacturer under appropriate category.
2. Equipment shall not be modified or installed to alter or void UL label or listing.
3. FM approved.

B. Fire Alarm System Operation – Local:

1. Activation of any signal initiating device shall cause following:
 - a. General alarm tone shall be sounded over fire alarm speakers.
 - b. One of two voice alarm messages shall be transmitted over fire alarm speakers in building except speakers in stairs.
 - 1) Speakers in stairs will be wired to operate only when voice messages are initiated manually via microphone at FACU.
 - c. General alarm visual notification appliances shall flash.
 - d. 5Specific alarm message shall be displayed and audible alarm shall sound at:
 - 1) FACU.
 - 2) Remote annunciator.
 - e. All fire alarm signals are automatically locked in at control panel and remote annunciators until originating device is returned to normal and control panel is manually reset.
 - 1) Audible alarm signals shall be silenceable from control panel allowing for re-initiation following a subsequent alarm. Silencing of alarm signals shall not impair ability of system to continue to perform as specified.
 - f. Remote station signaling unit shall automatically transmit fire alarm and/or trouble signals via cellular dialer to following location:
 - 1) Remote Supervising Station.
2. Activation of smoke detector(s) at elevator lobbies, elevator shaft shall initiate elevator recall sequence per ANSI/ASME-A17.1 for elevators in bank served by activated detector(s). Addressable control relays shall be wired to send signals to associated elevator controllers to match the following sequence of operation.
 - a. A smoke detector has been activated on second floor. Elevator manufacturer shall furnish logic at elevator controller to send elevator to first floor on receipt of this signal.
Or:
 - b. A smoke detector has been activated on first floor. Elevator manufacturer shall furnish logic at elevator controller to send elevator to designated second floor on receipt of this signal.

3. Activation of heat detector in elevator shaft, BACK ROOM 112 or TICKETING 109 shall shunt power to the Machine Room-less Elevator (MRE) controller.
 4. Activation of any system trouble or supervisory shall initiate the following:
 - a. Common audible signal shall sound at control panel, and at remote annunciator.
 - b. Condition shall display at the control panel, and at remote annunciators.
 5. Audible trouble or supervisory signal shall be silenceable by switch. Visual indication remains until condition is corrected. A subsequent condition received after manually silencing shall cause audible trouble signal to resound. Restoration of system to normal causes audible signal until silencing switch is returned to normal position.
 6. Trouble or supervisory signal shall be initiated under following conditions:
 - a. Open on an initiation or alarm indicating circuit.
 - b. Open in wiring to remote annunciator.
 - c. Ground fault condition.
 - d. Auxiliary manual control switch out of normal position.
 - e. Loss of 120 volt operating power to control panel, transponder or notification appliance panel.
 - f. Low or no battery voltage condition.
- C. Fire Alarm Control Panel (FACP)
1. Cabinets:
 - a. Lockable steel enclosure.
 - 1) Surface mounted.
 - b. Arrange so operations required for testing or for normal care and maintenance of system are performed from front of enclosure.
 - c. If more than single enclosure is required to form complete control unit, provide matching modular unit enclosures.
 - d. Accommodate components and allow gutter space for interconnection of units as well as field wiring.
 - e. Identify each enclosure by engraved red-laminated, phenolic resin nameplate.
 - 1) Lettering on enclosure nameplate shall not be less than 1 inch high.
 2. Systems:
 - a. Alarm and supervisory systems shall be separate and independent in each FACP.
 - b. Alarm-initiating zone boards in FACP shall consist of plug-in modules.
 - 1) Construction requiring removal of field wiring for module replacement is not acceptable.
 3. Following FACP Hardware:
 - a. 100 point capacity minimum where (1) point equals (1) monitor (input) or (1) control (output).
 - b. Provide battery voltage and ammeter readouts on FACP LCD Display from battery charging circuits in system.
 - c. Remote station signaling unit with disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or form "C" contact output.
 - 1) Listed and labeled according to UL 632.
 - 2) Functional Performance:
 - a) Unit receives alarm, supervisory, or trouble signal and automatically captures one of two cellular pathways and dials preset number for remote central station.
 - b) When contact is made with central station(s), signal is transmitted.
 - c) Unit supervises up to two cellular pathways. If service on either line is interrupted for longer than 60 seconds, unit initiates local trouble signal and transmits signal indicating loss of telephone line to remote alarm receiving

- station over remaining line. When telephone service is restored, unit automatically reports that event to central station.
- d) If service is lost on both telephone lines, local trouble signal is initiated.
- 3) Secondary Power:
 - a) Integral rechargeable battery and automatic charger.
 - b) Battery capacity to be adequate to comply with NFPA 72 requirements.
- d. One auxiliary electronically resettable fused 2A at 24VDC Output, with programmable disconnect operation for 4-wire detector reset.
- e. One auxiliary relay, SPDT 2A at 32VDC, programmable as trouble relay, either as normally energized or de-energized, or as auxiliary control.
- f. Provide battery charger for charging up to 110Ah batteries.
- g. Four (4) form C Auxiliary Relay Circuits (Form C contacts rated 2A at 24VDC, resistive), operation to be programmable for trouble, alarm, supervisory or other fire response functions.
 - 1) Relays shall be capable of switching up to 1/2 A at 120VAC, inductive.
- h. Programmable digital alarm communications transmitter (DACT) with per point reporting.
 - 1) Provide cellular dialer: Honeywell TG-7FS or equivalent.
 - a) Confirm owner cellular provider before ordering equipment.
- 4. Distributed Module Operation:
 - a. FACP shall be capable of allowing remote location of modules for following circuits;
 - b. Addressable Signaling Line Circuits.
 - c. Initiating Device Circuits.
 - d. Notification Appliance Circuits.
 - e. Auxiliary Control Circuits.
- 5. Alphanumeric Display and System Controls:
 - a. Arrange to provide basic interface between human operator at FACP and addressable system components, including annunciation, supervision, and control.
 - b. Include expanded content multi-line QVGA LCD display to indicate alarm, supervisory, and component status messages and shall include keypad for use in entering and executing control commands.
 - 1) Provide expanded content, multi-line, operator interface displays with Quarter-VGA (QVGA) or larger text capable of supporting minimum of 800 standard ASCII characters.
 - a) QVGA operator interface shall provide operator prompts and at least six context sensitive soft-keys for intuitive operation.
 - b) Operator interfaces shall be capable of providing following functions:
 - (1) Dual language operation with Instant-Switch language selection during runtime.
 - (2) Activity display choices for:
 - (a) First 8 events.
 - (b) First 5 events and most recent event with first and most recent event time and date stamps.
 - (c) First event and most recent event with first and most recent event time and date stamps.
 - (d) Scrollable list display displays scrollable list of active points for event category (alarm, priority 2, supervisory, or trouble) selected. Position in this list will be last acknowledged point (not flashing) at top followed by next 7 unacknowledged points (flashing).

- (e) General event status (alarm, priority 2, supervisory, or trouble in system)
 - (f) Site plan.
- c) In systems with two or more operator interfaces, each operator interface shall be programmable to allow multiple operator interfaces to have equal operation priority or to allow hierarchical priority control to be assigned to individual operator interface locations.
- d) Up to 50 custom point detail messages for providing additional point specific information in detailed point status screens.
- e) Bitmap file import for operator interface display of site plan and background watermark images. Site plan status icons shall indicate area status for highest priority active events.
- f) Provide dual-language operation:
 - (1) Language selection shall be via switch on operator interface panel. Operator interface panels shall support instant-language-switchover during runtime to allow operator to toggle between languages each time language selection switch is operated, without requiring complicated multi-step processes.
 - (2) Both one-byte and two-byte characters shall be supported.
- 6. FACP:
 - a. Control panel shall be listed under UL Standard 864 (Control Units).
- 7. Control unit construction shall be modular with solid state, microprocessor based electronics.
 - a. It shall display only those primary controls and displays essential to operation during fire alarm condition.
 - b. Keyboards or keypads shall not be required to operate system during fire alarm conditions.
- 8. Local audible device shall sound during Alarm, Trouble or Supervisory conditions.
 - a. This audible device shall also sound during each key press to provide audible feedback to ensure that key has been pressed properly.
- 9. Following primary controls shall be visible through door:
 - a. LCD display.
 - b. Individual fire alarm LED.
 - c. Individual priority 2 alarm LED.
 - d. Individual supervisory service LED.
 - e. Individual trouble LED.
 - f. Power on LED.
 - g. Signals silenced LED.
 - h. Fire alarm acknowledge key.
 - i. Priority 2 alarm acknowledge key.
 - j. Supervisory service acknowledge key.
 - k. Trouble acknowledge key.
 - l. Alarm silence key.
 - m. System reset key.
- 10. Following programmable secondary control switches and LEDs shall be available behind access door:
 - a. Remote station signal disconnect/switch.
 - b. Manual evacuation (drill).
 - c. Spare.

11. Control Unit:
 - a. Setting of time and date.
 - b. LED testing.
 - c. Alarm, trouble, and abnormal condition listing.
 - d. Enabling and disabling of each monitor point separately.
 - e. Activation and deactivation of each control point separately.
 - f. Changing operator access levels.
 - g. One Person test enable.
 - h. Running diagnostic functions.
 - i. Displaying software revision level.
 - j. Displaying historical logs.
 - k. Displaying card status.
 - l. Point listing.
12. For maintenance purposes following lists shall be available from point lists menu:
 - a. All points list by address.
 - b. Monitor point list.
 - c. Signal/speaker list.
 - d. Auxiliary control list.
 - e. Feedback point list.
 - f. Pseudo point list.
 - g. LED/switch status list.
13. Scrolling through menu options or lists shall be accomplished in self-directing manner in which prompting messages shall direct user.
 - a. These controls shall be located behind access door.
14. Under normal conditions front Unit shall display System is Normal message and current time and date.
15. Should abnormal condition be detected, appropriate LED (Alarm, Supervisory or Trouble) shall flash.
 - a. Unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
16. Two methods of acknowledgment for each abnormal condition shall be provided.
 - a. One may be chosen depending on NFPA requirements.
17. These acknowledge functions shall be passcode protected if user has insufficient privilege to acknowledge such conditions.
 - a. Message shall indicate insufficient privilege but allow user to view points without acknowledging them.
 - b. Should user have sufficient privilege to acknowledge, message will be displayed informing user that condition has been acknowledged.
18. After points have been acknowledged, LEDs shall glow steady and tone alert will be silenced.
 - a. Total number of alarms, supervisory and trouble conditions shall be displayed along with prompt to review each list chronologically.
 - b. End of list shall be indicated by end of message END of LIST.
19. Alarm silencing:
 - a. Should Alarm Silence button be pressed alarm signals shall cease operation and signals silenced LED will illuminate.
 - b. Signals shall not be silenced during alarm silence inhibit mode.
20. System reset:

- a. System reset button shall be used to return system to normal state after alarm condition has been remedied.
 - 1) LCD display shall step user through reset process with simple English Language Messages, SYSTEM RESET IN PROGRESS, will first be displayed followed by message, SYSTEM RESET COMPLETED, and finally, SYSTEM IS NORMAL, should all alarm conditions be cleared.
 - b. Should alarm condition continue to exist, SYSTEM RESET IN PROGRESS, will be followed by message, SYSTEM RESET ABORTED, and system will remain in abnormal state.
 - 1) System control relays shall not reset.
 - 2) Tone alert and Alarm LED will be on.
 - 3) Display will indicate total number of alarms and troubles present in system along with prompt to use ACK keys to review points.
 - 4) These points will not require acknowledgment if they were previously acknowledged.
 - c. Should Alarm Silence Inhibit function be active, SYSTEM RESET key press will be ignored.
 - 1) Message, SYSTEM RESET INHIBITED, will be displayed for short time to indicate action was not taken.
 - 2) As feedback to operator, message SYSTEM RESET NO LONGER INHIBITED will be displayed when inhibit function times out.
21. Function keys:
- a. Additional function keys shall be provided to access status data for following points:
 - b. Initiating device circuits.
 - c. Indicating appliance circuits.
 - d. Auxiliary relays.
 - e. Feedback points.
 - f. All other input/output points.
22. Following status data shall be available:
- a. Primary state of point.
 - b. Zone, PID and card type information.
 - c. Current priority of outputs.
 - d. Disable/Enable status.
 - e. Verification tallies of initiating devices.
 - f. Automatic/Manual control status of output points.
 - g. Acknowledge status.
 - h. Relay status.
23. System shall be capable of logging and storing a minimum of 500 events in alarm log and 500 events in trouble log.
- a. Each recorded event shall include time and date of event's occurrence.
 - b. Following historical alarm log events shall be stored:
 - 1) Alarms.
 - 2) Alarm acknowledgment.
 - 3) Alarm Silence.
 - 4) System reset.
 - 5) Alarm historical log cleared.
 - c. Following historical trouble log events shall be stored:
 - 1) Trouble conditions.
 - 2) Supervisory alarms.

- 3) Trouble acknowledgment.
 - 4) Supervisory acknowledgment.
 - 5) Alarm verification tallies.
 - 6) One Person test results.
 - 7) Trouble historical log cleared.
24. LED supervision:
- a. Control module LEDs shall be supervised for burnout or disarrangement.
 - b. Should problem occur LCD shall display module and LED location numbers to facilitate location of LED.
25. System trouble reminder
- a. Should trouble condition be present within system and audible trouble signal silenced, trouble signal shall resound at preprogrammed time intervals to act as reminder that fire alarm system is not 100 PCT operational.
26. Access levels:
- a. There shall be four (4) access levels with level 4 being highest Level 1 actions shall not require a pass code. Pass codes shall consist of up to ten (10) digits. Changes to pass codes shall only be made by authorized personnel.
 - b. In order to maintain security when entering pass code digits entered will not be displayed but cursor will move along filling position with "x" to indicate that digit has been accepted. All key presses will be acknowledged by local audible sound.
 - c. When correct pass code is entered, message "Access Granted" shall be displayed. New access level shall be in effect until operator manually logs out or keypad has been inactive for ten (10) minutes.
 - d. Should invalid code be input, operator shall be notified with message, ERROR...INCORRECT PASSCODE, and shall be allowed up to three chances to enter valid code.
 - 1) After three unsuccessful tries, message, "ACCESS DENIED", shall be displayed.
 - 2) Level shall not be altered, and operator shall no longer be in menu option.
 - e. Access to level will only allow operator to perform all actions within that level plus actions of lower levels, not higher levels.
 - f. Following keys/switches shall have access levels associated with them:
 - 1) Alarm silence.
 - 2) System reset.
 - 3) Set time/date.
 - 4) Manual control.
 - 5) On/off/auto control.
 - 6) Disable/enable.
 - 7) Clear historical alarm log.
 - 8) Clear historical trouble log.
 - 9) One person testing.
 - 10) Change alarm verification.
 - 11) Acknowledge keys shall also require privileged access to acknowledge points.
 - a) If operator presses (ACK) key with insufficient access, error message will be displayed.
 - b) Points will scroll with (ACK) key presses to view points on list, but points will not get acknowledged in database.
27. Convert main 120 volt AC power to low voltage direct current for 24 volt DC system operation.

- a. Incorporate transformer, rectifier, fuses and other power supply components in FACU, or separate panel if approved for application.
- b. Circuits requiring system-operating power shall be 24 VDC and shall be individually fused at control unit.
- c. Power supply shall supply sufficient power to operate magnetic door holders, annunciator and devices furnished by others, such as door or shutter release mechanisms.
- d. System shall support 100 PCT of addressable devices in alarm or operated at same time, under both primary AC and secondary battery power conditions.
- e. Incoming power to system shall be supervised so that any power failure will be indicated at control unit. Green power on LED shall be displayed continuously at user interface while incoming power is present.
- f. Provide low maintenance sealed type battery designed for fire alarm use with automatic battery charger.
 - 1) Batteries shall be capable of operating maximum normal load of system for 24 HRS and then capable of operating system for 15 minutes in alarm condition.
 - 2) System batteries shall be supervised so that low battery or depleted battery condition, or disconnection of battery shall be indicated at control unit and displayed for specific fault type.
 - 3) System shall support NAC Lockout feature to prevent subsequent activation of notification appliance circuits after depleted battery condition occurs in order to make use of battery reserve for front panel annunciation and control.
- g. Loss of primary power shall sound trouble signal at FACP. FACP shall indicate when system is operating on alternate power supply.

D. Remote LCD Annunciator:

- 1. Provide one remote LCD annunciator where indicated with same look and feel as FACP operator interface.
 - a. Remote LCD annunciator shall use same Primary Acknowledge, Silence, and Reset Keys; Status LEDs and LCD Display as FACP.
- 2. Annunciator shall have super-twist LCD display with two lines of 40 characters each.
 - a. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.
- 3. Annunciator to be recessed in wall with finish approved by architect.
- 4. Under normal conditions LCD shall display SYSTEM IS NORMAL message and current time and date.
- 5. When an abnormal condition is detected appropriate LED (Alarm, Supervisory or Trouble) flash.
 - a. Unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
- 6. LCD shall display following information relative to abnormal condition of point in system:
 - a. 40 character custom location label.
 - b. Type of device (e.g., smoke, pull station, waterflow).
 - c. Point status (e.g., alarm, trouble).
- 7. Operator keys shall be key switch enabled to prevent unauthorized use.
 - a. Key shall only be removable in disabled position. Acknowledge, Silence and Reset operation shall be same as FACP.

E. Signal Initiating Devices:

- 1. General:
 - a. There shall be no limit to number of stations, sensors, or zone adapter modules, which may be activated or in alarm simultaneously.

2. Manual Fire Alarm Stations:
 - a. General alarm initiation device with integral addressable module, arranged to communicate manual station status, normal, alarm, or trouble, to FACP.
 - b. Double-action type,
 - c. Red Lexan or metal, with molded, raised-letter operating instructions of contrasting color, semi-flush mounted at 4 FT above floor level.
 - d. Station shall mechanically latch upon operation and remain so until manually reset by opening with key common with FACP.
 - 1) Stations that use Allen wrenches or special tools to reset will not be accepted.
 - e. Manual station shall be fitted with screw terminals for field wire attachment.
 - f. Stations requiring breaking of glass panel are not acceptable.
 - g. Stations requiring breaking of concealed rod may be provided.
 - h. Pull stations shall contain communication transmitter and receiver having unique identification and capability for reporting status to FACP.
 - i. In unfinished rooms, use surface mount back box.
3. Smoke Sensors:
 - a. General:
 - 1) Comply with UL 268 Smoke Detectors for Fire Protective Signaling Systems.
 - 2) Include following features:
 - a) Factory nameplate: Serial number and type identification.
 - b) Operating voltage: 24 VDC, nominal.
 - c) Self-restoring: sensors shall not require resetting or readjustment after actuation to restore normal operation.
 - d) Integral addressable module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
 - e) Plug-in arrangement:
 - (1) Detector and associated encapsulated electronic components to be mounted in module that connects to fixed base with twist-locking plug connection.
 - (2) No special tools shall be required to remove head once it has been locked.
 - (3) Removal of sensor head shall interrupt supervisory circuit of fire alarm detection loop and cause trouble signal at FACP.
 - (4) Plug connection requires no springs for secure mounting and contact maintenance.
 - f) Terminals in fixed base shall accept building wiring.
 - g) Each detector base shall contain LED that will flash each time it is scanned by FACP (once every 4 seconds). In alarm condition, sensor base LED shall be on steady.
 - (1) Sensors that do not provide visible indication of abnormal condition at sensor location shall not be acceptable.
 - h) Each detector base shall contain magnetically actuated test switch to provide for easy alarm testing at sensor location.
 - i) Each detector shall be scanned by FACP for its type identification to prevent inadvertent substitution of another detector type.
 - (1) Upon detection of wrong device, FACP shall operate with installed device at default alarm settings for that sensor; 2.5 PCT obscuration for photoelectric detector, 135 DEGF and 15 DEGF rate-of-rise for the heat detector but shall indicate Wrong Device trouble condition.
 - j) Detector electronics shall be immune from nuisance alarms caused by EMI and RFI.

- k) Sensors shall include communication transmitter and receiver in mounting base having unique identification and capability for status reporting to FACP.
 - (1) Detector address shall be located in base to eliminate false addressing when replacing detectors.
 - l) Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 - m) Removal of detector head for cleaning shall not require setting of addresses.
 - n) Each concealed detector shall have remote test station with an alarm LED and test switch.
 - b. Area smoke detector shall be of photoelectric or combination photoelectric / heat type.
 - 1) Alternative bases with relay output or sounder shall be provided as required.
 - c. Quantity and Spacing:
 - 1) Smooth ceilings:
 - a) Layout is based on 30 FT spacing.
 - b) If UL rating of detector provided varies from this spacing, provide additional detectors as required to for code compliance.
 - 2) Non-smooth ceilings:
 - a) Detector symbols in rooms without smooth ceilings indicate the room or space to be protected but not the number or spacing of detectors.
 - b) Determine ceiling conditions and provide number of detectors and spacing to fully protect room or space in accordance with NFPA-72.
 - 3) Detectors shall not be located adjacent to or within 3 FT of HVAC diffusers, return grills or other locations where diffusers or return grills would cause false detector readings.
 - a) Any detectors not in compliance with minimum distance requirements shall be relocated as required to attain code compliance.
- 4. Addressable Circuit Interface Modules:
 - a. Arrange to monitor or control one or more system components that are not otherwise equipped for addressable communication.
 - 1) Modules shall be used for monitoring of waterflow, valve tamper, fire suppression systems, non-addressable devices, and for control of AHU systems.
 - b. Capable of mounting in standard electric outlet box.
 - c. Include cover plates to allow surface or flush mounting.
 - d. Modules shall receive their operating power from signaling line circuit or separate two wire pair running from appropriate power supply, as required.
 - e. Provide following types of modules (as applicable):
 - 1) Type 1: Monitor circuit interface module:
 - a) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision.
 - (1) Supervision of zone wiring shall be Class B.
 - (2) Module shall communicate status (normal, alarm, trouble) to FACP.
 - b) For conventional 4-wire smoke detector with Class B wiring supervision.
 - (1) Module shall provide detector reset capability and over-current power protection for 4-wire detector.
 - (2) Module shall communicate status (normal, alarm, trouble) to FACP.
 - 2) Type 2: Line powered monitor circuit interface module:
 - a) Individually addressable module that has both its power and its communications supplied by two wire signaling line circuit.
 - (1) Module shall provide location specific addressability to initiating device by monitoring normally open dry contacts.

- (2) This module shall be capable of communicating four zone status conditions (normal, alarm, current limited, trouble) to FACP.
 - b) Provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices.
 - (1) Module shall communicate four zone status conditions (open, normal, abnormal, and short).
 - (2) Two-wire signaling line circuit shall supply power and communications to module.
- 3) Type 3: Single address multi-point interface modules
 - a) Module shall provide location specific addressability for four initiating circuits and control two output relays from single address.
 - (1) Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions, normal, open, current limited, and short.
 - (2) Input circuits and output relay operation shall be controlled independently and disabled separately.
 - b) Module shall provide supervised multi-state input and relay output, using single address.
 - (1) Input shall provide supervised monitoring of two normally open, dry contacts with single point and be capable of communicating four zone status conditions (normal, open, current limited, and short).
 - (2) Two-wire signaling line circuit shall supply power and communications to module.
 - c) Module shall monitor unsupervised normally open, dry contact with one point and control output relay with other point, using single address.
 - (1) Two-wire signaling line circuit shall supply power and communications to module.
- 4) Type 4: Line powered control circuit interface module
 - a) Module shall provide control and status tracking of Form "C" contact.
 - b) Two-wire signaling line circuit shall supply power and communications to module.
- f. Circuit interface modules shall be supervised and uniquely identified by control unit.
 - 1) Module identification shall be transmitted to control unit for processing according to program instructions.
 - 2) Modules shall have on-board LED to provide an indication that module is powered and communicating with FACP.
 - 3) LEDs shall provide troubleshooting aid since LED blinks on poll whenever peripheral is powered and communicating.
- 5. Isolator Modules:
 - a. Provide for short circuit isolation on addressable alarm initiation circuits.
 - b. Isolator shall be listed to UL 864.
 - c. Isolator shall mount directly to minimum 2 1/8 IN deep, standard 4 IN square electrical box, without the use of special adapter or trim rings.
 - d. Power and communications shall be supplied by addressable controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from other when short circuit occurs.
 - e. Following functionality shall be included in Isolator module:
 - 1) Report faults to host FACP.
 - 2) On-board Yellow LED shall provide module status.
 - 3) After wiring fault is repaired, Isolator modules shall test lines and automatically restore connection.

6. Flow and Tamper Switches:

- a. See mechanical Specification Divisions for different devices.
- b. Provide alarm or supervisory wiring circuits and make connections from switch terminals to fire alarm system.
- c. Provide individual address or zone for each switch of following types as applicable:
 - 1) Main sprinkler water flow detector.
 - 2) Sprinkler and standpipe flow alarm switches.
 - 3) Main sprinkler water valve tamper switches
 - 4) Post indicator valve tamper switches.
 - 5) O, S & Y valve tamper switches for sprinkler and stand pipe valves.

F. Alarm Signal Devices:

1. Fire Alarm Speakers:

- a. Input voltage: 25 or 70.7 VRMS.
- b. Power taps: 1/4, 1/2, 1 and 2 W.
- c. Input terminal ratings: 18 to 12 AWG.
- d. Frequency response: 400 to 4000 Hz for fire alarm and 125 to 12 kHz for general signaling.
- e. Wall speakers:
 - 1) Rectangular housing approximately 5 IN by 5 IN by 1.5 IN deep.
 - 2) Finish: White with red ALERT lettering.
- f. Ceiling speakers:
 - 1) Round housing approximately 7.5 IN diameter by 1/2 IN deep.
 - 2) Finish: Off-white.
 - 3) Provide tile bridge for mounting in lay-in ceilings as applicable.
- g. Speaker shall be moisture repellant and fire repellant.
- h. Sound output ratings at 3 M 10 FT per anechoic chamber, 1 kHz input, on-axis test:
 - 1) 87 dBA with 1/4 W tap setting.
 - 2) 96 dBA with 2 W tap setting.
- i. Provide as indicated.

2. Visual Notification Appliances:

- a. Strobe shall be listed to UL 1971.
- b. Strobe shall consist of xenon flash tube and associated lens/reflector system.
- c. Enclosure shall mount directly to standard single gang, double gang or 4 IN square electrical box, without use of special adapters or trim rings.
 - 1) Finish: White with red "FIRE" lettering.
- d. Visual notification appliances shall be wall or ceiling mounted as indicated.
- e. Appliances shall be provided with different minimum flash intensities of 15cd, 30cd, 75cd and 110cd.
- f. Synchronize strobes when multiple strobes and reflections can be seen from one location.
- g. Provide label inside strobe lens to indicate listed candela rating of specific appliance.

3. Combination audible/visible notification appliances: Combine audible and visible devices into common housing.

- a. Combination audible/visible notification appliances shall be listed to UL 1971 and UL 464.
- b. Combination audible/visual notification appliances shall be wall or ceiling mounted as indicated.

- c. Audible/visible enclosure shall mount directly to standard single gang, double gang or 4 IN square electrical box, without use of special adapters or trim rings.
 - 4. Combination Speaker/Visible Units:
 - a. Combine speaker and visible devices into common housing.
 - b. Addressable combination audible/visible notification appliances shall be listed to UL 1971 and UL 464.
 - c. Addressable functionality controls visible operation, while speaker operates on 25VRMS or 70.7VRMS NAC.
 - d. Twisted/shielded wire is required for speaker connections on standard 25VRMS or 70.7VRMS NAC and UTP conductors, having minimum of 3 twists per foot is required for addressable strobe connections.
 - e. The following speaker taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At 1.0W tap, speaker has minimum UL rated sound pressure level of 84dBA at 10 FT.
 - f. Speaker shall have frequency response of 400 to 4000 Hz for fire alarm and 125 to 12 kHz for general signaling.
 - g. Speaker/visible device shall install directly to 4 IN square, 1-1/2 IN deep electrical box with 1-1/2 IN extension.
 - 5. Combine horn and visible devices into common housing.
 - a. Addressable combination audible/visible notification appliances shall be listed to UL 1971 and UL 464.
 - b. Audible/visual device characteristics as indicated for individual audible and visual devices.
 - c. Audible/visible enclosure shall mount directly to standard single gang, double gang or 4 IN square electrical box, without use of special adapters or trim rings.
 - d. Appliance shall be capable of two-wire synchronization with synchronized strobe with temporal code pattern on horn.
 - e. Appliance shall be capable of two-wire synchronization with synchronized strobe firing to NAC sync signal with horn silenced.
 - 6. Isolator Modules:
 - a. Provide for short circuit isolation on addressable notification appliance circuits.
 - b. Isolator shall be listed to UL 864.
 - c. Isolator shall mount directly to minimum 2 1/8 IN deep, standard 4 IN square electrical box, without the use of special adapter or trim rings.
 - d. Power and communications shall be supplied by addressable controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from other when short circuit occurs.
 - e. Following functionality shall be included in Isolator module:
 - 1) Report faults to host FACP.
 - 2) On-board Yellow LED shall provide module status.
 - 3) After wiring fault is repaired, Isolator modules shall test lines and automatically restore connection.
- G. Power Supply to Control:
- 1. Each FACU shall be supplied by dedicated 120 VAC emergency circuit.
 - a. Each circuit breaker serving FACU shall have red marking and shall be labeled as FIRE ALARM CIRCUIT.
 - b. Post permanent label at each FACU indicating associated panel, circuit number and location of panel serving FACU.
 - c. Comply with NFPA-72 and local and State codes.
 - d. The location of the circuit disconnecting means shall be permanently identified at the fire alarm control unit and noted on as-built.

H. Wiring:

1. Conduit:
 - a. 1/2 IN minimum.
 - b. See Section 26 05 33.
2. Conductors:
 - a. 120 VAC and power supply connections: 12 GA, minimum.
 - b. Low-voltage general and evacuation alarm circuits: 14 GA, minimum.
 - c. Low-voltage signal initiating circuits: 18 GA, minimum.
 - d. Annunciator and data communication circuits: As required by manufacturer, UL listed.
 - e. Use larger wire sizes when recommended by equipment manufacturer.
3. Provide pathway survivability per NFPA 72 requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. In exposed areas:
 1. Conduit to be painted in accordance with architectural and interiors contract drawings for exposed areas.
 2. Paint fire alarm system junction boxes and junction box covers with red paint.
- B. In concealed areas:
 1. Install wiring in red conduit.
 2. Paint fire alarm system junction boxes and junction box covers with red paint.
- C. Install components as indicated and in accordance with manufacturer's wiring diagrams, instructions and recommendations.
- D. Install wiring in accordance with local and national codes and NFPA-72.
- E. Make fire alarm wiring continuous from terminal to terminal or from terminal to device pigtail lead.
 1. Circuit splices not permitted.
 2. Wiring joints, only when required at device pigtail leads shall utilize Scotchlok insulate conical spring connector.
- F. Color code wiring by type of device. Coordinate colors with Owner.
- G. Identification:
 1. Identify each detector base using printed labels indicating appropriate system loop and address number to assist Owner in maintenance and troubleshooting.
- H. Do not install smoke or heat detectors or both within 36 IN of any HVAC supply/return air diffuser/grills.
- I. Installation of equipment and devices that pertain to other work in contract shall be closely coordinated with appropriate subcontractors.
- J. Cover smoke detection devices with protective coverings immediately after installation to maintain cleanliness.
- K. Remote indicator lights and test stations for concealed detectors: Locate on wall or ceiling immediately adjacent to device they monitor.

3.2 TESTING

- A. Obtain services of factory trained representative of system manufacturer to supervise installation and its progress, supervise final connections to equipment and provide testing to

assure that system is in proper operating condition, and is in compliance with all applicable regulations.

- B. Entire system shall test free from opens, grounds, and short circuits.
- C. Contractor shall pretest system prior to the scheduled acceptance test by the Authority Having Jurisdiction.
- D. Test system to satisfaction of Engineer and State and local fire authorities.
- E. Acceptance Operational Tests:
 - 1. Perform operational system tests to verify conformance with specifications:
 - a. Each alarm initiating device installed shall be operationally tested.
 - b. Each device shall be tested for alarm and trouble conditions.
 - c. Contractor shall submit written certification that Fire Alarm System installation is complete including all punch-list items.
 - d. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified.
 - e. Test supervising station signal transmitter. Coordinate testing with supervising station monitoring firm/entity.
 - f. Test each notification appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.
 - g. Test FACP and remote annunciator.
 - 2. Provide minimum 10 days notice of acceptance test performance schedule to Owner, and local Authority Having Jurisdiction (AHJ).
- F. Retesting:
 - 1. Correct deficiencies indicated by tests and completely retest work affected by such deficiencies.
 - 2. Verify by system test that total system meets Specifications and complies with applicable standards.
- G. Report of Tests and Inspections:
 - 1. Provide written record of inspections, tests, and detailed test results in form of test log. Use NFPA 72 Forms for documentation.
- H. Final Test, Record of Completion, and Certificate of Occupancy:
 - 1. Test system as required by Authority Having Jurisdiction in order to obtain certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Owner and AHJ.

3.3 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris from all devices and equipment panels. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments:
 - 1. When requested within one year of date of substantial completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions.
 - 2. Provide up to three visits to site for this purpose.

3.4 TRAINING

- A. Provide services of factory-authorized service representative to demonstrate system and train Owner's maintenance personnel as specified below.
 - 1. Train Owner's maintenance personnel in procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of system.

2. Provide minimum of 4 HRS training.
3. Schedule training with Owner at least 2 weeks in advance.
4. Fill out Owner instruction reports.

END OF SECTION



DIVISION 31

EARTHWORK



SECTION 31 10 00
SITE CLEARING (Olsson)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Removing existing vegetation.
 - 2. Clearing and grubbing.
 - 3. Removing above- and below-grade site improvements.
 - 4. Temporary erosion and sedimentation control.

1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.
- C. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

- A. Except for materials indicated to be salvaged or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site in accordance with the plans and specifications.

1.5 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or video recordings.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing and construction activities:
 - 1. Do not close or obstruct public streets, walks, or other adjacent occupied or used facilities without permission from City of Lincoln and an approved traffic control plan.

- B. Utility Locator Service: Notify Nebraska One Call (Nebraska811) at least 72 hours in advance of site clearing operations.
- C. Do not commence site clearing operations until temporary erosion- and sedimentation-control and tree-protection measures are in place.
- D. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving".

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction. Re-establish site benchmarks and control points for those locations impacted by site clearing operations. Work shall be performed by a State of Nebraska Licensed Surveyor.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Contractor is required to submit a Construction Stormwater Notice of Intent (CSW-NOI) to the Nebraska Dept. of Environment and Energy to obtain a Construction Stormwater Discharge Permit for the Project.
- B. Provide temporary erosion- and sedimentation-control best management practices (BMPs) to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent roadways and storm sewer systems.
 - a. Contractor shall plan and execute work methods to control stormwater runoff from discharging from the site.
 - b. Contractor shall regularly inspect and maintain erosion control BMPs during construction. Inspections and documentation shall occur in accordance with the requirements of the Construction Stormwater Discharge Permit. Repair all damaged BMPs to their original condition.
 - c. Record inspection activities and maintain record documents at the project site.
 - d. Once permanent vegetation has been established, remove erosion and sedimentation BMPs, and restore stabilize areas disturbed during removal.
- C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- D. Sediment or vehicle track out which enters onto adjacent public streets shall be swept up and cleaned at the end of each project day.

- E. Contractor shall submit a Construction Stormwater Notice of Termination (CSW-NOT) at the completion of the project once permanent vegetation has been established.
- F. Inspections shall continue on erosion control BMPs until permit is closed by the NDEQ, in accordance with the permit requirements.

3.3 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be protected, removed or abandoned in place.
- B. Utility Locator Service: Notify Nebraska One Call (Nebraska811) at least 72 hours in advance of site clearing operations.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Use only hand methods or spade for grubbing within protection zones.
 - 3. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.5 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Pavement Removal
 - 1. Confirm that all traffic control measures are in place and coordinate schedule with Owner.
 - 2. Sawcut and remove slabs, paving, curbs and gutters as indicated. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 - 3. Do not damage existing concrete curbing, sidewalk pavement, roadway pavement, drainage structures or other utilities to remain. Any items damaged by the work of this item will be repaired at the Contractor's expense.
 - 4. Legally dispose of pavements off site.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 20 00
EARTH MOVING (Olsson)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Geotechnical Exploration Report, as prepared by Olsson, dated October 14, 2024 and all issued addenda.

1.2 SUMMARY

- A. Section Includes:
 - 1. Excavating and filling for rough grading the Site.
 - 2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses.
 - 3. Excavating and backfilling for buildings and structures.
 - 4. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.3 DEFINITIONS

- A. Backfill: Soil material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe up to some distance around the pipe as indicated on the plans.
- C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- E. Fill: Soil materials used to raise existing grades.
- F. Structural Fill: Fill material subjected to structural loadings.
- G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- H. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- I. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.5 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify Nebraska One Call (Nebraska811) at least 72 hours in advance of site clearing operations.
- C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures are in place.
- D. Field verify all existing facilities and utilities prior to starting work to identify all conflicts with the work.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soils (Low Plasticity, Cohesive Soil):
 - 1. Fill materials placed within 12 inches of the base of the floor slab aggregate base have a liquid limit less than 45, and a plasticity index less than 25. We recommend structural fill soils within 12 inches of the base of pavements have a liquid limit less than 50, and a plasticity index less than 30, or be chemically treated. Soils with Atterberg limits greater than these values will require removal, chemical treatment, or blending with less plastic materials prior to use immediately beneath floor slabs or pavements.
 - 2. All structural fill soils should also be relatively free of organic materials (less than about 2 percent by weight), debris, and particles larger than 3 inches in nominal diameter.
- B. Unsatisfactory Soils: Soils not meeting the requirements of the satisfactory soils.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within the required range of the material's optimum moisture or density as determined by a Standard Proctor (ASTM D 698) test.
 - 2. As identified in the Report of Geotechnical Exploration, the on-site soils, except the dark brown altered Peoria loess, generally appear unsuitable for reuse as structural fill. Samples of all proposed structural fill should be submitted to Olsson at least seven days before placement for testing and approval.
 - 3. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory materials which contains root and other organic matter or frozen material.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- C. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- D. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.
- E. Protect excavations from loose soil falling into the excavation.
- F. Protect survey bench marks.
- G. Notify the Engineer in writing of unexpected subsurface conditions and discontinue work in affected area until notification to resume work.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area at no additional cost to the Owner.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.4 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- B. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a

tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.5 BUILDING OVER-EXCAVATION

- A. In accordance with the recommendations of the Geotechnical Exploration Report, soils beneath the floor slab aggregate base shall be supported by a minimum of 12-inches of properly compacted lean clay structural fill. Some over-excavation of the existing fill or altered Peoria loess may be required.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. In accordance with the recommendations of the Geotechnical Exploration Report, the existing unsuitable fill material shall be removed to a depth of 12-inches from below the base of the pavement slab elevation. Excavate to depths as necessary to remove existing unsuitable fill material as directed by field inspection staff.
- B. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches according to utility manufacturer's recommendations and the plans.
- C. Hand trim excavation and leave free of loose matter.
- D. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

3.8 SUBGRADE INSPECTION

- A. Notify Geotechnical Testing Agency when excavations have reached required subgrade.
- B. If Geotechnical Testing Agency determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Geotechnical Testing Agency, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials in areas designated in the plans or as directed by the Engineer without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
- B. Stockpile area shall be left completely free of excess materials and returned to pre-construction condition upon Project completion.

3.11 BACKFILL, GENERAL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Surveying locations of underground utilities for Record Documents.
 - 2. Testing, inspecting, approval of underground utilities.
 - 3. Removing concrete formwork.
 - 4. Removing trash and debris.
 - 5. Removing temporary shoring and bracing, and sheeting.
 - 6. Verifying subgrade has been inspected, tested, and approved.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

- A. Place, consolidate and moderately compact bedding course from the trench bottom to height indicated on the plans.
 - 1. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, from top of bedding up to a height of 12 inches over the pipe or conduit or as indicated on the plans.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- C. Place and compact final backfill of satisfactory soil to final subgrade elevation.
 - 1. If additional material is needed to get trench backfill to the final subgrade elevation, the contractor shall supply and install additional material at his expense.

3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Scarify, moisture condition, and compact stripped subgrade in the presence of the Engineer prior to placing any soil fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, or moisture condition otherwise satisfactory soil material that is not within the specified moisture content range as shown on Table 7 of the Geotechnical Exploration Report.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 9 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 9 inches of existing subgrade and each layer of backfill or fill soil material at 98 percent.
 2. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Top surface site subgrade: Plus or minus 1 inch.

3.17 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 2. Determine that fill material and maximum lift thickness comply with requirements.
 3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
 1. Contractor shall be responsible for all testing of materials intended to be used as off-site borrow and all materials that are supplied by the Contractor as part of the project.

- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Testing agency will test compaction of soils in place according to ASTM D 2922, as applicable. Tests will be performed at the following locations and frequencies (or as determined by the testing agency):
 - 1. Pavement and Walkways: At subgrade and at each compacted fill and backfill layer, at least one test for every 150 ft. of pavement length and at least one test at every intersection.
 - 2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests or as determined by the Engineer.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained; all at no additional cost to the Owner.

3.18 REPAIR

- A. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- B. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.
 - 2. Contractor shall make, or cause to be made, all repairs or replacements within 30 days after notice from the Engineer or Owner.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Engineer.

END OF SECTION

SECTION 31 23 00
BUILDING EXCAVATION, FILLING, AND BACKFILLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Building Excavation, Filling, and Backfilling, as indicated, in accordance with provisions of Contract Documents.
- B. Definitions:
 - 1. Unsuitable material:
 - a. Debris and/or soil material judged unsuitable by Geotech for support of slabs and foundations or for use as a fill or backfill material.
 - 2. Maximum density:
 - a. As determined using ASTM D698, Standard Proctor.
 - 3. Geotech:
 - a. Geotechnical Engineer or Representative of Foundation Consultant employed by Owner to inspect foundation work.
- C. Completely coordinate with work of other trades.

1.2 EXTRA WORK

- A. Removal and replacement of unsuitable material will be paid as extra work.
 - 1. Notify (Owner's agent) in time to estimate and record quantity removed.
 - 2. If Contractor is unwilling to accept estimate, notify Architect or Construction Manager prior to backfilling and a surveyor will be hired at Contractor's expense to measure and determine excavated volumes.
 - 3. Recorded quantity will be basis for payment.
 - 4. Include unit price on Bid Form.

1.3 QUALITY ASSURANCE

- A. Subsurface Soils Investigations:
 - 1. Soils information was obtained at project site for use in preparing foundation design.
 - 2. Availability of soils report information is indicated in specifications.
 - 3. Examine site and soils report and independently determine character of materials to be encountered.
- B. Inspection and Compaction Density Tests:
 - 1. Owner will hire the Geotech to inspect earthwork and to conduct in-place compaction moisture-density tests.
 - 2. Initial test at each location will be paid by Owner.
 - 3. If initial test fails, Contractor pays for retesting.
- C. Subgrade Tolerance:
 - 1. 0.10 feet plus/minus from required elevations.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Maximum Density curves for fill and backfill material.
 - 2. Sieve analysis for granular fill.

1.5 JOB CONDITIONS

- A. Determine safe slopes of excavations for the earth materials encountered.
- B. Shoring and bracing excavations as required to protect personnel, utilities, existing construction, and new work.
- C. Removing bracing when safe.
- D. Protecting from damage (or replacing as directed) sidewalks, pavements and other facilities resulting from settlement, lateral movement, undermining erosion, or other hazards created by earthwork operations.
- E. Complying with rules and regulations governing earthwork and respective utilities.
- F. Providing adequate barricades and warning lights as required to protect persons and property and to satisfy applicable regulations.
- G. Maintaining bench marks, movements and other reference points and replacing any disturbed or destroyed.

PART 2 - PRODUCTS

2.1 MATERIALS: THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS

- A. Fill and backfill material:
 - 1. Clean selected materials, approved by Geotech, from site excavation or from off-site borrow areas.
 - 2. Submit Maximum Density curves for each source of fill or backfill material.
- B. Granular fill:
 - 1. Clean, densely graded granular material with a balanced fine content.
 - 2. Compactable, east-to-trim, granular fill that will remain stable and support construction traffic.
 - 3. DOT approved road base.
 - 4. Submit sieve analysis verifying following gradation.
 - a. 100% passing 1 1/2 inches sieve.
 - b. 15 to 55% passing the No. 4 sieve.
 - c. Less than 12% pass the No. 200 sieve that is clean granular fill with less than 3% clay or friable particles.

PART 3 - EXECUTION

3.1 EXCAVATION - GENERAL

- A. Do not perform blasting.
- B. Excavate to dimensions and elevations indicated regardless of materials encountered.
 - 1. Allow additional space as required for construction operations and inspection of foundations.
- C. Remove old foundations, building construction, and other materials concealed beneath present grade, as required to execute work, and as indicated.
- D. Remove and replace unsuitable material with compacted backfill as directed by Geotech.
- E. Properly level off bottoms of excavations.
- F. Where cuts are required to bring floor slabs to proper elevations, excavate to level below slabs allowing for required granular fill.

1. Remove rocks, lumps, vegetation, and other foreign material.
 2. Scarify top 12 inches of earth below granular fill and recompact to 98% of maximum density.
 3. Where compacted subgrade is disturbed by frost, moisture, or construction operations, re-scarify and recompact as directed by Geotech.
- G. Control grading around building.
1. Pitch surface to prevent water from running into excavated areas or damaging structure.
 2. Maintain pits and trenches where footings will be placed free of water.
 3. Provide pumping required to keep excavated spaces clear of water during construction.
 4. When springs or running water are encountered, notify Architect. Provide free discharge of water by trenches or pumps, and drain to appropriate point of disposal as directed.

3.2 FOOTINGS

- A. Provide undisturbed, level, dry, unfrozen surfaces free of foreign or loose material for placement of footings.
- B. Obtain Geotech's approval of footing subgrade before placing concrete.
- C. Do not carry excavations lower than indicated, except when directed by Geotech.
- D. If excavations are made below indicated level, fill with concrete of same strength as foundation concrete at no extra cost.
- E. When excavations become soft and wet, remove soft material and replace with concrete of same strength as foundation concrete, at no extra cost.
- F. When freezing temperatures are expected, do not excavate to full depth unless footings or pile caps can be placed immediately. Protect bottoms of excavations from freezing if placement is delayed.

3.3 BUILDING SUBGRADE PREPARATION, FILLING, AND BACKFILLING

- A. Remove rocks, lumps, frozen ground, soft or wet material, vegetation, and other foreign material upon which fill or backfill is to be placed.
- B. Before scarifying subgrade, obtain approval of Geotech.
- C. Scarify top 12 inches of excavation surface or subgrade and compact to 98% of maximum density.
- D. Place fill material in 6 inches lifts and compact each lift to 98% maximum density.
- E. Maintain moisture between 0 and 3% above optimum moisture content during compaction.
- F. Compact fill and backfill using suitable mechanical tamping equipment to obtain specified density.
 1. Use mechanical hand tampers for filling and backfilling next to walls.
 2. Compact granular fill using vibratory methods.
- G. Where existing ground surface is steeper than one vertical to four horizontal, step surface with steps not exceeding 12 inches or slope surface not exceeding one vertical to 50 horizontal.
- H. Correct and recompact compacted material not meeting specified compaction requirements. Continue corrective measures until required compaction has been attained.
- I. Do not backfill against part of walls, piers, or columns until each part has reached design strength.
 1. Do not place fills against walls until floor slabs at top and bottom of walls are in place.
 2. Bring backfill up uniformly around building and individual wall units.

- J. Do not backfill against foundations, walls, curbs, footings, and areaways until concrete forms have been removed, masonry work has been pointed, and concrete finishing, dampproofing, and waterproofing have been completed.

3.4 GRADING NEXT TO BUILDING

- A. To provide drainage evenly slope finished grade away from building walls at slopes not less than one (1) vertical to fifty (50) horizontal.

3.5 GRANULAR FILL UNDER SLABS ON GRADE

- A. Place minimum 6 inches granular fill below vapor retarder under slabs on grade.

3.6 ACCEPTANCE OF WORK

- A. Obtain Architect's and Geotech's approval of each earthwork operation before next operation.
- B. Notify Architect and Geotech in sufficient time for inspection.

3.7 DISPOSAL OF EXCESS AND WASTE MATERIAL

- A. Remove waste and excess materials including excess earth, unsuitable materials, trash, and debris and legally dispose of it off Owner's property.

END OF SECTION



DIVISION 32

EXTERIOR IMPROVEMENTS



SECTION 32 13 13
CONCRETE PAVING (Olsson)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Driveways.
 2. Roadways.
 3. Parking lots.
 4. Curbs and gutters.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Action Submittals:
1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 REVIEW SUBMITTALS

- A. Shop Drawings: Provide detailed shop drawings of proposed sidewalk jointing plans for all concrete sidewalk areas. Plans should be drawn to scale and clearly identify all typical dimensions for sidewalk joint layout and detailed dimensions for all non-uniform joint dimensions/curves/etc.

1.4 INFORMATIONAL SUBMITTALS

Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

1. Steel reinforcement and reinforcement accessories.
 2. Admixtures.
 3. Curing compounds.
 4. Applied finish materials.
 5. Bonding agent or epoxy adhesive.
 6. Joint fillers.
- B. Material Test Reports: For each of the following:
1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.
- B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- C. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- D. ACI Publications: Comply with ACI 301 unless otherwise indicated.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A 934; with ASTM A 615, Grade 60 deformed bars.
- C. Joint Dowel Bars: ASTM A 615, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- D. Epoxy-Coated, Joint Dowel Bars: ASTM A 775; with ASTM A 615, Grade 60, plain-steel bars.
- E. Tie Bars: ASTM A 615, Grade 60, deformed.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- G. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

2.3 CONCRETE MATERIALS

- A. City of Lincoln, L-3500 Mix Design

2.4 CURING MATERIALS

- A. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.5 SEALER

- A. Clear, water-based penetrating sealer: 20% alkylalkoxysilane minimum, breathable, UV-Stable, non-film forming; suitable for exterior concrete paving. Product shall be capable of meeting project performance requirements when installed per manufacturer's instructions. Submit manufacturer data and applications for approval.

2.6 RELATED MATERIALS

- A. Joint Fillers: ASTM D8139, semirigid, closed-cell polypropylene foam in preformed strips, $\frac{3}{4}$ ".
- B. Joint Sealant: ASTM D 5893, Type SL, single component, self-leveling, silicone joint sealant for concrete, color as selected by Owner.

2.7 CONCRETE MIXTURES

- A. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. May use water-reducing admixture or plasticizing admixture in concrete as required for placement and workability.
 - 2. May use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons or Engineer approved equal.
 - 2. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 2 inches according to requirements in Section 31 20 00 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with grease one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
 - 1. Extend joint fillers full width and depth of joint.
 - 2. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 3. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 - 4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 5. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
 - 1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/4-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 - a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
 - 2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with grease one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Contraction Joints (Sidewalks): Form weakened-plane contraction joints, sectioning concrete into areas as indicated on Architects drawings. Construct contraction joints for a depth equal to at least one-fourth of the concrete

thickness. Tool edges of gutters, curbs, and sidewalk joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

1. Concrete sidewalk joint: Prior to installation, contractor to submit detailed layout plan for review and approval by Architect
- F. Contraction Joints (Parking Lot Pavement): Maximum joints spacing 15'. All joints shall be made with a motor driven concrete saw to a minimum to depth of 1/4 of the pavement thickness. The sawing shall be accomplished not later than 48 hours after concrete placement. Joints shall be as square as possible and should be perpendicular to curblines, walls or other fixed objects. All contraction joints shall be sealed in accordance with these specifications.
- G. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.
- H. Sealing
1. Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
 2. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
 3. Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
 4. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
 5. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

- F. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- G. Screed paving surface with a straightedge and strike off.
- H. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- I. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
- J. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- K. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or

inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

- C. Float Finish for Sidewalks: Light broom finish, perpendicular to foot traffic. Verify finish requirements with Owner and Architect.

3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by curing compound as follows:
 - 1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 1/2 inch.
 - 2. Thickness: Plus 1/2 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/4 inch.
 - 4. Joint Spacing: 3 inches.
 - 5. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 6. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each 150 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.

- 5. Compression Test Specimens: ASTM C 31; cast and field cure one set of four standard cylinder specimens for each composite sample.
- 6. Compressive-Strength Tests: ASTM C 39; test two specimens at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample.
- C. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
- D. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.
- E. Concrete paving will be considered defective if it does not pass tests and inspections.
- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.
- B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 13 14
CONCRETE PAVING FINISHES - OLSSON

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 321313 " Concrete Paving" for complete site paving.
- C. Section 321373 " Concrete Paving Joint Sealants" for complete site paving.

1.2 SUMMARY

- A. Section includes
 - 1. Finishes for site P-2 exposed aggregate concrete paving.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 REFERENCES

- A. City of Lincoln, NE., Standard Specifications for Municipal Construction, 2023
- B. American Concrete Institute: Specifications for Structural Concrete
 - 1. ACI 301
- C. American Association of State Highway and Transportation Officials (AASHTO)
- D. American Society for Testing and Materials (ASTM)
 - 1. ASTM C 1059 standard specification for latex agents for bonding fresh to hardened concrete
 - 2. ASTM D 1751 standard specification for preformed expansion joint filler for concrete paving and structural construction
 - 3. ASTM C1315 standard specification for liquid membrane-forming compounds having special properties for curing and sealing concrete
 - 4. ASTM C 881/C 881M standard specification for epoxy-resin-based bonding systems for concrete
- E. NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Manufacturer's product literature and installation instructions for top casting / surface retarder product.
- B. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.

2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.
9. Surface Retardant

1.7 PERFORMANCE REQUIREMENTS

- A. Slip Resistance: Minimum PTV of 55 wet (hard rubber) and 45 wet (soft rubber), conforming to ASTM E 303.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving products.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing specialty ready-mixed concrete products.
- C. Source Limitations: Obtain concrete paving finish products and each type or class of cementitious material of the same brand from same manufacturer's plant, and obtain each aggregate from single source.
- D. ACI Publications: Comply with ACI 301 unless otherwise indicated.
- E. Mock-ups: Build mock-ups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Build mock-ups of decorative concrete paving finishes as follows:
 - a. First round of mockups: Provide a minimum of (4) four 12" x 12" mockups of four (4) aggregate exposures to achieve basis of design product.
 - 1) If mock-up is not approved, provide a second round of (4) 12"x12" mockups of each finish to achieve the basis of design product. If Landscape Architect approves providing fewer than (4) samples in second round of mockups, proceed with agreed upon number of samples. Provide a 3rd round of mockups if desired finish is not obtained in the second round.
 - 2) Once mock-ups are approved, build full size mock-ups.
 - b. Full scale mock-ups: Once design product mock-ups are approved, build a full scale, full thickness 3'x3' minimum mockup of application of decorative concrete paving, steps, and site conditions to demonstrate typical joints, surface color, pattern, and texture, curing, and standard of workmanship.
 - 1) Mock-ups shall include all steps, paving and turned-down paving edge conditions and be inclusive of adjacent paving conditions.
 - 2) Approve mock-ups may NOT be part of final installations and shall remain through construction.
 - 3) If mock-up is not approved, provide a second round of mockups of each application finish. Provide a 3rd round of mockups if desired application finishes are not obtained in the second round.
 2. Approval of mock-ups does not constitute approval of deviations from the Contract Documents contained in mock-ups unless Architect specifically approves such deviations in writing.

- F. Preinstallation Conference: Conduct conference at Site Office compliant with Division 1, and a minimum of (5) working days prior to first installation.
 - 1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Quality control of concrete materials and decorative concrete paving construction practices.

1.9 FIELD CONDITIONS

- A. Comply with manufacturer's specifications and conditions for installation performance.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS.

2.2 EXPOSED AGGREGATE PAVING

- A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.
- B. Basis-of-Design Product: The Bomanite Company, or Pre-approved Equal.
Address: 34501 East Quincy Ave. Building 28, Watkins, Colorado 80137
Phone: (303) 369-1115
Website: www.bomanite.com
- C. P-2: Exposed Aggregate Paving
 - 1. Bomanite Profiler: Water-based reactive compound designed to etch the surface concrete at the surface.

2. Bomanite Dry Shake Surface Applied Alloy color: Full range selection to match building façade.
3. Bomanite Con-Shield: Hydrolyzed Quartz compound designed to reduce surface porosity while improving surface abrasion resistance and bond strength of sand aggregates.
4. Bomanite Hydro-Lock: Epoxy modified acrylic sealer with medium sheen and minimal film formation.
5. Installation: Per manufacturer's specifications.

2.3 EXPOSED AGGREGATE PAVING JOINTS

- A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.
- B. Basis-of-Design Product: Husqvarna, or Pre-approved Equal.
Address: 9335 Harris Corners Pkwy #500, Charlotte, North Carolina 28269
Phone: (704) 597-5000
 1. Website: www.husqvarna.com
- C. P-2: Specialty Saw-Cut Joints
 1. Blade Size: 6" x .375" V x .125 Pilot.
 2. Blade Specification: XL6-V21 ProEdge Series Blades for Soff-Cut Model 150 Saws.
 3. Number: P/N 542756151.

2.4 FORMS

- A. Refer to City of Lincoln, NE. Standard Specifications for Municipal Construction, 2023, for paving forms.

2.5 STEEL REINFORCEMENT

- A. Refer to City of Lincoln, NE. Standard Specifications for Municipal Construction, 2023, for paving reinforcement.

2.6 CONCRETE MIX DESIGN

- A. Portland cement: shall conform to ASTM C 150, Type I.
- B. Aggregates: shall conform to ASTM C 33 and be optimized with minimal gap grading and the largest top sized aggregate feasible.
- C. Water: Mixing water shall be fresh, clean and potable.
- D. Air Entrainment: Conforming to ASTM C260. In freeze-thaw areas, air entrainment shall be provided.
- E. Water-Reducing Admixtures: Water-reducing admixtures and/or super-plasticizers are permitted and shall conform to ASTM C 494.
- F. Pozzolans: Fly Ash shall conform to ASTM C618 – type F.

2.7 RELATED MATERIALS

- A. Isolation Joint Materials: Non-tar; pre-formed joint filler.
- B. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic in pre-formed strips.
- C. Diamond Dowels: Required to provide load transference at all expansion and construction joints. Dowel at a minimum spacing of 24" o.c.
- D. Water: Potable, at a temperature not exceeding 70 degrees F.

PART 3 - EXECUTION

3.1 CONCRETE PAVING INSTALLATION

- A. General: Comply with manufacturer requirements, requirements in Section 03 30 00 and/or Refer to City of Lincoln Standard Specifications for Municipal Construction, 2023, for placement and execution of decorative concrete paving, including:
 - 1. Concrete placement
 - 2. Concrete reinforcement and installation
 - 3. Installation tolerances

3.2 SUB GRADE

- A. Sub-grade to meet requirements of project's soils report.
- B. A minimum of 2" of well draining road base or no fines crushed stone or crushed recycled concrete is required over the prepared sub-grade to provide the correct base for Alloy due to uniformity of hydration requirements.
- C. Ensure that utilities, including irrigation lines are buried and compacted below bottom of road base.
- D. Keep base damp prior to placing concrete.

3.3 CONCRETE MIX SPECIFIC TO ALLOY REQUIREMENTS

- A. Requirements:
 - 1. Slump: 3 to 5 inch slump. Obtain approval from Owner's Authorized Representative if slump is outside these parameters.
 - 2. Minimum PSI Rating at 28 days: 4,000.
 - 3. Cement quantity per yard of mix:
 - a. Minimum: 6 sacks.
 - b. Maximum: 7 sacks.
 - 4. Water/cement ratio: Maximum .6.
 - 5. Aggregates: Use maximum 1" top size aggregate.
 - 6. Admixtures:
 - a. Air entrainment: As determined required by aggregate size and environment.
 - b. Water Reducing: Mid range water reducers recommended.
 - 7. Fly ash: Use in all applications as required up to 25% of total cement content.
 - 8. Accelerators: Do not use accelerators.

3.4 ALLOY INSTALLATION

- A. Per manufacturer installation requirements.

3.5 JOINTING

- A. General: Form construction, isolation, weakened plane, and score joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
 - 2. All joints shall be as shown in plan and as identified in City of Lincoln, NE. Standard Specifications for Municipal Construction, 2023.

- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 - 2. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints per specifications.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 5. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Control Joints: Form control/contraction joints, sectioning concrete into areas as indicated. Construct weakened plane joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent decorative concrete paving:
 - 1. Specialty Sawed Joints: Form weakened plane joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks per manufacturer's installation specifications.
 - a. Saw all joints while concrete is still green or after 27 days of curing or per manufacturer's specifications.
 - b. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

3.6 CURING

- A. After initial Alloy exposure, wet cure the slab for a minimum of 24 hours by means of fogging, sheet or spraying.

3.7 SEALING

- A. Treat Alloy surface once cured with Bomanite Con-Shield as per manufacturer's instructions
- B. After Bomanite Con-Shield has reacted fully, Bomanite Hydro-Lock is applied as per manufacturer's instruction.

3.8 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117.
 - 1. Elevation: 1/4 inch (6 mm).

3.9 REPAIRS AND PROTECTION

- A. See 03 30 00 and/or Refer to City of Lincoln Standard Specifications for Municipal Construction, 2023.
- B. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement or per manufacturer specifications.
 - 1. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 13 73

CONCRETE PAVING JOINT SEALANTS (Olsson)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cold-applied joint sealants.
 - 2. Hot-applied joint sealants.
 - 3. Cold-applied, fuel-resistant joint sealants.
 - 4. Hot-applied, fuel-resistant joint sealants.
 - 5. Joint-sealant backer materials.
 - 6. Primers.
- B. Related Requirements:
 - 1. Section 07 92 00 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each kind and color of joint sealant, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.

1.5 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 Sidewalk expansion joints: The expansion joints for the sidewalks should be formed as follows:

- A. The joint filler should be polyethylene closed-cell expansion joint filler material.
- B. Install to a depth of one-half inch (1/2") below the walk surface.
- C. Prior to applying joint sealant, clean the joint and prime joint with primer. Do not prime expansion joint filler material.
- D. Apply one-component polyurethane self-leveling sealant, conforming to ASTM C920, Type S, Grade P, Class 25, Use T or M, in the upper one half inch (1/2") depth of the joint, over the joint filler material.

2.3 JOINT SEALANTS

- A. Single-component polyurethane self-leveling sealant, conforming to ASTM C920, Type S, Grade P, Class 25, Use T or M
- B. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I, II, or III.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or

prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.
- C. Install joint-sealant backings to support joint sealants during application and at position to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
 - 1. Place joint sealants so they fully contact joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
 - 1. Remove excess joint sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
- B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion.

END OF SECTION

SECTION 32 33 00
SITE FURNISHINGS - OLSSON

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Bench
- B. Bike Parking
- C. Picnic Tables
- D. Trash Receptacles
- E. Ash Receptacle
- F. Tree Grate

1.3 REFERENCE

- A. ASTM Testing Standards:
 - 1. ASTM B 117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - 2. ASTM D 522 – Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
 - 3. ASTM D 523 – Standard Test Method for Specular Gloss.
 - 4. ASTM D 2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
 - 5. ASTM D 2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
 - 6. ASTM D 3359 – Standard Test Methods for Measuring Adhesion by Tape Test.
 - 7. ASTM D 3363 – Standard Test Method for Film Hardness by Pencil Test.
 - 8. ASTM G 155 – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.
- B. ISO Testing Standards:
 - 1. ISO 1520 – Paints and Varnishes – Cupping Test.
 - 2. ISO 2815 – Paints and Varnishes – Buchholz Indentation Test.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, including installation or subsurface recommendations.
- B. Warranty: Products shall be free from defects in material and workmanship for a period of 3 years from substantial completion.
- C. Shop Drawings: Indicate details of each type and size of furniture, component supports, anchorages, openings, construction details, and tolerances.
- D. Delegated Custom Design Submittals: Submit signed and sealed Shop Drawings with design calculations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.
- B. Furnish extra materials that match products installed and that are packages with protective covering for storage and identified with labels describing contents.
 - 1. Wood Bench Replacement Slats: No fewer than 10 full size units for each slat size.
 - 2. Furniture Anchors: No fewer than 2 full size units for each anchor.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area in accordance with manufacturer's written instructions. Keep materials in manufacturer's original, unopened containers and packaging until installation.
- C. Handling: Protect materials and finish during handling and installation to prevent damage per manufacturer's written specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS.

2.2 BENCH

- A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.
- B. Basis-of-Design Product: Forms + Surfaces, or Pre-approved Equal.
Address: 5505 6th Street, Carpinteria, California 93013
Phone: (800) 451-0410
Website: www.forms-surfaces.com
- C. S-1: Circuit Bench
 - 1. Color: Custom RAL powdercoat to match transit canopies; teakwood.
 - 2. Hardware: Stainless steel.
 - 3. Mounting: Surface mount with stainless steel anchors and mounting screw mounting kit by manufacturer.
 - 4. Installation: Per manufacturer's specifications.

2.3 PICNIC TABLE

- A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.
- B. Basis-of-Design Product: Basis-of-Design Product: MMcite, or Pre-approved Equal.
Address: 2905 Westinghouse Blvd, Suite 100, Charlotte, North Carolina 28273

Phone: (704) 995-1942

Website: www.mmcite.com

- C. S-2: Rautster Table - customized with ADA access legs.
 - 1. Materials: Steel structure; wood slats.
 - 2. Finish: Protective zinc and powder coating.
 - 3. Color: RAL 5011, to match City color palette.
 - 4. Mounting: Surface mount with anchors per manufacturer.
 - 5. Installation: Per manufacturer's specifications.
- D. S-3: Rautster Table
 - 6. Materials: Steel structure; wood slats.
 - 7. Finish: Protective zinc and powder coating.
 - 8. Color: RAL 5011, to match City color palette.
 - 9. Mounting: Surface mount with anchors per manufacturer.
 - 10. Installation: Per manufacturer's specifications.

2.4 BIKE SHARE

- A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.
- B. Basis-of-Design Product: BCycle, or Pre-approved Equal.

Address: Waterloo, Wisconsin

Phone: (754) 200-5672

Website: www.bcycle.com
- C. S-4: 3.0 DSocket
 - 1. Size: Per plans.
 - 2. Finish: Full range, to match existing city stations.
 - 3. Signage: Per city standards.
 - 4. Mount: Per city standards.

2.5 BIKE RACK

- A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.
- B. Basis-of-Design Product: Forms + Surfaces, or Pre-approved Equal.

Address: 5505 6th Street, Carpinteria, California 93013

Phone: (800) 451-0410

Website: www.forms-surfaces.com
- C. S-5: Capitol Bike Rack
 - 1. Size: 34"x5"x4".

2. Color: Ink Blue Texture.
3. Materials: Cast aluminum.
4. Hardware: Stainless steel.
5. Mounting: Surface mount with embedded stainless steel anchors and tamper-resistant stainless steel bolt mounting kit by manufacturer.
6. Installation: Per manufacturer's specifications.

2.6 SCOOTER RACK

- A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.
- B. Basis-of-Design Product: MMcite, or Pre-approved Equal.
Address: 2905 Westinghouse Blvd, Suite 100, Charlotte, North Carolina 28273
Phone: (704) 995-1942
Website: www.mmcite.com
- C. S-6: Trot
 1. Size: 29"x27"x18"
 2. Color: RAL 9005.
 3. Mount: Surface mount with anchors per manufacturer.
 4. Installation: Per manufacturer's specifications.

2.7 RECYCLING and LITTER RECEPTACLES

- A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.
- B. Basis-of-Design Product: Forms + Surfaces, or Pre-approved Equal.
Address: 5505 6th Street, Carpinteria, California 93013
Phone: (800) 451-0410
Website: www.forms-surfaces.com
- C. S-7 and S-8: Corida Litter
 1. Color: RAL 5015, to match City color palette.
 2. Opening: Top with rain shield.
 3. Lock: Tool-operated security latch.
 4. Signage:
 - a. Recycle.
 - b. Landfill.
 5. Materials: Corrosion-resistant aluminum; FSC 100% Cumaru hardwood slats.
 6. Hardware: Stainless steel.
 7. Mounting: Surface mount with stainless steel anchors and mounting bolt kit by manufacturer.

8. Installation: Per manufacturer's specifications.

2.8 ASH RECEPTACLE

A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.

B. Basis-of-Design Product: Basis-of-Design Product: MMcite, or Pre-approved Equal.

Address: 2905 Westinghouse Blvd, Suite 100, Charlotte, North Carolina 28273

Phone: (704) 995-1942

Website: www.mmcite.com

C. S-9: Valet Movable

11. Materials: Steel structure; Stainless Steel Urn.

12. Finish: Protective zinc and powder coating.

13. Color: RAL 5015, to match City color palette.

14. Mounting: None, movable.

15. Installation: Per manufacturer's specifications.

2.9 TREE GRATE

A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.

B. Basis-of-Design Product: IronAge, or Pre-approved Equal.

Address: 2104 SW 152nd St., Suite #4, Burien, Washington 98166

Phone: (877) 418-3568

Website: www.ironagegrates.com

C. M-1 and M-2: Rain

1. Frame Material: Cast Ductile Iron, ASTM A536; alloy 65-45-12.

2. Grate Material: Cast Iron: ASTM A48, CL 30 or better .

3. Accessories: As required for lighting plan.

4. Finish: Baked on oil.

5. Product: Custom RNX72-72199TGHP (M-1); RNX72-72199TGHP (M-2).

6. Size: 72".

7. Mounting: E-Frame Installation.

8. Installation: Per manufacturer's specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Install site furnishings after trees, lighting, and paving have been completed.
- C. Install site furnishings level, plumb, true, and positioned at locations indicated on Drawings.
- D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
- E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch 19 mm larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
- F. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with non-shrink grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION

SECTION 32 84 00
PLANTING IRRIGATION - OLSSON

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes furnishing all labor, materials, accessories and equipment, and performing all operations necessary for the complete installation of the landscape irrigation system, permits and including items listed below:
 - 1. Piping.
 - 2. Manual valves.
 - 3. Automatic control valves.
 - 4. Automatic drain valves.
 - 5. Spray and rotor heads.
 - 6. Driplines.
 - 7. Root watering systems.
 - 8. Quick couplers.
 - 9. Controller.
 - 10. Boxes for automatic control valves.
- B. Irrigation Control System
 - 1. The construction includes one (1) satellite controller as shown on the irrigation plans.
 - 2. Power shall be provided to the irrigation controller by electrical contractor. Final connection by irrigation contractor.
- C. All bids should reflect a total "turn-key" installation for the site. This would include all equipment necessary to install satellite controller, central control system, including necessary wiring, communications equipment, electrical service, water supply and lines needed to communicate with the central irrigation control system. Each bid shall include all equipment and labor necessary to provide a "turn-key" installation.
- D. Each proposal shall include the cost to install a combination flow meter and master valve as indicated on the design drawings. This meter and valve shall be connected just past the water meter connection at each site. This meter and valve shall be capable of relaying this information to the central irrigation control system point computer to provide flow information of each valve as it waters. It shall also be capable of detecting any flow that is occurring when no valves are operating, such as a broken main line would create. This flow sensor should then be capable of sending a signal to the central irrigation control system that will then in turn close the master valve. The bid for each flow meter and valve shall include the meter/valve and any other items needed for a "turn-key" installation. The bid price for this meter and valve shall be shown as a separate bid item for this site.
- E. The contractor shall include a projected time frame for installing the system. It should reflect, in calendar days, the anticipated time required from the day of the award to completion of the system in a fully operational mode. This schedule should reflect anticipated time for ordering and receiving all components, starting and ending times for installation, starting and ending times for training, system start-up, etc.

1.3 PERFORMANCE REQUIREMENTS

- A. Irrigation zone control shall be central control system with automatic operation with controller and automatic control valves.
- B. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.
- C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
 - 1. Irrigation Main Piping: 120 psi
 - 2. Circuit Piping: 60psi

1.4 SEQUENCING/SCHEDULING

- A. Obtain information pertaining to the location of all existing utility lines and equipment prior to irrigation installation.
- B. Install sleeves for all mainline, laterals, and wire that cross roadways, drives, sidewalks, and all other paving surfaces prior to placement of paving. It is the responsibility of the Irrigation Contractor to coordinate timing of sleeve installation and construction procedure with Paving Contractor to ensure proper sequencing.
- C. Give at least seven (7) days notice to the Landscape Architect or his representative prior to all required site visits as indicated herein.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Only materials and items of equipment so approved shall be used.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Approvals: Submit documentation of all approvals required by local, municipal, and state jurisdictions.
- D. Grounding and Line Surge Protection Verification: The Irrigation Contractor is to provide written documentation and verification that each grounding device meets the manufacturer's specified requirements for grounding and line surge protection. The tests shall be completed using an approved ground resistance tester. The Rain Bird ASP shall conduct testing.

1.6 INFORMATIONAL SUBMITTALS

- A. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.
- B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operational and Maintenance Data: Submit manufacturer's data in a three-ring binder, labeled and indexed
- B. Record Drawings: Irrigation Contractor shall record and submit an "As-Built Drawing" which records actual installed conditions. The As-Built Drawing shall be submitted in an electronic format. Irrigation Contractor shall submit the As-Built Drawing to the Landscape Architect before work under this contract will be considered for Acceptance.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Manufacturing Qualifications: Provide landscape irrigation system as a complete unit produced by acceptable manufacturers for all portions of work, including heads, valves, piping, controllers, and accessories.
- C. Installer qualification: Contractor shall be a firm specializing in irrigation work with a minimum of 10 years' experience in work of this type. The irrigation contractor shall provide written proof of attendance at a manufacture's supported training program regarding the installation, programming and trouble-shooting for a Rain Bird IQ v4.0 decoder-based irrigation control system. These qualifications must be present prior to any work beginning on this project.
- D. Authorized Service Provider requirements: Contractor shall have Authorized Service Provider (ASP) provide Rain Bird IQ Commissioning of central irrigation control system including verification of specified Rain Bird Components, Correct wire and connectors, Grounding of required components, proper installation of communication and software has been set up with proper start-up and initial programming.
 - 1. Approved Rain Bird Authorized Service Provider/Central Control Service Provider
 - a. Irrigation Management Company (IMC) 816-215-1810
- E. Referenced Standards: American Society for Testing and Materials, Annual Book of ASTM Standards, latest edition.
- F. Codes and Standards: Irrigation installation shall comply with all applicable federal, state and local governing agency requirements and to industry standards. Notify Landscape Architect immediately in writing of any discrepancies, inconsistencies, or contradictory requirements.
- G. Workmanship: Install materials and equipment in a neat and professional manner following manufacturer's recommendations.

1.9 FEES AND PERMITS

- A. Work under this Section shall include all fees, permits, licenses, and required inspections by concerned governing agencies.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and equipment in such a manner as not to damage the parts or decrease the useful life of equipment.
- B. Store materials away from detrimental elements. Coordinate with Owner's Representative, General Contractor, or Landscape Contractor, as appropriate, to secure a safe staging area.
- C. Handle, load, unload, stack, and transport materials carefully to avoid damage. Handle pipe in accordance with manufacturer's recommendations.

1.11 JOB CONDITIONS

- A. Prior to commencing any work required under the Contract, the Contractor shall locate all utilities, subsurface drainage, and underground construction so that proper precautions may be taken not to disturb or damage any subsurface improvements. Damage to any of the above mentioned items or other shall be promptly repaired by the contractor at no additional cost to the owner.
- B. Water service and electric service will be supplied by the General Contractor as indicated on the plans for the purpose of the automatic irrigation system.
- C. Irrigation System is to operate under the water pressure and flow rates prevailing at the project site. Irrigation Contractor shall be responsible for determining these parameters, and shall design the irrigation system in accordance with the existing or anticipated conditions.
- D. Insurance on irrigation materials or equipment stored or installed is the responsibility of the Irrigation Contractor. Such insurance shall cover fire, theft, and vandalism. Should the Irrigation Contractor elect not to provide such insurance the Owner shall in no way be responsible for any losses incurred by the aforementioned acts. The Irrigation Contractor is responsible for all costs incurred in replacing damaged or stolen materials or equipment prior to Substantial Completion.

of the Work.

- E. Obtain all required permits and pay all required fees at no additional cost to the Owner. Any penalties imposed due to failure to obtain permits or pay fees are the responsibility of the Irrigation Contractor.
- F. Provide and maintain all passageways, guard fences, warning lights, and other protection devices required by local authorities or others having jurisdiction.
- G. Irrigation Contractor shall adequately protect adjacent property as provided by law and the Contract Documents.
- H. Existing Site Improvements: Perform Work in a manner that avoids damage to existing site improvements. The Irrigation Contractor is responsible for any damage of mechanical nature as well as damage resulting from leaks in the irrigation system whether due to negligence or otherwise.
- I. Test water conditions: Irrigation System is to operate under the water pressure and flow indicated on the irrigation plan. It shall be the responsibility of the Irrigation Contractor to measure or analyze the existing or anticipated water supply at the tap. Notify the Landscape Architect if conditions vary from plans.

1.12 WARRANTY AND SUBSTANTIAL COMPLETION

A. Substantial Completion

- 1. At the completion of the installation of the irrigation system components, and at the direction of the Owner, the Landscape Architect shall observe the conditions of the project for the purpose of verifying compliance with plans, details and specifications. A written report will be provided to the Owner listing any deviations or omissions. These issues will be resolved and verified by the Landscape Architect prior to the issuance of a Letter of Substantial Completion.
 - 2. Contractor shall provide Landscape Architect with written notification from Rain Bird ASP stating that all installation, testing and training of the Central Control System has been completed and approved. Notification shall be received prior to substantial completion.
- B. All irrigation equipment including central irrigation control system, controller(s), control valves, sprinklers, rotors, and accessories shall have a five (5) year manufacturer's warranty. All other irrigation equipment, workmanship, and, supplies shall be warranted for one (1) year from date of issuance of the letter of substantial completion. All warranties shall be turned over to the Owner.

1.13 TRAINING

- A. A minimum of 2 hours of training, as determined by Rain Bird, for up to two (2) users determined by Owner and Landscape Architect shall be conducted by the ASP on site, with installed system, after completion of project. The contractor is to schedule, coordinate, and attend the training session. Training shall include an overview of system operations as well as detailed one-on-one training for selected individuals for both software and hardware operation.
- B. The control system manufacturer is to provide toll-free phone-in support to the Owner at no cost for a period of one (1) year within the initial purchase price of the system.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS.

2.2 GENERAL

- A. Specific requirements concerning the various materials and the arrangements in which they are

to be installed are outlined in this Specification.

B. Quality and Size

1. Material specified by name and / or model number in the Specifications, on the site, or detailed drawings are used for the purpose of identification of materials and to ensure specific use of that material in the construction of the system. No substitutions will be permitted without approval.
2. All materials used in the system must be new and without flaws or defects of any type and be the best quality available.

2.3 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Contractor materials shall comply with all requirements and provide irrigation equipment products from only the following:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products not listed within this section may be incorporated into the Work.
2. Irrigation equipment including spray heads, rotors, nozzles, control valves, quick couplers, master valves, irrigation controller, rain sensors, low volume irrigation equipment, drip tubing and drip fittings including pressure regulators, filters, air relief valves, tree root watering devices, pipe fittings including swing assemblies, swing joints, barbed fittings, swing pipe and compression fittings shall be manufactured by the Rain Bird Corporation.
 - a. Or approved equal
3. Decoder based irrigation control system equipment including, field decoders, line surge protection devices, sensors decoder and field transmitters shall be manufactured by the Rain Bird Corporation.
 - a. Or approved equal
4. Wire connectors shall be manufactured by 3M Corporation.
 - a. Or approved equal

2.4 DELIVERY, STORAGE AND HANDLING

A. Manufactured materials shall be delivered in original containers with brand and maker's names marked thereon. Materials in broken containers or showing evidence of damage will be rejected and must be immediately removed from the work.

B. Store plastic pipe on flat pallets and protect from sunlight.

2.5 PIPES, TUBES, AND FITTINGS

A. Main Irrigation supply line for potable water. PVC plastic pipe, ASTM D 2241 Class 200 SDR 21.

1. All PVC pipe from sizes three (3) inches and above shall, unplasticized rigid polyvinylchloride (PVC) pipe with integral bell and rubber ring gasket unless otherwise specified.
2. All PVC pipe from sizes two and one - half (2 1/2) to one (1) inch shall be Class 200, solvent weld PVC pipe.
3. All pipe shall be supplied in standard twenty (20) foot lengths.
4. Polyethylene pipe will not be accepted unless prior written approval is obtained by the landscape architect.

B. Circuit Pipe for potable water (downstream from circuit valves): PVC plastic pipe, ASTM D 2241 Class 200 SDR 21.

1. All PVC pipe from sizes three (3) inches and above shall, unplasticized rigid polyvinylchloride (PVC) pipe with integral bell and rubber ring gasket unless otherwise specified.

2. All PVC pipe from sizes two and one - half (2 1/2) to one (1) inch shall be Class 200, solvent weld PVC pipe.
 3. All pipe shall be supplied in standard twenty (20) foot lengths.
 4. Polyethylene pipe will not be accepted unless prior written approval is obtained by the landscape architect.
- C. All pipe that is exposed or not below grade shall be Schedule 80 PVC or HDPE. Seamless Copper Pipe: ASTM B88, Type M, drawn temper.
- D. Sleeving Pipe for Potable Water Irrigation Supply Line: PVC plastic pipe, Schedule 40, ASTM D 1785 and D 1784, PS 21-70.
- E. Fittings:
1. For PVC plastic pipe,
 - a. All pipe fittings size four (4) inches and greater shall be ductile iron.
 - b. 3" fittings shall be bell and rubber gasket.
 - c. Fittings 2-1/2" and under shall be Schedule 40 solvent weld PVC. ASTM D 2466 socket fittings with ASTM A 2564 solvent cement.
 2. Metallic: Cast bronze with standard iron pipe thread; 125 bl. class rating in conformance with ANSI B16.15.
 3. Copper: ANSI B16.22 wrought copper or cast brass, recessed solder joint type fittings.
- F. Nipples:
1. Metallic: Schedule 40 red brass (35% copper, 15% zinc) pipe: threaded both ends. Pipe shall be in accordance with ASTM B43.
 2. Plastic: Factory-threaded Schedule 80, Type 1, Grade 1 polyvinyl chloride (PVC) pipe, threaded both ends. Pipe shall be in conformance with ASTM D1784 and D1785. Color: grey.
- G. Pipe Connection Materials: Solvent, primer and lubricants as recommended by the manufacturer.
1. Joint compound for threaded connections is Teflon or approved equal tape; UL listed.
 2. No thinning of solvent or primer is allowed in any manner whatsoever.

2.6 WATER METER

- A. Water meter per Building MEP; REF: Building MEP Plans

2.7 BACKFLOW PREVENTER

- A. Back Backflow preventer per Building MEP; REF: Building MEP Plans

2.8 IRRIGATION CONTROL SYSTEM SLEEVING

- A. Install separate sleeve beneath paved areas to route each run of wiring. Any existing sleeving is not to be used without the consent of the owner's representative.
- B. Sleeving material beneath pedestrian pavements shall be PVC Class 200 pipe with solvent welded joints.
- C. Sleeving beneath drives and streets shall be PVC Schedule 40 pipe with solvent welded joints.
- D. Sleeving diameter shall be equal to twice the diameter of the wiring bundle.

2.9 VALVES

- A. Manufacturer's Standard, of type and size required, and as follows:
- B. Furnish valves with plastic bodies, glass filled nylon or red brass, unless otherwise indicated.

- C. Pressure Reducing Valve: If required, standard capacity water pressure reducing valve with integral strainer, Watts U5 series or equal.
- D. Master Valve.
1. Globe valve shall be normally closed 24 VAC 50/60 cycle solenoid actuated with a pressure rating of not less than 200 psi.
 2. The valve body and bonnet shall be constructed of heavy cast red brass; diaphragm shall be of nylon reinforced nitrile rubber. All other internal parts shall be made of bronze, brass and stainless steel.
 3. The valve shall have both internal and external manual open/close control to manual open and close the valve without electrically energizing the solenoid. The valve shall house a fully-encapsulated one piece solenoid.
 4. The valve shall have a stainless steel flow control stem and cross handle for regulating or shutting off flow of water. The valve must open or close in less than one minute at 200psi.
 5. The valve shall be sized to meet flow requirements shown on plans.
 - a. Potable irrigation system: Rain Bird 150-EFB-CP IVM Series valve
- E. Zone Control Valves for potable irrigation system.
1. Globe valve shall be normally closed 24 VAC 50/60 cycle solenoid actuated with a pressure rating of not less than 200 psi.
 2. The valve body and bonnet shall be constructed of heavy duty glass filled UV-resistant nylon and have stainless steel studs and flange nuts with a nylon reinforced nitrile rubber diaphragm.
 3. The valve shall have both internal and external manual open/close control to manual open and close the valve without electrically energizing the solenoid. The valve shall house a fully-encapsulated one piece solenoid.
 4. The valve shall have a brass flow control stem for accurate manual regulation and/or shut off of outlet flow.
 5. The valves shall be sized to meet flow requirements shown on plans.
 - a. Potable irrigation system: Rain Bird PE-IVM series valves
- F. Drip Zone Control Valve.
1. Preassembled Zone Control Valve Assembly designed specifically for drip irrigation applications. The Zone Control Kit shall consist of a valve, ball valve, pressure regulator and 200 mesh filter.
 2. Globe configuration valve shall be normally closed 24 VAC 50/60 cycle solenoid actuated with a pressure rating of not less than 150 psi.
 3. The valve body and bonnet shall be constructed of high impact, weather resistant plastic, stainless steel and other chemical / UV resistant materials.
 4. The valve shall have a one unit diaphragm constructed of durable Buna-N rubber material with a clog resistant metering orifice and a double knife seal. The valve shall have one 90 mesh pilot filter attached to the diaphragm.
 5. The valve shall have one fully encapsulated solenoid with captured plunger. The valve shall have one 90-mesh filter attached to the solenoid base.
 6. The valve shall be capable of on/off control by turning the solenoid $\frac{1}{4}$ turn. The valve shall provide a flush mode that is manually activated by $\frac{1}{2}$ turn of the bleed screw where external port is permissible.

7. The pressure regulating filter body shall be constructed of heavy duty, glass filled, UV resistant plastic material with a pressure rating of not less than 150 psi. The filter element shall be constructed of a durable polyester fabric attached to a propylene frame and shall be serviceable for cleaning by unscrewing the cap from the body.
8. The pressure regulator shall have a preset outlet pressure of approximately 40 psi in the 1" size and will accommodate an inlet pressure of not less than 150psi.
9. The valves shall be sized to meet flow requirements shown on plans.
 - a. Potable irrigation system: Rain Bird XCV-100-IVM-Q series valves
- G. Pressure Regulating Module for regulating outlet pressure at control valve from 15 – 100 psi.
 1. The pressure regulating module shall be a two-piece device consisting of a glass filled UV resistant nylon housing and dial cartridge. The regulator shall have visible pressure indication scale ranging from 0-100psi and an adjustable knob to provide fine tune adjustments in 1/3 psi increments.
 2. The regulator shall have a Schrader valve to accommodate a pressure hose gauge. The regulator shall be waterproof and provide regulation if the valve is manually internal bled or electronically activated.
 3. The Pressure Regulating Module shall be Rain Bird PRS-D.
- H. Quick Coupling Valve: Brass, Single piece construction, one inch female iron pipe size connection; vinyl covered brass hinged locking cover.
 1. Potable irrigation system: Yellow cap Rain Bird 44RC
- I. Manual Gate Valves (Isolation Valves): Non-rising stem, 125 lbs. brass body and parts with wedge disc filled for key operation, as supplied by Crane or equal.
- J. Pressure Relief Valves: As manufactured by Waterman, or equal.
- K. Valve Box Cover and Frame:
 1. Manufactures:
 - a. Rain Bird VB Series, manufactured by Rain Bird Corporation
 - b. Ametek plastic valve boxes, manufactured by Plymouth Products
 - c. or equal.
 2. Potable water irrigation system:
 - a. Turf Areas: Green Cover
 - b. Landscape Beds: Black Cover/Brown Cover
 3. Sizes:
 - a. 10" Round; Rain Bird PVB10RND
 - b. 12" Standard; Rain Bird PVB-STD
- L. Drainage Pit Backfill: Cleaned gravel or crushed stone, graded from 2" maximum to 3/4" minimum. AB3 or equivalent is not acceptable backfill material.

2.10 AUTOMATIC DRAIN VALVES

- A. Description: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig.

2.11 SPRINKLER HEADS

- A. Manufacturer's standard unit designed to provide uniform coverage over entire area of spray shown on drawings at available water pressure.

1. Pop-up spray heads, 6" for turf: Rain Bird 1800 Series with plastic body, co-molded wiper seal, precision controlled flush at pop-down, built-in pressure regulator (PRS) built in the stem to maintain constant outlet pressure of 30 psi, designed for use with Rain Bird matched precipitation rate (MPR) plastic nozzles and high efficiency variable arc nozzles (HEVAN) in odd angle locations, installed using Rain Bird SA series swing assemblies. All pop-up spray heads are to have the built-in Seal-A-Matic (SAM) check valve.

2.12 TURF ROTORS

- A. Manufacturer's standard unit to provide uniform coverage over entire area of spray shown on drawings at designated water pressure.
 1. 6" Pop-up gear driven turf rotor: Rain Bird 5000 plus series with flow shut off device, an integral pressure regulator to reduce operating pressure to 45PSI and top arc adjustment using flat bladed screwdriver of 40-360 degrees, pressure activated multi functional wiper seal, designed for use with the MPR nozzle set providing matched precipitation from 25' to 35' using Rain Curtain technology installed using Rain Bird TSJ series swing joints. Rotors located in low elevation areas and will be susceptible to lateral pipe drain down as designated by Landscape Architect are to have a spring loaded Seal-A-Matic (SAM) device in the base of the case.

2.13 LANDSCAPE DRIPLINE

- A. Flexible In-Line Drip Tubing
 1. Polyethylene tubing with factory installed, pressure compensating emitters with a spacing and consistent flow as listed on the plans.
 2. Pressure compensation will be accomplished through effective lengthening of the emitter flow path resulting with superior clog resistance.
 3. In-line emitter drip line shall have dual outlet ports to ensure direct contact with the ground.
 4. All drip tube to be staked in place using 12 gauge galvanized steel staples at 24"-36" OC.
 5. Rain Bird Easy Fit Compression Fitting System shall be used to connecting all drip tubing.
 6. In-line drip tubing shall be Rain Bird Landscape Dripline.
 - a. Potable water irrigation system XFD-06-18 in shrub beds
 - b. Potable water irrigation system XFD-09-12 in planters

2.14 SUBSURFACE IRRIGATION

- A. Root Watering System (RWS): Manufacturer's standard unit designed to provide subsurface aeration and irrigation. RWS with subsurface bubbler, locking grate, below grate installation, self-contained and factory assembled units. Rain Bird RWS-B-C-1402-Sock.

2.15 AUTOMATIC CONTROL SYSTEM

- A. The irrigation controller shall be a Rain Bird ESP-LXIVM controller.
 1. The controller shall be housed in a wall-mountable, plastic locking cabinet suitable for either indoor or outdoor installation. The controller shall be capable of supporting up to 60 stations.
 2. The controller shall support up to 5 independently managed flow sensors interfaced with sensor decoders. The controller shall support up to five flow zones.
 3. The controller shall incorporate a FloManager feature that shall provide real-time flow, power, and station management. FloWatch shall compare the current real-time flow rate to the learned rates and take user defined actions if problem is detected. FloWatch shall automatically determine the location of the flow problem and isolate the problem by turning off the affected station or master valve.
 4. The controller shall be compatible with the IQ v4.0 Central Control System utilizing IQ-NCC Network Communication Cartridges providing remote computer control of the controller via a

variety of communication options (Direct Connect Cable, Phone, GPRS/Cellular, Ethernet, WiFi, Radio, and IQNet Communication Cable).

5. Shall have the dimensions of:
 - a. Width: 14.32 in. (36.4 cm)
 - b. Height: 12.69 in. (32.2 cm)
 - c. Depth: 5.50 in. (14.0 cm)
- B. Surge Protection: Rain Bird Line Surge Protector IVM-SD (built in surge protection), required every 500' along two-wire path.
 1. Output power: Adjustable from controller – Inrush and holding current valves adjustable at controller.
 2. Encapsulation: Fully waterproof
 - a. Address: Pre-coded from factory Electrical Input: Nominal voltage: 34Vpp (24V AC) from two-wire line. Minimum voltage: 21 Vpp (15V AC). Maximum Voltage: 36 Vpp (25V AC)
 3. Electrical Output:
 - a. Max. voltage: 36 Vpp
 4. Maximum Cable Runs: 14 gauge – Star Pattern: 2.4 miles; Loop Pattern: 9.6 miles

Maximum Critical Path Lengths for 2-Wire Paths					
Nominal Wire Size	Ohms per 1000' or Ohms per Km (per conductor) Miles	Max. Length For Critical Path			
		Star		Loop	
		Km	Miles	Km	Miles
2.5 mm2	7.5 Ohms/Km	3.00	1.86	12.00	7.46
14 AWG	2.58 Ohms/1000'	2.66	1.65	10.63	6.61
12 AWG	1.62 Ohms/1000'	4.23	2.63	16.93	10.52

5. Decoder/Solenoid Wires - Electrical Resistance: Max. 3 ohms
6. Max. Distance Decoder/Solenoids: Cable length: 14 gauge: 456 feet
7. Wiring: Paige special direct burial irrigation control cable,
8. Environment: Working range: 32° to 122° F (0° to 50° C); storage range: -4° to 158° F (-20 to 70° C); Humidity: 100%
9. Surge Protection: 40 V, 1.5 kW transil

2.16 ELECTRIC WIRING

- A. 120 Volt AC Wiring: 120 volt service to controller shall consist of three wires: one black, one white, and one ground. Electrical service is to be provided by the General Contractor unless otherwise directed by Owner's Representative.
- B. Provide junction box, flush-mounted and gasketed per code as required.
- C. 2-Wire Control Wiring shall be dual core, tin-coated, double insulated special irrigation control wire. Minimum wire size shall be fourteen (14) gauge. Wire to be Maxi-cable as manufactured by Rain Bird® Corporation, Azusa, California or approved equal.
- D. Splices in controller wiring shall be waterproof direct bury application. Use Rain Bird-DBY T or R wire connectors. No substitutions will be allowed.

2.17 SURGE PROTECTION FOR THE TWO-WIRE PATH

- A. An IVM-SD shall be installed on the 2-wire communication path at each ESP-LXIVM controller location.
 - 1. The Rain Bird™ IVM-SD Line Surge Protector decoder specifications include but are not limited to:
 - a. The line surge protector decoder shall be grounded on a two-wire path every 500 feet (150 meters) or every 15 valves, whichever is smaller.
 - b. Install one (1) within controller cabinet.
 - c. The IVM-SD Line Surge Protector decoder shall be placed on a two-wire path.
 - d. The IVM-SD Line Surge Protector decoder shall be used for surge protection only, and shall not have a decoder address.
 - e. The IVM-SD Line Surge Protector decoder shall protect against 40V, 1.5kW transients.

2.18 GROUNDING

- A. Controller, decoders and ancillary products used on a two-wire path shall be connected to a grounding system with a ground resistance of ten (10) ohms or less.

2.19 FLOW SENSOR

- A. The flow sensor shall be an in-line type with a nonmagnetic, spinning impeller (paddle wheel) as the only moving part. The electronics housing shall have two, ethylenepropylene O-Rings and shall be easily removed from the meter body. The sensor electronics will be potted in an epoxy compound designed for prolonged immersion. Electrical connections shall be 2 single conductor 18 AWG leads 48 inches (1,2 meters) long. Insulation shall be direct burial "UF" type colored red for the positive lead and black for the negative lead. The sensor shall be capable of operating in line pressures up to 400 psi (27,5 bars) and liquid temperatures up to 220° F, and operating in flows of ½ foot per second to 15 feet per second with linearity of ±1% and repeatability of ±1%. The meter body shall be cast 85-5-5-5 bronze, in 1" and 1½", female iron pipe thread sizes. This flow sensor shall be Rain Bird Model FS100B series.

2.20 RAIN SENSOR

- A. Provide and install a wireless Rain Bird Rain Sensor (RSD-BEx) capable of turning off the irrigation system if adequate rainfall is received.
- B. Contractor to install per Rain Bird's recommendations and specifications. Location to be approved by Landscape Architect.
- C. Rain sensor shall employ an electro-mechanical actuating mechanism designed to cause a circuit interrupt if programmable low temperature or rainfall set points are satisfied.
- D. The device shall be used with 24VAC controllers and shall be of sufficient capacity to be used with a maximum of six 24VAC 7VA solenoids plus an additional master valve that does not exceed 53VA.

2.21 EQUIPMENT

- A. The following list of items shall be submitted to the Owner prior to the final inspection of the irrigation system.
 - 1. 2 quick coupler valve keys, Rain Bird 44-K
 - 2. 2 hose swivel (1" x 3/4"), Rain Bird SH-2
 - 3. 2 gate valve keys (48")

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall install all irrigation system components in accordance with the Irrigation and Landscape Plans, Details and these Specifications.
- B. Schedule of Work: The Irrigation Contractor shall be responsible for the installation of the piping and equipment in a manner that will effect the earliest completion of the work in conformance with the construction progress schedules of other Contractors and Trades, and these Specifications.
- C. Observations: In addition to normal progress inspection, the Contractor shall give at least 48 hours notice to the Landscape Architect for inspection as follows:
 - 1. Layout of the system.
 - 2. Pressure tests.
 - 3. Coverage adjustment; Automatic operation.
 - 4. Punch list inspection.
- D. Quick Coupler Valves: Locate quick coupler valves on mainline runs only, near pavement surfaces, and adjacent to annual planting beds. Space quick coupler valves at maximum 100' intervals near parking lots, islands, building entries, sidewalks, entry monuments, and annual planting beds. Space quick coupler valves at maximum 200' interval for large turf areas.

3.2 PROTECTION

- A. The Contractor shall be responsible for storage of materials and any damage to the work covered by these Specifications before the final acceptance of the work.
- B. Protect work and materials from damage during construction. Storage of polyvinyl chloride (PVC) pipe and fittings shall be protected from direct sunlight. Beds on which materials are stored must be the full length of the pipe to avoid damage. Any pipe that has been damaged or dented shall not be used in the work.
- C. Any existing structures, equipment, utilities, pavement, landscaping, etc., damaged by Irrigation Contractor during the course of the work, including any damage caused by leakage or settling of piping systems being or having been installed by them, shall be restored at Contractor's expense and to the Owner's satisfaction.
- D. Securely cover openings into the system and cover apparatus, equipment, and appliances, both before and after being set in place, to prevent obstruction in the pipes and the breakage, misuse or disfigurement of the apparatus, equipment or appliances.

3.3 LAYOUT AND VERIFICATION

- A. The Contractor shall stakeout the locations of all piping, quick coupling valves, spray heads, rotors, and emitters in accordance with the irrigation design drawings. The Contractor shall check and verify dimensions of layout and report variations to the Landscape Architect before proceeding. Layout work as accurately as possible to the drawings.
- B. Minor changes in locations to the above from locations shown shall be made as necessary to avoid existing or proposed planting, piping, utilities, structures, etc., at the Contractor's expense, or when directed by the Landscape Architect, providing such change is ordered before such items or work directly connected to same are installed, and providing no additional materials are required.
- C. The Contractor will be held responsible for the relocating of any items without first obtaining the Landscape Architect's approval. The Contractor shall remove and relocate such items, at his expense; if so directed by the Landscape Architect.
- D. Before starting work on irrigation system, carefully check all grades to determine that work may safely proceed, keeping within the specified material depths. The Contractor shall be aware of the fact that the drawings are horizontal dimensions. Actual measurements taken along the slope of a bank will differ from those shown on the drawings.

- E. No fittings shall be installed on pipe underneath pavement or walls except where noted on the irrigation drawings. If such a need should occur, the Contractor shall bring it to the attention of the Landscape Architect.
- F. Exact sprinkler head placement is based on and shall be coordinated with actual planting layout and shall be verified by the Landscape Architect.
- G. All changes shall be recorded daily on the Record Drawings.

3.4 TRENCHING AND BACKFILLING

- A. Provide a minimum of 24" cover over top of PVC main line for potable irrigation systems, or per city code.
- B. Provide a minimum of 12" cover over top of PVC lateral piping for potable irrigation systems, or per city code.
- C. Backfill for irrigation lateral lines shall be with clean material from excavation. Remove organic material as well as rock and debris larger than 1" diameter. Irrigation piping shall have no rock or debris touching at any point along its length. A minimum of 6" clearance is required around all piping from all immovable obstructions. Place acceptable backfill material in 6" lifts, compacting each lift. Compact within 90% of the maximum density of the material used as determined by ASTM D-698 (Standard).
- D. Backfill trench to within 6" of finished grade. Continue fill with acceptable topsoil and compact to bring even with existing grade. Thorough compaction at each sprinkler head, valve, and piping will be required. Repair all settled areas.
 - 1. Under pavement areas contractor shall meet compaction requirements of pavement section plans and geotechnical report. Include flowable fill as required.
- E. Boring underneath existing pavement may be required. PVC sleeving for irrigation main line shall be installed underneath all pavements.
- F. Unless otherwise indicated, comply with requirements of the Uniform Plumbing code, city specifications, and all state or local codes.

3.5 TAPPING AND SUPPLY

- A. Verify meter and backflow preventer have been installed in building.
- B. Install irrigation mainline tap at backflow preventer provided by building MEP. Coordinate with site contractor.

3.6 MASTER VALVE AND FLOW SENSOR

- A. Install master valve, flow sensor and pulse transmitter as per manufacturer's directions.
- B. Master valve and flow meter shall be installed in locking valve box per specification on detail sheets.

3.7 SLEEVING AND BORING

- A. Install sleeving at a depth which permits the encased wiring to remain at the specified depth.
- B. Extend the sleeve ends 6" beyond the edge of the paved surface. Cover pipe ends and mark with stakes.
- C. Install separate sleeve beneath paved areas to route each run of wiring. Any existing sleeving is not to be used without the consent of the Owner's Representative.
- D. Sleeving material beneath pedestrian pavements shall be PVC Class 200 pipe with solvent welded joints.
- E. Sleeving beneath drives and streets shall be PVC Sch. 40 pipe with solvent welded joints.
- F. Sleeving diameter shall be equal to twice the diameter of the wiring bundle.

3.8 CIRCUIT VALVES

- A. All valves shall be connected to main irrigation line in a plumb position. Each valve shall be installed in a valve box so that all parts of valve can be serviced. Valve boxes shall be installed over 6" of drainage gravel and shall be set so that the cover is flush with finish grade. Thorough compaction at valve boxes is required to bring the top of valve box 1" for turf and 2" for shrubs above finished grade after compaction and settlement has occurred. All settled valve boxes shall be raised prior to establishment acceptance.
- B. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.
- C. Provide pressure regulation modules on the control valves for all zones that exceed recommended operating pressure by 5 psi as indicated in the irrigation zone schedule.

3.9 PIPING

- A. Lay pipe in properly excavated trenches.
- B. For all mainline piping, slope to manual drain valve and drainage pit at least 1/2" in 10' of run.
- C. Install PVC pipe in dry weather when temperature is above 40 F in strict accordance with manufacturer's instructions. Allow joints to cure at least 24 hours at temperatures above 40 F (4 C) before testing, unless otherwise recommended by manufacturer.
- D. Manual Drain Valves: Install manual drain valves at all low points in main irrigation supply line. Record location on as-built drawings.
- E. Manual Gate Valves: Install manual gate valves at location shown on plan in main irrigation supply line. Record location on as-built drawings.
- F. Drainage Pits: 3 cu. ft. of clean gravel, minimum 18" deep, 1-1/12" - 2" size, shall be located at all manual and automatic drain valves. Cover drainage pit with a soil separator and backfill to finish grade with excavated soil material.
- G. Sleeves: Install sleeves for all main line, laterals, and wire that cross roadways, drives, sidewalks, and all other paving surfaces. Sleeves shall be a minimum of 4" diameter and shall be sized to accommodate all equipment necessary. Top of sleeves shall be a minimum of 24" below surface of paving. Sleeves shall extend a minimum of 12" behind back of curb. Permanently mark location of each end of sleeve on back of curb.

3.10 SPRINKLER AND ROTOR HEADS

- A. Flush circuit lines with full head of water and install heads after hydrostatic test is completed.
- B. All sprinkler heads shall be set plumb at the elevation to be flush with finish grade.
- C. Contractor shall adjust, if necessary, the elevation of the sprinkler heads after finish grade and landscape plantings are complete.
- D. Install all sprinkler heads with pre-assembled swing-joints or swing-assemblies. Funny pipe will not be accepted for installation of any kind.

3.11 LANDSCAPE DRIPLINE

- A. Final installation of drip irrigation to occur after the trees, shrubs and other plant material has been installed.
- B. Flexible inline tubing or point source emitter tubing shall be used.
- C. Layout drip and distribution tubing as detailed on the plans to place drip tubing near root zone of the plantings. Install drip tubing at or near the surface of planting soil.
- D. Install one (1) OPERIND drip system operation indicator per drip zone at the furthest point of the drip zone from the remote control valve.
- E. Stake all drip tubing with steel stakes so that no movement of the pipe exists.

- F. Pressurize, flush and cap drip tubing.
- G. Cover drip tubing with specified depth of mulch.

3.12 SUBSURFACE IRRIGATION

- A. Flush circuit lines with full head of water and install heads after hydrostatic test is completed.
- B. All rootwatering system heads shall be set plumb at the elevation to be flush with finish grade.
- C. Contractor shall adjust, if necessary, the elevation of the rootwatering system heads after finish grade and landscape plantings are complete.
- D. Install all rootwatering system heads with pre-assembled swing-joints or swing-assemblies. Funny pipe will not be accepted for installation of any kind.

3.13 CONTROLLER

- A. Controller shall be installed in permanent location as shown on plan and verified by Landscape Architect.
- B. Contractor shall properly programmed controllers for this particular job prior to substantial completion of this project.
- C. Control wire of system shall be 2 x 14 gauge, specifically designed for direct burial use. A minimum of 3'-0" of extra wire shall be spooled at each decoder location, at each splice, at each change in direction and at every 500 feet of straight run. At each termination of the mainline, an additional 6'-0" of wire shall be coiled and located within a valve box.
- D. Control wire shall be installed in multiple wire paths as shown on the plans.
- E. Wire shall be placed consistently along one side of the pipe in the trench. Splices and connections shall be watertight and leak proof, use Pin-Tight connections. Multiple wires in the trenches shall be banded together at 20-foot intervals for protection. Wire not along mainline pipe shall be placed within an electrical conduit.
- F. Install monitoring equipment including Weather Station, Flow Meter, and Soil Moisture Sensor. Electrical connections between controller and monitoring equipment shall be installed by contractor per manufacturer's recommendations. Irrigation contractor is responsible for all electrical power connections from power supply point adjacent to weather station.
- G. Install all surge protection as per manufacturer's latest instructions.
- H. Lightning protection: Drive three 8' copper-clad grounds into the soil. If soil conditions prevent proper penetration of the ground rods into the soil, contact the Landscape Architect. Connect controller to grounding rod with AWG No. 10 Solid conductor copper wire. Secure wire to grounding rod with brass or bronze clamp.
- I. Install electrical connections between controller manufacturer's recommendations.
- J. Install all surge protection as per manufacturer's latest instructions.
- K. Lightning protection: Drive three 8' copper-clad grounds into the soil. If soil conditions prevent proper penetration of the ground rods into the soil, contact the Landscape Architect. Connect controller to grounding rod with AWG No. 10 Solid conductor copper wire. Secure wire to grounding rod with brass or bronze clamp.
- L. Irrigation Control Units
 - 1. The locations of the control units depicted on the drawings are approximate; the Owner's Representative, with assistance from the manufacturer's representative and the Landscape Architect, will determine the exact site locations at the system layout review.
 - 2. General Contractor will provide all communication drop location as designated on the plans. The irrigation contractor is responsible for all connections from stubout locations. Coordinate with General Contractor.

3. General Contractor to provide all 120VAC power for control units. Coordinate location of power with Landscape Architect.
 4. Install electrical connections between central control unit components and satellite control units per manufacturer's recommendations.
 5. Install electrical connections between satellite control units and monitoring equipment per manufacturer's recommendations.
 6. Install all surge protection as per manufacturer's latest instructions.
 7. Lightning protection: Drive three 8' copper-clad grounds into the soil. If soil conditions prevent proper penetration of the ground rods into the soil, contact the Owner's Representative. Connect controller to grounding rod with AWG No. 10 solid conductor copper wire. Secure wire to grounding rod with brass or bronze clamp.
 8. Attach wire markers to the ends of control wires inside the controller unit housing. Label wires with an identification number that consists of the name and station number of the existing controller to which the control wire had been previously connected.
 9. Connect control wire to corresponding control unit terminal. Connect wires to the satellite controller in the same order they are connected to the existing controller.
 10. Connection to controller per manufacture recommendation.
- M. Irrigation Control System Setup
1. All irrigation schedules and programming shall be set up per manufacture recommendations.
 2. Contractor shall set up all modules including connection to all site controllers and sensors.

3.14 HYDROSTATIC TESTING

- A. Contact the Landscape Architect, while the necessary piping system components are exposed. All mainline piping is to be subjected to a hydrostatic test. Subcontractor is to supply all testing equipment including pump and all caps and gauges as required.
- B. Pressure gauges shall be read in PSI. Calibration shall be such that accurate determination of potential pressure loss can be ascertained. Test supply line at a pressure of 120 PSI for minimum of one hour with an allowable loss of 5 PSI.
- C. Re-test as required until the system meets the requirements. During the tests, regardless of the amount of leakage, all detectable leaks are to be stopped and all defects corrected.

3.15 ADJUSTING THE SYSTEM

- A. Adjust alignment and coverage of all sprinklers and rotors if it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage. Make all necessary changes or make arrangements as directed by Landscape Architect. These changes or adjustments shall be made without additional cost.

3.16 RECORD DRAWINGS

- A. Indicate actual location of all valves and controls including piping. Show dimensions from easily identifiable existing features such as walls, curbs, fences, buildings, or walks. Submit diagram to the Landscape Architect for approval.
- B. Maintain progress drawings on the construction site at all times during installation of the irrigation system. Make a daily record of all work installed each day until completion of the work.
- C. Submit to Owner one (1) electronic version of the irrigation record drawings.
- D. Submit to Owner one (1) ½ size reduction of the irrigation record drawing, laminated both sides, for inclusion into the inside of the controller door.
- E. Submit to Owner two (2) full size plan sets of the irrigation record drawings.

3.17 ACCEPTANCE

- A. The ASP shall instruct the owner's designated personnel in the operation of the system pursuant to the training section already outlined in the specifications.
- B. The irrigation control system must be commissioned the ASP prior to final walk through of the system. The ASP shall confirm that the system is installed and grounded per the manufacture's recommendations. The Contractor shall address any system deficiencies found by the ASP prior to substantial completion.

3.18 GUARANTEE AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall fill and repair all depressions and replace all necessary lawn and planting due to the settlement of irrigation trenches for one year following the completing and acceptance of the job.
- B. The Contractor shall also guarantee all materials, equipment and workmanship furnished by him to be free of all defects of workmanship and materials, and shall agree to replace at his expense, at any time within one year after installation is accepted, any and all defective parts that may be found. Contractor shall transfer all manufacturer material warranties to the Owner. All manufacturer warranties shall be in effect for the period outlined in the manufacturer literature from the date of installation. Contractor shall detail these warranties and provide all necessary information regarding them to the Owner in the record drawing submittals.
- C. The Contractor shall drain the irrigation system in the fall of the first year, and provide start up in the following spring.
- D. After the system is installed and approved, instruct the Owner or Owner's representative as to the complete operation and maintenance.

END OF SECTION

SECTION 32 91 15

SOIL PREPARATION - OLSSON

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes planting soils specified according to performance requirements of the mixes.

1.3 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.
- G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
- J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- M. SSSA: Soil Science Society of America.
- N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- Q. USCC: U.S. Composting Council.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include recommendations for application and use.
 - 2. Include test data substantiating that products comply with requirements.
 - 3. Include sieve analyses for aggregate materials.
 - 4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
 - a. Manufacturer's qualified testing agency's certified analysis of standard products.
 - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SU1P #25.
 - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- B. Samples: For each bulk-supplied material, four 1-quart (1-L) volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For each testing agency.
- B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil.
 - 1. Notify Architect seven days in advance of the dates and times when laboratory samples will be taken.
- B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
 - 1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.9 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Architect under the direction of the testing agency.
 - 1. Number and Location of Samples: Minimum of eight representative soil samples from pre-approved varied locations for each soil to be used or amended for landscaping purposes.
 - 2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."

3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.10 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:
 1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
 - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
 2. Bulk Density: Analysis according to core method of SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 3. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
- C. Chemical Testing:
 1. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.
- D. Fertility Testing: Soil fertility analysis according to standard laboratory protocol of SSSA NAPT NCR-13, including the following:
 1. Percentage of organic matter.
 2. CEC, calcium percent of CEC, and magnesium percent of CEC.
 3. Soil reaction (acidity/alkalinity pH value).
 4. Buffered acidity or alkalinity.
 5. Nitrogen ppm.
 6. Phosphorous ppm.
 7. Potassium ppm.
 8. Manganese ppm.
 9. Manganese-availability ppm.
 10. Zinc ppm.
 11. Zinc availability ppm.
 12. Copper ppm.
 13. Sodium ppm.
 14. Soluble-salts ppm.
 15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
 16. Other deleterious materials, including their characteristics and content of each.
- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."

- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm) depth of soil.
 2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm) depth of soil.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Do not move or handle materials when they are wet or frozen.
 4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS.

2.2 PLANTING SOILS SPECIFIED ACCORDING TO PERFORMANCE REQUIREMENTS

- A. Planting-Soil: Existing, on-site surface soil retained; and stockpiled on-site; modified to produce viable planting soil. Using preconstruction soil analyses and materials specified in other articles of this Section, amend existing, on-site surface soil to become planting soil complying with the following requirements:
1. Particle Size Distribution by USDA Textures: Classified as silt loam soil according to USDA textures.
 2. Percentage of Organic Matter: Minimum 6 percent by volume.
 3. Soil Reaction: pH of 6 to 8.
 4. RCRA Metals: Below maximum limits established by the EPA.
 5. Phytotoxicity: Below phytotoxicity limits established by SSSA.
- B. Planting-Soil: Imported, naturally formed soil from off-site sources and consisting of sandy loam loam, silt loam, loamy sand or sand soil according to USDA textures; and modified to produce viable planting soil. Amend imported soil with materials specified in other articles of this Section to become planting soil complying with the following requirements:
1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches (100 mm) deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass.

2. Additional Properties of Imported Soil before Amending: Minimum of 6 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration. Clean soil to be of the following:
 - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
 - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
 3. Percentage of Organic Matter: Minimum 6 percent by volume.
 4. Soil Reaction: pH of 6 to 8.
 5. RCRA Metals: Below maximum limits established by the EPA.
 6. Phytotoxicity: Below phytotoxicity limits established by SSSA.
- C. Planting-Soil: Manufactured soil consisting of manufacturer's basic topsoil, blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials as specified in other articles of this Section to produce viable planting soil.
1. Basic Properties: Manufactured soil shall not contain the following:
 - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
 - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
 - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1/2 inches (38 mm) in any dimension.
 2. Percentage of Organic Matter: Minimum 6 percent by volume.
 3. Soil Reaction: pH of 6 to 8.
 4. RCRA Metals: Below maximum limits established by the EPA.
 5. Phytotoxicity: Below phytotoxicity limits established by SSSA.

2.3 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 1. Class: T, with a minimum of 99 percent passing through a No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through a No. 60 (0.25-mm) sieve.
 2. Form: Provide lime in form of ground dolomitic limestone.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

2.4 ORGANIC SOIL AMENDMENTS

- A. Shall be mature, weed free, and produced by aerobic decomposition of organic matter. Compost feedstock shall be yard waste trimmings and/or source-separated municipal solid waste to produce a fugally dominated compost. The product must not carry and visible refuse or other physical contaminants, substances toxic to plants, or over 5% sand, silt, clay or rock material by dry weight. The product shall possess no objectionable odors. The product must meet all

applicable USEPA CRF, Title 40, Part 503 Standards for Class A biosolids. The moisture level shall be such that no visible water or dust is produced when handling the material.

- B. Compost shall be dark brown in color, approximately the color of dark chocolate candy (70% chocolate). Black compost and compost the color of milk chocolate shall be rejected.
- C. Compost shall have a strong aerobic (sweet) odor. Compost lacking a strong aerobic odor or which has an anaerobic (sour) odor shall be rejected.
- D. Testing: The testing data must be current and represent the material to be used on site. The results of Compost analysis shall be provided by the Compost supplier. Before delivery of the Compost, the supplier must provide the following documentation:
 - 1. Feedstock percentage in the final Compost product
 - 2. A statement that the Compost meets federal and state health and safety regulations.
 - 3. A Copy of the lab analysis, less than four months old, performed by a Seal of Testing Assurance Certified Laboratory verifying that the Compost meets the following requirements

Physical Requirements for Compost Organic Matter

<u>Parameter</u>	<u>Range</u>	<u>Testing Method</u>
pH	5.5-8.0	TMECC 4.11A
Soluble Salt Concentration	<4dS/m	TMECC 4.10-A
Moisture	35-55% wet weight basis	
Organic Matter	>35% dry weight basis	TMECC 5.07-A
Carbon to nitrogen ratio	15:1-30:1	
Particle Size	99% pass through 2 inch screen or smaller; 25% pass through 3/8 inch screen or smaller	TMECC 2.02-B
Maturity Index	6 to 8 Solvita	
Physical contaminants (man made inerts)	<1% dry weight basis	TMECC 3.08-A

- a. Chemical contaminants
- b. Meet or exceed US EPA Class A standard, 40 CFR§ 503.13,T ables 1 and 3 levels

Arsenic	<41 ppm	TMECC 4.06-AS
Cadmium	< 39 ppm	TMECC 4.06-CD
Copper	<1,500 ppm	TMECC 4.05-CU
Lead	<300 ppm	TMECC 4.06-PB
Mercury	<17 ppm	TMECC 4.06-HG
Molybdenum	<75 ppm	TMECC 4.05-MO
Nickel	<420 ppm	TMECC 4.06-NI
Selenium	<100 ppm	TMECC 4.06-SE
Zinc	<2,800 ppm	TMECC 4.06-ZN

- c. Biological contaminants Meet or exceed US EPA Class A standard, 40 CFR§ (pathogens) 503.32(a) levels:

Fecal coliform <1,000 MPN per gram, TMECC 7.01 by dry weight basis

Salmonella <3 MPN per 4 grams, TMECC 7.02 dry weight basis

- 4. Compost testing methodologies and sampling procedures shall be as provided in Test Methods for the Examination of Compost and Compost (TMECC), as published by the US Composting Council.
- 5. Provide a one gallon sample with manufactures literature and material certification that the product meets the requirements.

2.5 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches (150 mm) or 24 inches (600 mm) per plans and stockpile until amended.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Clean soil to contain a combined maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 1-1/2 inches (38 mm) 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Spread unamended soil to total depth of 6 inches minimum (150 mm) for turf areas and of 24 inches minimum (600 mm for landscape areas), but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.

- a. Mix fertilizer with planting soil no more than seven days before planting.
- 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 6 inches (150 mm) in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Application: Spread planting soil to total depth of 6 inches (150 mm) for turf areas of 24 inches (300 mm) for landscape areas, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Lifts: Apply planting soil in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 6 inches (150 mm) in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698 except where a different compaction value is indicated on Drawings.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 BLENDING PLANTING SOIL IN PLACE

- A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 6 inches (150 mm) for turf areas and of 24 inches (600 mm) for landscape areas. Remove stones larger than 3 inches (75 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.
- D. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
 - 1. Performance Testing: For each amended planting-soil type, demonstrating compliance with specified performance requirements. Perform testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
- C. Soil will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.7 PROTECTION

- A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Parking vehicles or equipment.
 - 2. Vehicle traffic.
 - 3. Erection of sheds or structures.
 - 4. Impoundment of water.
- C. If planting soil or subgrade is over compacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.8 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
 - 1. Dispose of excess subsoil and unsuitable materials on-site where directed by specifications.

END OF SECTION

SECTION 32 93 00
LANDSCAPE MATERIALS - OLSSON

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
- C. Section 328400 "Planting Irrigation" for complete irrigation systems.
- D. Section 328400 "Soil Preparation" for landscape soil preparation.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fertilizers.
 - 2. Herbicides and pesticides.
 - 3. Landscape edgings.

1.3 COORDINATION

- A. Coordination with Turf Areas: Coordinate trees planting by Others with Construction Manager after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. If trees are planted after planting turf areas, protect turf areas and irrigation system, and promptly repair damage caused by planting operations.
 - 2. Coordinate timing of planting with Owner and protect finished grades until tree plantings by Others.
 - 3. Provide erosion-control measures needed to prevent erosion or displacement of established grades until tree plantings by Others.
- B. Coordination with Turf Areas: Coordinate shrub and native planting areas by Owner with Construction Manager after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. If planting shrubs and native planting areas after planting turf areas, protect turf areas and irrigation system, and promptly repair damage caused by planting operations.
 - 2. Coordinate timing of planting with Owner and protect finished grades until shrubs and native plantings are installed by Owner.
 - 3. Provide erosion-control measures needed to prevent erosion or displacement of established grades until shrub and native plantings by Owner.
- C. Coordination of pre-emergent herbicide applications: Coordinate shrub and native planting areas by Owner with Construction Manager for timing of pre-emergent herbicide applications and associated planting by Owner.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data:
 - 1. Fertilizers.
 - 2. Herbicides and pesticides.

3. Landscape edgings.
- B. Samples for Verification: Actual sample of finished products for each of the following:
 1. Organic Mulch: 1-quart (1-L) volume of each organic mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Provide an accurate representation of color, texture, and organic makeup.
 2. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of manufactured product, from manufacturer, and complying with manufacturer's certified analysis of standard products.
- B. Pesticides and Herbicides: Product label and manufacturer's written application instructions specific to Project.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Installer's Field Supervision: Maintain an experienced full-time supervisor on Project site when work is in progress.
 2. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

1.9 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS.

2.2 FERTILIZERS

- A. Granular Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 1. Composition:
 - a. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 HERBICIDES AND PESTICIDES

- A. Owner approved Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- B. Owner approved Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

- C. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.4 LANDSCAPE EDGINGS

- A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
 - 1. Edging Size: 1/4 inch (6.4 mm) thick by 5 inches (125 mm) deep.
 - 2. Stakes: Tapered steel, a minimum of 15 inches (380 mm) long.
 - 3. Accessories: Standard tapered ends, corners, and splicers.
 - 4. Finish: Unfinished or Black.

2.5 ROCK AND AGGREGATE MULCH

- A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.
- B. Basis-of-Design Product: Outdoor Solutions, or Pre-approved Equal.
Address: 10901 South 14th Street, Roca, Nebraska 68430.
Phone: (402) 420-1477
Website: www.outdoorsolutions-lincoln.com
- C. R-1: Rock Mulch
 - 1. Mulch: Mexican Beach Pebbles.
 - 2. Size: 1-2".
 - 3. Depth: 3" minimum.
- D. R-2: Aggregate Mulch
 - 1. Mulch: Black Granite Chips.
 - 2. Size: 1-8".
 - 3. Depth: 2-1/2" minimum.

2.6 HARDWOOD MULCH

- A. Hardwood Mulch: Mulch in all open planting beds and tree grates shall be shredded double ground oak or dark hardwood mulch of its natural color. Cypress, or dyed or colored mulch is unacceptable. Bark shall be of a relative uniform particle size with a median size of one and one-half inches (1-1/2") and shall be free of sticks, stones, leaves and any other debris

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 INSTALLATION OF LANDSCAPE EDGINGS

- A. Steel Edging: Install steel edging where indicated in accordance with manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches (760 mm) apart, driven below top elevation of edging.

- B. Shovel-Cut Edging: Separate mulched areas from turf areas with 45-degree, 4- to 6-inch- (100- to 150-mm-) deep, shovel-cut edge as indicated on Drawings.

3.3 APPLICATION OF HERBICIDES AND PESTICIDES

- A. Owner approved Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written instructions. Do not apply to seeded areas.
- B. Owner approved Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.
- C. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and in accordance with manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.4 PLANT MAINTENANCE

- A. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- B. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.5 CLEANING AND PROTECTION

- A. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect trees, plants, native plantings, and mulch from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Immediately inform Owner of any damages to owner installed plantings. Treat, repair, or replace damaged plantings as required.
- D. After installation and before Substantial Completion remove debris from plant material, planting areas, and Project site.

END OF SECTION

SECTION 32 94 33
PLANTERS - OLSSON

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Planters

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, storage and handling requirements and recommendations, installation methods and available colors, styles, patterns and textures.
- B. Shop Drawings: Submit manufacturer's shop drawings, including plans and elevations, indicating overall dimensions.
- C. Samples: Submit manufacturer's samples of materials, finishes, and colors.
- D. Warranty: Manufacturer's standard warranty.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area in accordance with manufacturer's written instructions. Keep materials in manufacturer's original, unopened containers and packaging until installation.
- C. Handling: Protect materials and finish during handling and installation to prevent damage per manufacturer's written specifications.

1.5 WARRANTY

- A. Warranty Information:
 - 1. Products will be free from defects in material and/or workmanship for a period of three years from the date of invoice.

PART 2 - PRODUCTS

2.1 MATERIALS

- B. THIS PROJECT MUST COMPLY WITH THE BABA ACT, ENSURING ALL IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS MEET ITS REQUIREMENTS.

2.2 PLANTERS

- A. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.
- B. Basis-of-Design Product: Landscape Forms, or Pre-approved Equal.
Address: 7800 E. Michigan Ave, Kalamazoo, Michigan 49048
Phone: (800) 521-2546
Website: www.landscapeforms.com

C. PL-1 and PL-2: Dune Planters.

1. Style 1: DS-40: 60" dia x 40"H, 28" base. Weighs 2280 lbs. Capacity: 24.8 cu.ft.
2. Style 2: DS-32: 44" dia x 32"H, 20" base. Weighs 1020 lbs. Capacity: 9.9 cu.ft.
3. Color: Concrete Dune and Ash White.
4. Sealant: DryWay exterior and Bituminous interior sealants.
5. Finish/sandblasting option: Smooth finish (no sandblasting).
6. Mount: Free-standing.
7. Drainage: Standard 2-3/8" diameter, centered.
8. Materials:
 - a) Concrete: Portland cement, sand, aggregate, air entrainment, and color admixture. Use only one brand, type and source of cement for entire Project. Provide integral colored concrete with lightfast (UV and fade resistant) color pigments.
 - b) Water: Clean and potable.

D. PL-3: Paseos Planter.

1. Style: CS-48: 44" dia x 48.27"H, 18" base. Weighs 2,627 lbs. Capacity: 9.8 cu.ft.
2. Color: Concrete Dune and Ash White.
3. Sealant: Alga-chem exterior and Bituminous interior sealants.
4. Finish/sandblasting option: Smooth finish (no sandblasting).
5. Mount: Free-standing.
6. Drainage: Standard.
7. Materials:
 - a) Concrete: Portland cement, sand, aggregate, air entrainment, and color admixture. Use only one brand, type and source of cement for entire Project. Provide integral colored concrete with lightfast (UV and fade resistant) color pigments.
 - b) Water: Clean and potable.

2.3 PLANTER RESERVOIRS

- C. Basis-of Design manufacturer and product is identified. Products by other manufacturers shall be bid as an alternate. Substitution request and pre-approval by the Architect is required if proposing a manufacturer not listed in the drawings or specification section. Acceptance of alternate bids by Owner or Architect is not solely based on price.

- D. Basis-of-Design Product: Planters Unlimited, or Pre-approved Equal.

Address: 6088 Corte Del Cedro, Carlsbad, California 92011

Phone: (888) 320-0626

Website: www.plantersunlimited.com

- E. PL-1, and PL-2: Dune Planters.

1. Style 1: Reservoir 28" WW-R28.
2. Style 2: Reservoir 18" WW-R18.

- F. PL-3: Paseos Planter.

1. Style 3: Reservoir 28" WW-R28.

2.4 RECYCLED CONTENT

- A. Planter:

1. Post-Consumer Material Content: Minimum 0 percent.
 2. Pre-Consumer Material Content: Minimum 0 percent.
- B. Recyclable: 100 percent.

2.5 FABRICATION

- A. Formwork:
1. Fabricate steel forms for close control of dimensions and details.
 2. Fabricate forms sufficiently rigid to meet casting tolerances.
 3. Coat formwork with form release agent.
- B. Casting:
1. Provide face mix for full unit depth.
 2. Fabricate units to required profiles and sizes. Execute work accurately to specified tolerances and free of broken edges. Fabricate edges straight and with clean accurate arises.
 3. Ensure exposed edges and ends match finish and texture of face of unit.
- C. Curing:
1. Protect units from exposure to weather until concrete strength is adequate for form removal.
 2. Cure units under identical conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive planters.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.2 INSTALLATION

- A. Install planters in accordance with manufacturer's written instructions at locations indicated on the Drawings.
- B. Install planters level and plumb.

3.3 ADJUSTING

- A. Finish Damage: Contact manufacturer for assistance to repair minor damages to finish as approved by Architect.

3.4 CLEANING

- A. Clean planters promptly after installation in accordance with manufacturer's instructions.
- B. Do not use harsh cleaning materials or methods that could damage finish.

3.5 PROTECTION

- A. Protect installed planters to ensure that, except for normal weathering, planters will be without damage or deterioration at time of Substantial Completion.

END OF SECTION



DIVISION 33

UTILITIES



SECTION 33 41 00

STORM UTILITIES DRAINAGE PIPING (Olsson)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Cleanouts.
 - 3. Curb Inlets
 - 4. Drainage Inlets
 - 5. Pipe outlets

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For pre-manufactured drain basins and curb inlets structures

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.4 PROJECT CONDITIONS

- A. Work in City of Lincoln Right of Way requires a Right of Way Construction Permit from Lincoln Transportation & Utilities. Contractor to obtain and adhere to permit requirements. Contractor to provide Traffic Control Plan and Traffic Control Measures in accordance with Lincoln Transportation & Utilities requirements.
- B. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of service.

PART 2 - PRODUCTS

2.1 HDPE PIPE AND FITTINGS

- A. Basis of Design:
 - 1. Advanced Drainage Systems, Type N-12, was used as the Basis of Design for dimensional coordination, hydraulic performance, installation approach and functional requirements.
 - 2. Products from other manufacturers shall be permitted provided that they meet or exceed all specified performance, material, structural, and installation requirements of this specification.
- B. Corrugated HDPE Pipe and Fittings 4" to 36": AASHTO M 294M, ASTM F 2306, smooth interior, annular exterior.
 - 1. Watertight Fittings: ASTM F477 gaskets, PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

2.2 CLEANOUTS

- A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM D 3034, PVC Pipe and Fittings.

2.3 DRAIN BASINS AND CURB INLETS:

- A. Basis of Design:
 1. Nyloplast Curb Inlets and Drain Basins, manufactured by Advanced Drainage Systems, were used as the Basis of Design for dimensional coordination, hydraulic performance, installation approach and functional requirements.
 2. Products from other manufacturers shall be permitted provided that they meet or exceed all specified performance, material, structural, and installation requirements of this specification.
- B. Curb Inlets and Drain Basins shall
 1. Provide watertight, gasketed pipe connections.
 2. Allow field adjustment to finished grade.
 3. Be suitable for installation in paved traffic areas.
 - a. Load rating H-20 in vehicular traffic areas, H-10 in pedestrian-only areas.

2.4 SLOT DRAIN:

- A. Basis of Design:
 1. ACO SlotDrain, manufactured by ACO, were used as the Basis of Design for dimensional coordination, hydraulic performance, installation approach and functional requirements.
 2. Products from other manufacturers shall be permitted provided that they meet or exceed all specified performance, material, structural, and installation requirements of this specification.

2.5 HYDRODYNAMIC SEPARATOR:

- A. Basis of Design:
 1. Arcadia AR4PC, manufactured by Advanced Drainage Systems, was used as the Basis of Design for dimensional coordination, hydraulic performance, installation approach and functional requirements.
 2. Products from other manufacturers shall be permitted provided that they meet or exceed all specified performance, material, structural, and installation requirements of this specification.
- B. Hydrodynamic Separator shall
 1. Provide a combination curb inlet and grate opening at the top of the structure.
 2. Provide a minimum treated flowrate of 1.25 CFS (OK-100 80% Removal).
 3. Provide a minimum internal by-pass flowrate of 13 CFS.
 4. Provide watertight, gasketed pipe connections.
 5. Allow field adjustment to finished grade.
 6. Be suitable for installation in paved traffic areas.
 - a. Load rating H-20 in vehicular traffic areas, H-10 in pedestrian-only areas.

2.6 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.7 AGGREGATE

- A. Pipe Bedding (Storm Sewer Mains): Well graded, “crusher run” crushed stone or crushed concrete. Percent passing: 1” – 100%, #4 – 20% to 40%, #10 – 0 to 30%, #200 – 0 to 10%.

2.8 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
 - 1. Green: Sewer systems.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 31 20 00 – Earth Moving.

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of micro tunneling.
- F. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.

2. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
3. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
4. Install Corrugated HDPE and HP pipe according to manufacturer's specifications in accordance with ASTM D2321.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
 2. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
 3. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Install piping so cleanouts open in direction of flow in sewer pipe.
 1. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 10 inches deep. Set with tops 1 inch above surrounding earth grade.
 2. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAIN BASIN AND CURB INLET INSTALLATION

- A. Set frames and grates to elevations indicated.
- B. Install drain basin and trench drain in accordance with manufacturer's recommendations.
- C. Make connections to proposed storm sewer piping with standard fittings in general conformance with construction documents.

3.6 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.7 CONNECTIONS

- A. Coordinate proposed connections to existing storm sewer curb inlets with City of Lincoln Transportation & Utilities.
- B. Make connections to existing piping and underground manholes.
 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through

pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

- a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
- b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 IDENTIFICATION

- A. Install continuous underground warning tape during backfilling of trench for underground storm sewer piping. Locate below finished grade, 12" above piping. Underground warning tapes are specified in Section 31 20 00 "Earth Moving."

3.9 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 1. Submit separate reports for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.

- c. Option: Test concrete piping according to ASTM C 924.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with water if approved by the Engineer.

END OF SECTION



DIVISION 48

ELECTRICAL POWER GENERATION



SECTION 48 14 00
SOLAR PHOTOVOLTAIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PV Modules.
2. Inverters.
3. Data Acquisition System.

B. General Requirements:

1. Contractor shall provide a system to meet the power and energy criteria specified in Section 2.2 and as determined by Contractor's equipment selection and the requirements in the Project Drawings and Specifications.
2. All proposed equipment shall work together to form a fully functioning system without adjustments, derates, or field modification.
3. The PV system is intended to operate in parallel with the utility service provider. Contractor shall coordinate with the Power Company to ensure system compliance.
4. The PV system consists of multiple interconnection points on the facility secondary system, including a 25 kW system connected behind the customer meter and a 100 kW system connected via a separately metered service, both supplied from a common utility service transformer. All interconnections shall comply with applicable Power Company requirements and interconnection standards.

C. Related Requirements: Include, but are not necessarily limited to:

1. Section 26 05 00 - Electrical - Basic Requirements.
2. Section 26 05 19 – Wire and Cable – 600 Volt and Below.
3. Section 26 05 26 – Grounding and Bonding
4. Section 26 05 33 – Raceways and Boxes
5. Section 26 09 16 – Electrical Metering Devices
6. Section 26 28 00 – Overcurrent and Short Circuit Protective Devices

1.2 QUALITY ASSURANCE

A. Referenced Standards (latest version adopted by AHJ):

1. ETL Testing Laboratories (ETL).
2. International Electrotechnical Commission (IEC):
 - a. 61215, Crystalline Silicon Terrestrial Photovoltaic (PV) Modules.
 - b. 61730, Photovoltaic (PV) Module Safety Qualification.
 - c. 61853-1, PV Module Performance Testing.
 - d. 60529, Degrees of Protection Provided by Enclosures.
3. Federal Communications Commission (FCC):
 - a. Code of Federal Regulations, Title 47 Part 15.
4. International Code Council (ICC):
 - a. International Building Code and associated standards in accordance with the local Building Official requirements, Edition including all amendments, referred to herein as Building Code.
5. Institute of Electrical and Electronics Engineers (IEEE):
 - a. 519, Standard for Harmonic Control in Electric Power Systems.

- b. 929, Recommended Practice for utility Interface of PV Systems.
 - c. 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems.
 - d. National Electrical Safety Code (NESC).
- 6. International Organization for Standardization (ISO):
 - a. 9001, Quality Management Systems.
- 7. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
- 8. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 70E, Standard for Electrical Safety in the Workplace.
- 9. Underwriters Laboratories, Inc. (UL):
 - a. 508A, Standard for Industrial Control Panels.
 - b. 746, Evaluation of Polymer Materials in Electrical Applications.
 - c. 790, Standard Test Methods for Fire Tests of Roof Coverings.
 - d. 60950, Information Technology Equipment – Safety.
 - e. 61010, Standard for Safety Requirements of Electrical Equipment for Measurement, Control, and Laboratory Use.
 - f. 1703, Standard for Safety of Flat-Plate Photovoltaic Modules and Panels. Electrical Safety Authority (ESA).
 - g. 1741, Inverters, Converts, Controllers and Interconnection System Requirements for Use with Distributed Energy Resources.
 - h. 2703, Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels.
- B. Qualifications:
 - 1. Module Manufacturer:
 - a. Having sufficient capacity to produce and deliver required materials without causing delay in work.
 - b. Manufacturing facility certified to ISO 9001 and to ISO 14001.
 - 2. Inverter and DAS Manufacturers:
 - a. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of PV equipment for a period of 5 years or more and whose products have been in satisfactory use in similar service.
 - 1) Upon request, provide references of a minimum of three previous projects within the past 5 years with similar applications and that have comparable system size.
 - b. Field service representative shall have had experience in overseeing installation and startup of at least three similar installations within the last five years.
 - 3. PV Contractor/Installer:
 - a. Certified in writing by equipment manufacturers as qualified for installation of specified systems, experienced in performing work of this section and has specialized in installation of work similar to that required for this project.
 - b. PV Contractor/Installer must provide proof of a minimum of 5 prior completed installations of PV Array at least 50 KW and be acceptable to the PV manufacturer.
 - c. Shall have any of the following credentials:
 - 1) NABCEP Certification (North American Board of Certified Energy Practitioners)
 - 2) IBEW-NECA Electrical Journeyman & Apprentice Training (International Brotherhood of Electrical Workers and National Electrical Contractors Association).
 - 3) UL (Underwriters Labs) Credential.

1.3 DEFINITIONS

- A. DAS: Data Acquisition System.
- B. Inverter: Equipment that converts DC power to AC power.
- C. NOCT: Normal Operating Cell Temperature.
- D. PV: Photovoltaic.
- E. STC: Standard Test Conditions.

1.4 SUBMITTALS

- A. Product Technical Data:
 - 1. See Section 26 05 00 for additional requirements.
 - 2. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - 3. Manufacturer product data including specification, installation instructions, capacity, performance charts, test data, materials, dimensions, and weights.
 - 4. Manufacturing quality control documentation.
 - 5. Explanation of inverter and DAS monitoring and control features.
 - 6. Inverter and DAS Product technical data including:
 - a. Communication Schematics and Topology.
 - b. Wiring Diagrams.
 - 1) Power Supplies.
 - 2) I/O Points.
 - 3) Communications.
 - c. All login and Passwords for device accessibility. (To be submitted via secure methods to OWNER).
 - d. A well-documented SCADA Points List.
 - e. Assigned IP addresses (to be confirmed with OWNER).
- B. Energy Generation Estimate
 - 1. Model the proposed PV system using industry-standard software – Helioscope, System Advisor Mode, or PVsyst.
 - 2. Provide energy analysis report including:
 - a. Equipment selection.
 - b. Design information.
 - c. Loss assumptions.
 - d. Annual energy generation.
 - e. Hourly energy generation values for one year (8760).
 - 3. Energy estimate shall show exceedance of the criteria in Section 2.2.
- C. Informational Submittals
 - 1. Testing Plans, Procedures, and Testing Limitations:
 - a. Testing procedure, apparatus, and limitations of apparatus and procedure, for:
 - 1) Source quality control activities indicated in this Section.
 - 2) Field quality control activities indicated in this Section.
 - 2. Certificate of Compliance
 - a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
 - b. PV modules shall be supplied with a copy of UL and IEC certification reports indicating compliance for the model numbers used and indicating the certification is in force as of the dates of module manufacture.

- c. Submit certification verifying that components and materials specified in this Section are from a single manufacturer.
 - d. Qualifications of inverter and DAS installation supervisor.
- 3. Software.
 - a. Web portal account access information.
- D. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - 2. Submit maintenance procedures available to Owner.
 - a. Include the location and phone numbers of service centers.
 - b. Provide specific information including operation and maintenance requirements, programming assistance, troubleshooting guide, parts ordering, field service personnel requests, and service contracts.
 - 3. Warranty.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. See Section 26 05 00.
- B. Deliver and handle material in accordance with manufacturer's written instructions. All instructions and reference documents shall be reviewed and understood by the contractor prior to handling and unpacking the equipment.
- C. Deliver materials in manufacturer's original packaging with identification labels intact and in sizes to suit project.
- D. Components and materials shall be stored in a secure and clean location per the manufacturer's recommendations and documentation. Equipment shall be protected from exposure to harmful weather conditions and at temperature/humidity conditions recommended by manufacturer.
- E. Handle and store steel members and all equipment that are to attach to the rack (i.e., interconnecting cables, wires, and PV modules) above ground on supports. Keep free of dirt and other foreign material and protect against corrosion.
- F. Components of the inverters may be damaged by electrostatic discharge (ESD). When handling the electrical components observe all ESD safety regulations.

1.6 WARRANTY

- A. PV modules shall have a minimum 10-year manufacturer's warranty covering defect and workmanship.
- B. PV modules shall have a minimum 30-year manufacturer's warranty covering product performance that incorporates a degradation guarantee with peak power rating at year 30 not less than 85% of the original peak power rating identified on the product nameplate.
- C. Inverters shall have a minimum 5-year manufacturer's warranty covering defects and workmanship that provides for all parts and labor required to replace or repair warranty-eligible failures.
- D. The Data Acquisition System shall have a minimum 5-year manufacturer's warranty of service, support, and replacement, if required.

1.7 FIELD CONDITIONS

- A. Minimum design temperature: -11 degrees F.
- B. Maximum design temperature: 97 degrees F.
- C. See Structural drawings and specifications for additional site condition information.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. A. The PV system consists of three (3) PV glass covered walkway arrays. The arrays utilize integrated rail systems with concealed wiring, with DC string circuits routed underground to inverters located in the electrical equipment yard.
- B. The PV system includes two interconnection configurations: a 25 kW system connected behind the building service meter, and a 100 kW system connected via a separately metered service. Both systems are supplied from a common utility service transformer located in the electrical yard.
- C. The PV system does not include battery or backup storage. The PV system shall supply AC power to facility loads when solar energy is available and shall automatically disconnect from the utility system upon loss of grid power in accordance with IEEE 1547 and applicable utility requirements.
- D. The PV system shall not operate in parallel with the facility backup generator.
- E. The PV system must comply with these specifications, all applicable construction document drawings, all applicable codes, and all local authorities having jurisdiction. System must comply with all policies and standards required by the electrical utility having jurisdiction and all applicable incentive program guidelines. PV system equipment includes, but is not limited to, PV modules and electrical insulating components such as encapsulants and backsheets, raceways, inverters, combiner boxes, disconnect switches, wire, conduit, junction boxes, mounting hardware, mounting structure for modules (racking), monitoring and communication equipment.

2.2 SYSTEM REQUIREMENTS

- A. Solar photovoltaic system characteristics:
 - 1. Minimum rated DC capacity: 145 kWdc
 - 2. Minimum rated AC capacity: 125 kWac
 - 3. Minimum Annual Energy (year 1): 160 MWh
 - 4. 1000 VDC system voltage.
 - 5. Walkway mounted.
 - 6. Design Life: 30-years
- B. Provide all accessories needed for a complete, secure, operational grid-tied PV system.
- C. Conform electrical installations to NFPA 70, and requirements specified herein.
- D. All equipment must be listed and labeled in accordance with NFPA 70 and OSHA-listed nationally recognized testing laboratories (NRTL) and installed in accordance with the listing requirements and the manufacturer's instructions.
- E. Wiring and connections of inverters, PV source circuits, AC branch circuits, and all interconnections must be rated at a minimum for IP65 in accordance with NEMA IEC 60529.

2.3 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. PV Modules:
 - a. Lumos.
 - b. Or approved equal.
 - 2. Inverters:
 - a. Yaskawa
 - b. SMA.
 - c. Or approved equal.

3. Data Acquisition System
 - a. From Inverter manufacturer.
 - b. Campbell Scientific.
 - c. Obvius.
 - d. Or equal.

B. Submit request for other manufacturers for approval.

2.4 COMPONENTS

A. PV Module:

1. Basis of Design: Lumos, L-type, 72-cell, 430 Wp.
2. Ratings:
 - a. Listed to UL 61730, including the Class A Fire Rating pursuant to UL 790 and UL 1703.
 - b. Manufactured in an ISO 9001 certified facility.
3. Electrical criteria, minimum under Standard Test Conditions (STC):
 - a. Power: 430 Wp.
 - b. Power tolerance: +/- 3%.
 - c. Efficiency: 18.8%.
 - d. Maximum degradation: 2% initial degradation, and 0.5% per year for 30 years.
4. Mechanical criteria:
 - a. Weight: 105.5 lbs.
5. PV modules and ancillary materials shall be rated to withstand and be capable of continuous operation for the full range of environmental conditions in Section 1.7.
6. PV modules shall be of monocrystalline bifacial technology, 72-cell, and rated for a minimum system voltage of 1,000 Vdc.
7. PV modules shall utilize fully tempered 3.2 mm glass.
8. PV modules must be of the same manufacturer and model number and consistent sub-components.
9. Modules shall have passed hail testing with a minimum of 1" diameter ice balls.
10. Wire leads and connectors shall be factory-installed with lengths appropriate for the module connection scheme. Connectors shall be locking, Staubli MC4 or equivalent, and consistent throughout the design. Staubli MC4 EV)-2 connectors are not allowed. Provide USE-2 or RHH or RHW-2 wire, and UV-resistant wire.
11. PV modules shall not utilize top or back sheet coatings made from fluoropolymers such as per- and polyfluoroalkyl substances (PFAS) or GenX. PV module manufacturer to provide evidence that PFAS, GenX, or similar chemicals are not used in the module manufacturing process. Letter confirmation from the module manufacturer is sufficient.
12. Grounding of PV modules will be performed by use of WEEB system or a self-grounding racking system that meets the applicable requirements of UL 2703 and their referenced requirements for grounding. PV module design offered shall be compatible with this grounding method.

B. Inverter:

1. Basis of Design: Yaskwa Solectria PVI-25TL-480 and PVI-50TL-480.
2. Ratings:
 - a. Listed to UL 1741.
 - b. Compliant with IEEE-1547, IEEE 929, and IEEE 519.
 - c. Approved by FCC Part 15, Class A as an unintentional radiator.
 - d. Compliant with the latest applicable ANSI and FCC standards and addenda, and inspected before commissioning, testing, and operation of the system.
3. Electrical Criteria:

- a. AC Capacity: 25 kWac, 50 kWac.
 - b. AC Voltage: 480 Vac, 3-phase.
 - c. DC Voltage: 1,000 Vdc.
 - d. MPPT Voltage Range: 560 Vdc – 1000 Vdc
 - e. Efficiency: CEC efficiency of 98% minimum.
 - f. Power factor: Capable of 0.80 leading or lagging.
4. Inverter shall include the following integral protection features:
 - a. DC and AC overcurrent.
 - b. DC and AC ground-fault protection.
 - c. DC and AC surge protection.
 - d. DC and AC disconnect devices. Devices must be listed with ratings suitable for the intended use and purpose. Devices must meet the requirements of NFPA 70.
 - e. Anti-islanding protection.
 - f. Voltage and frequency ride-through and VAR support.
 5. Inverter shall include the following integral monitoring/communications features:
 - a. Network capability.
 - b. Communications protocol: Ethernet/IP to coordinate with plant SCADA system.
 - c. Monitoring system and metering system.
 - d. Self-diagnostics routines.
 - e. Remote and local display of operating status.
 - f. Remote monitoring capabilities.
 6. Inverters shall be rated to withstand and be capable of continuous operation for the full range of environmental conditions in Section 1.7.
 7. Same-sized inverters supplied must be of the same manufacturer and model number.
 8. Materials, equipment and parts comprising the units specified herein shall be new and unused, of current manufacture, of highest grade, and assembled in a workmanlike manner.
 9. Inverter shall be identified for use in solar photovoltaic systems.
 10. Inverter shall be fully coordinated with the PV module:
 - a. Match inverter DC input quantity and rating to the array design.
 - b. Match inverter DC system voltage and current withstand and operating ranges to the array design, accounting for temperatures adjustments for the conditions in Section 1.7.
 - c. Array-to-inverter kW ratio must not exceed manufacturer limitations.
 11. Inverter shall be suitable for utilizing a wall-mount or support structure mounting system.
 12. Inverter DC and AC terminations shall be rated 90°C, suitable for copper and aluminum conductors, and suitable with compression lugs.
 13. Provide inverter utilizing a NEMA 4X enclosure in accordance with NEMA 250.

2.5 ACCESSORIES

A. Data Acquisition System

1. Basis of Design: Solectria SolrenView.
2. PV modules and ancillary materials shall be rated to withstand and be capable of continuous operation for the full range of environmental conditions in Section 1.7.
3. The DAS shall be fully compatible with the project inverters.
4. Monitoring:
 - a. The Data Acquisition System (DAS) shall be capable of providing both historical and real-time information on the solar PV system.

- b. Monitoring points shall have the ability to be recorded at a minimum frequency of 1 minute, with the capability for instantaneous collection of data when data is outside of set parameters.
- c. System should have the ability to remotely access and monitor the data as well as have a thirty-day on-site memory storage capacity.
- d. Monitoring points shall include:
 - 1) DC Voltage, Current, and Power for each inverter.
 - 2) AC Voltage, Current, Real/Apparent Power, Power Factor.
 - 3) Cumulative Energy Production – daily, weekly, monthly, yearly.
 - 4) Fault/Alarm Status.
 - 5) All available meteorological data.
- 5. Communications:
 - a. The DAS shall include a web-based platform to allow Owner access to information.
 - b. Inputs: Modbus RS232/RS485 or similar standard communication protocol
 - c. Two-way site communication through supported protocols
 - 1) TCP/IP over Ethernet for HTTP data transmission via PROXY
 - 2) File Transfer Protocol (FTP)
- 6. Power requirements:
 - a. Site power will be provided at 120 Vac, 20A. Power supplies shall be included if required input power to device(s) is not 120 Vac.
 - b. Backup power shall be provided for 8-hours duration by a UPS.
- 7. Enclosure:
 - a. All equipment, with the exception of instrumentation devices that need to be exposed, shall be housed in a non-corrosive NEMA 4X enclosure.
 - b. Enclosure shall be UL 746C rated. All AC powered monitoring and control panels shall be UL508A listed.
 - c. All equipment should be securely mounted to a DIN rail.
- 8. The system shall have the necessary hardware and software (i.e. firewalls and malware detection) such that it is compliant with the latest standards at the time of commissioning for control system security requirements.
- 9. The system shall be designed for isolation, testing, diagnostic monitoring, and removal without interruption of the PV system availability.

2.6 SOURCE QUALITY CONTROL

- A. PV module manufacturer shall provide factory flash test results in accordance with IEC 61853-1, and temperature coefficients at: STC, nominal operating cell temperature (NOTC), low irradiance conditions (LIC), high temperature conditions (HTC), and low temperature conditions (LTC).

2.7 MAINTENANCE MATERIALS

- A. Spare Parts:
 - 1. Provide manufacturer's recommended spare parts.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Manufacturer's Installation Instructions and Drawings.
 - 1. Install all components as indicated in the Drawings and in accordance with manufacturer's recommendations and instructions.

2. Contractor shall be responsible for the performance of all inspection and testing activities to demonstrate compliance with the drawings, specifications, referenced standards, applicable codes, and industry practices.
3. All fasteners shall be torqued per the manufacturer's documentation.

B. Modules

1. Secure modules to the racking system using the manufacturer-provided mounting holes and attachment points. Do not field-modify equipment to provide attachments.
2. Organize and secure module leads and connections behind the panels in a uniform and workmanlike manner.
3. Maintain minimum wire bend radius in accordance with the NEC. Do not strain connections at the module junction boxes.
4. Install module grounding clips in accordance with the Drawings. Ensure that the complete module and racking system is electrically continuous.

C. Inverters

1. Inverters shall be installed on a level surface. The inverter shall be secured to the foundation, wall, or rack utilizing all of the provided mounting points. Reference the manufacturer's documentation for location and size of mounting points.
2. Provide service access and equipment setbacks per NEC 110.26 and manufacturer's requirements. Ensure enclosure doors are able to swing a full 180 degrees at installed location.
3. Conductors shall be connected to the inverter per the manufacturer's recommendations and documentation making note of recommended terminations, torque values, and bolt stack up details if provided. All buss bars, conductors, and terminations shall be clean prior to making the connection.
4. All disconnect switches shall be in the open position during installation and shall remain in the open position until proper testing, inspection, and commissioning has been completed.
5. Do not open the inverters electrical cabinets when it is raining or when humidity exceeds 95%.
6. It is prohibited to modify the inverter or install equipment not explicitly recommended by the manufacturer. Do not store documents, instructions, plans, or any other foreign material not intended to be part of the system inside the inverters cabinets.

3.2 SIGNS AND LABELS

- A. Provide all required warning and safety labels in accordance with the NEC.
- B. Provide all equipment labels matching the convention shown on the Drawings.
- C. Provide arc flash labels in accordance with NFPA 70E.
- D. Install cable tags at each termination.

3.3 FIELD QUALITY CONTROL

- A. Perform all inspections using a NABCEP-certified professional and in accordance with NABCEP inspection procedures, and in accordance with the manufacturer's recommendations.
- B. Perform acceptance checks and tests in accordance with the manufacturer's recommendations and NETA ATS.
- C. Contractor shall inspect all packages for damage upon delivery. Any damaged packages shall be opened so the equipment can be inspected. Any damage to the packaging or equipment shall be documented and reported to the owner immediately. Equipment to be stored shall be properly replaced in the packaging for storage.
- D. Verify that all electrical components are installed and connected according to the requirements of the PV electrical drawings, specifications, and manufacturer's written instructions.
- E. Modules

1. Solar PV module manufacturer, model, and number of modules must match the approved plans.
2. Solar PV modules must be in good conditions (including but not limited to no broken glass or cells, no discoloration, frames not damaged).
3. Verify output of PV modules according to manufacturer's recommendations and NABCEP practices.

F. Inverters

1. Inverter manufacturer, model, and number of inverters must match the approved plans.
2. Inverters must be in good condition.
3. Verify output of inverters according to manufacturer's recommendations and NABCEP practices.

G. Grounding

1. Inspect ground system for compliance with contract plans and specifications.

3.4 FUNCTIONAL PERFORMANCE TESTING

- A. Contractor is to obtain all electrical approvals by the authorities having jurisdiction, approval from the utility company, and approval from the Owner prior to energizing any inverters.
- B. Make final adjustments to all inverters and monitoring equipment so that they will be placed in an acceptable operating condition. Adjustable parameters must be set so that the PV system will produce the maximum possible amount of energy on an annual basis.
- C. Develop and implement a testing plan and schedule that meets the requirements of IEEE 1547 and NREL guidance. Include a checklist of startup requirements and safety tests to ensure proper installation, safe operation, and performance conforming to specification.
- D. Equipment manufacturer's field service representative(s) to conduct startup of equipment and perform operational checks. Individual qualified in testing protective equipment (e.g., professional engineer, factory-certified technician, licensed electrician with experience in testing protective equipment) must perform or directly supervise tests.
- E. Testing shall include the following:
 1. All inverter startup tests as specified by the inverter manufacturer in the inverter operation manual;
 2. Actual power
 3. Loss of grid;
 4. Grid resume;
 5. Data monitoring check out;
 6. Voc measurement of every source circuit and log it;
 7. Verify tightness of all wiring terminations;
 8. Verify proper markings and labeling of all wire terminations and enclosures;
 9. Verify startup/shut down procedures;
 10. Verify system minutes delay upon restart;
 11. Verify PV array quick connectors are fully mated and wires are neatly secured;
 12. Verify no debris on the modules, no damaged or broken modules;
 13. Verification and inspections (see IEEE 1547.1 7.2)
 14. Field-conducted type and production tests (see IEEE 1547 7.3)
 15. Unintentional islanding functionality test (see IEEE 1547.1)
 16. Cease-to-energize functionality test (see IEEE 1547.1)
 17. Unintentional islanding functionality test (see IEEE 1547.1)
 18. Cease-to-energize functionality test (see IEEE 1547.1 7.5)

19. Revised settings (see IEEE 1547.1 7.6)
 20. Verify "Zero Export" functionality.
 21. Verify Rapid Shutdown functionality.
- F. Coordinate, observe and record the results of the functional performance testing. Coordinate re-testing as necessary until satisfactory performance is verified. Verify the intended operation of individual components and system interactions under various conditions and modes of operation. Document items of non-compliance in materials, installation or operation. Immediately address observed non-conformance and deficiencies in terms of notification to responsible parties, and provide recommended actions to correct deficiencies. Prepare and submit final testing report.
- G. The acceptance of the solar PV system occurs only after all deficiencies identified by the functional tests are corrected, and the system operates successfully during a 30 day initial testing period.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstration
1. Upon completion of the work provide instructions by a qualified instructor to the Owner in the proper adjustment, system operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required.
- B. Training
1. Furnish training service by a factory-trained representative.
 2. The training period must consist of a total of 4 hours of normal working time and begin after the system is functionally completed. Provide all training documentation for those that cannot attend. Extend safety training to fire department representatives.
 3. As a minimum, training shall cover:
 - a. Hardware overview.
 - b. Software overview.
 - c. Documentation.
 - d. Maintenance.
 - e. Trouble shooting.
 - f. Operation, e.g., changing set points, passwords, etc.
- C. Documentation
1. Update O&M manuals to reflect as-built conditions.
- D. Support
1. Provide on-call technical support for a period of one year after substantial completion. Include a minimum of two site visits to work with owner on any final modifications to the logic.

END OF SECTION

SECTION 49 00 00
PUBLIC ROW IMPROVEMENTS (Olsson)

GENERAL

This section includes special provisions and technical specifications for work associated with the MMTC project that is within the existing public ROW for 9th Street, 10th Street, G Street, and H Street.

**SPECIAL PROVISIONS TO THE
CITY OF LINCOLN STANDARD SPECIFICATIONS
FOR MUNICIPAL CONSTRUCTION, 2023 EDITION**

***CITY OF LINCOLN, NE (2026)
STARTRAN MMTC
PUBLIC ROW IMPROVEMENTS
EXECUTIVE ORDER NO. ROW250031***



Coordinating Professional
Date: June 1, 2026






LINCOLN

555 South 10th Street
Lincoln, NE 68508



601 P Street, Suite 200
Lincoln, NE 68508
Nebraska C.O.A. #CA-0638

SEALS AND SIGNATURES

	<p>I hereby certify that the portion of the Specifications described below was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Nebraska.</p> <p>_____ Shane A. King, E-12448 6/1/26</p> <p>Pages or Specifications divisions or sections covered by this seal:</p> <p>Sections: All sections except those noted specifically below.</p> <p>COORDINATING PROFESSIONAL</p>
	<p>I hereby certify that the portion of the Specifications described below was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Nebraska.</p> <p>_____ Sarah W. Mulloy 6/1/26</p> <p>Pages or Specifications divisions or sections covered by this seal:</p> <p>Sections: Paving and Storm Drainage Systems</p>
	<p>I hereby certify that the portion of the Specifications described below was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Nebraska.</p> <p>_____ Jeffrey S. Morrison, E-17412 6/1/26</p> <p>Pages or Specifications divisions or sections covered by this seal:</p> <p>Sections: Sanitary Sewers and Water Mains</p>

END OF SEALS AND SIGNATURES

ON 6/2/2026

AUTHORIZED FOR CONSTRUCTION BY John McLaughlin

TABLE OF CONTENTS

GENERAL	3
CONTRACT TIME	3
CONSTRUCTION PHASING	3
General	3
Phasing.....	4
Traffic Control	4
Access During Construction	4
STATUS OF RIGHT-OF-WAY.....	4
GENERAL CONDITIONS AND REQUIREMENTS	5
PROJECT COORDINATION AND CONTACTS.....	5
Public Safety	5
Public Building Commission	5
StarTran	5
VERIFICATION OF EXISTING CONDITIONS.....	6
STATUS OF UTILITIES.....	7
City of Lincoln	7
Private Utilities	8
Allo	8
Black Hills Energy (BHE)	8
Lincoln Electric Systems (LES)	8
Lumen	9
Spectrum.....	9
Uniti	9
PERMITS AND LICENSES.....	10
ARCHAEOLOGICAL AND PALEONTOLOGICAL DISCOVERIES.....	10
GENERAL MISCELLANEOUS ITEMS.....	10
MOBILIZATION	10
CONSTRUCTION STAKING	11
EARTHWORK.....	11
TREE CLEARING	11
TREE PROTECTION	11
PAVING	11
SILICONE SEALANT	11
TRAFFIC SIGNS	12
GENERAL.....	12
SIGNS	12
TRAFFIC CONTROL	13
TRAFFIC CONTROL	13
STORM DRAINAGE SYSTEMS	13
SPECIAL GRATE INLET, BEEHIVE.....	13
PVC STORM DRAIN	14
SANITARY SEWERS.....	14
REMOVE SANITARY PIPE	14
DIRECTIONAL DRILLING FOR 8" SANITARY PIPE	14
WATER MAINS	14
MATERIALS	14
GATE VALVE	15
TEMPORARY HYDRANT	16
REMOVE OFFSET	16
CROSS, MJ, 16"X16"	16
TRAFFIC SIGNALS, ITS, AND LIGHTING	16

TRAFFIC SIGNALS, ITS AND LIGHTING – APPROVED SPECIAL PROVISION	16
GENERAL	16
REMOVE WOOD POLE	18
CONDUIT 1 ¼”	18
COMBINATION MAST-ARM POLE	18
FOUNDATION DESIGN	19
FOUNDATION CONCRETE	19
FOUNDATION STEEL	19
PEDESTRIAN PUSH BUTTONS.....	19
CABINETS	20
SIGNAL HEADS AND OVERHEAD SIGNS	24
TRAFFIC MONITORING CAMERA	29
BLANK-OUT SIGN	32
DOWN GUY	34
COMMUNICATIONS	35
COMMUNICATIONS – APPROVED SPECIAL PROVISION.....	35
ITS FIELD SWITCH.....	35
SEEDING AND SODDING	38
MATERIALS (GENERAL INFORMATION)	38
EROSION AND SEDIMENT CONTROL.....	38
SWPPP SIGN.....	38
APPENDIX.....	38
A. CHAPTER 24 – TRAFFIC SIGNALS, ITS AND LIGHTING – APPROVED SPECIAL PROVISION 3-8-24	38
B. CHAPTER 26 – COMMUNICATIONS – APPROVED SPECIAL PROVISION 3-8-24	38

GENERAL

These Special Provisions amend or supplement the City of Lincoln Standard Specifications for Municipal Construction, 2023 Edition and other provisions of the Contract Documents as indicated herein. All provisions that are not so amended or supplemented via these special provisions remain in full force and effect.

CONTRACT TIME

The Contractor shall begin construction of this project beginning in Summer 2026. The Contractor shall have a total of 90 calendar days from the Beginning of Work date to achieve Final Completion on the Sanitary and Water work and on Roadway work (excluding traffic signals) on the west side of 9th Street including along H Street. It is anticipated that the Contractor will receive a Notice to Proceed on or before June 15, 2026. Weather dependent, work shall begin by July 6, 2026.

Substantial completion of all other work shall be achieved by October 31, 2027. Determination of Substantial completion shall be subject to the City Project Personnel's approval and shall be defined as all roadway construction being complete and all lanes open to traffic, all pedestrian facilities open and ADA compliant, all roadway lighting and traffic control complete and operational, and final grading complete.

Final completion of all work including final site clean-up, irrigation system installed, and acceptance of all landscaped areas shall be completed by December 15, 2027. Determination of Final Completion shall be subject to the City's Project Personnel's approval.

Failure to meet these dates (Substantial and/or Final completion) shall result in liquidated damages to be assessed per the City of Lincoln Standard Specifications.

CONSTRUCTION PHASING

The following prosecution and progress of work shall be used in developing the baseline schedule for the project. Exact phasing sequencing has not been developed for this project, but it is anticipated to generally complete this project under lane closures.

The Contractor shall be required to develop a general phasing and sequencing plan as part of the construction schedule for construction. The Contractor will be required to generally proceed with sequencing of the construction work with approval by the City's Project Personnel.

General

All work shall be confined within the limits of the existing right-of-way and easements owned by the City unless the Contractor has obtained separate rights from an adjacent property owner. The Contractor shall provide to the City's Project Personnel written copies of any agreements for separate property rights that are obtained.

Phasing

The Contractor shall maintain two lanes on 9th Street and on 10th Street at all times.

During active work on H Street between 8th Street and 9th Street, H Street may be closed while maintaining local access via 8th Street.

The new parking bays on H Street (8th to 9th), the northwest corner of 9th Street and H Street, and the east/west ramp in the northeast corner of 9th Street and H Street must be complete and useable before the existing H Street on-street parking (9th to 10th) can be eliminated.

During active work in G Street (sanitary sewer), G Street may be closed while maintaining local access via 9th Street.

The Contractor shall be directly responsible for communicating street closures, lane closures, and sidewalk closures, and access closures with LTU, the Public Building Commission, and area emergency services (LPD, LFR, LSO).

Traffic Control

The Contractor shall be responsible for determining the Traffic Control needs for the project, including all devices and personnel, and to develop the bid amount accordingly. The temporary traffic control plans shall include temporary traffic control for pedestrians during each phase. Preparation, submittal and approval of the Temporary Traffic Control Plan shall be per the City of Lincoln Standard Specifications.

Access During Construction

The Contractor shall not close any portion of the public roads or begin any work which may impact access to adjacent properties without an approved Temporary Traffic Control Plan, Submitted Lane Closure Notification and the permission of the City's Project Personnel.

The Contractor shall notify all adjacent property owners a minimum of 7-days in advance of any roadway closures or changes in access to their properties during the work on all phases of this project. To the extent practical, the Contractor shall make every effort to minimize the time access is restricted to the adjacent properties. The Contractor shall maintain existing pedestrian facilities during construction of the project to provide pedestrian access to adjacent businesses and residences.

Pedestrian access must be always maintained to the Drug Testing facility on the south side of 605 S. 10th Street. The Contractor will need to phase the sidewalk removals to maintain 9th Street and 10th Street pedestrian crossings during construction.

STATUS OF RIGHT-OF-WAY

No permanent acquisition of private property or temporary easements are anticipated for construction of this project.

The Contractor will be allowed to do work within the existing right-of-way upon the Notice to Proceed from the City.

GENERAL CONDITIONS AND REQUIREMENTS

The following are modifications or additions to parts of the General Conditions and Requirements of the City of Lincoln Standard Specifications for Municipal Construction.

PROJECT COORDINATION AND CONTACTS

The Contractor shall coordinate their work on this project and the development of their project schedule with other public or private projects located along the project corridor, or in proximity to the project site.

Public Safety

The Contractor shall notify Lincoln Police Department (LPD), Lincoln Fire and Rescue (LFR), and Lancaster Sherriff Office (LSO) with any lane or street restrictions or closures for the project. The following individuals shall be contacted a minimum of seven (7) days prior to any street closures or changes in access within the project area. Access for emergency vehicles shall always be maintained.

The point of contact for the Lincoln Police Department is:

Contact: Captain Don Scheinost
Phone: 402-441-7751

The point of contact for Lincoln Fire and Rescue is:

Contact: Chief Dave Engler
Phone: 402-441-6822

The point of contact for Lancaster County Sherriff is:

Contact: Captain Jason Mayo
Phone: 402-441-8877

Public Building Commission

The point of contact for the Public Building Commission is:

Contact: Kerin Peterson
Phone: 402-441-7056

StarTran

The Contractor will be required to coordinate public access via the StarTran transit system. StarTran Route 13 operates along 9th, 10th, and G Streets Routes 51 and 56 operate along 9th and 10th Streets. The Contractor shall coordinate the road closure for the project with StarTran. The following individuals shall be contacted a minimum of fourteen (14) days prior to any street closures or changes in access within the project area that may affect bus routes, bus stops, or require an alternate route.

The point of contact for StarTran is:

Contact: Carla Cosier
Phone: 402-441-7185

VERIFICATION OF EXISTING CONDITIONS

All prospective bidders shall visit the site to familiarize themselves with the existing site conditions, access locations, site constraints, existing site drainage, existing utilities and other construction currently underway or planned within the project area. In addition, the selected Contractor shall be required to verify the location, elevations and flowlines of existing utilities that may be in conflict with the proposed work or that will need to connect to the new work prior to start of construction. This may require the Contractor to pothole existing utilities in advance of the start of work to verify flowlines at outlets or connection points, location and depth of utilities, size and or material types of existing utilities. This verification work shall include but not be limited to connections to existing storm sewers, sanitary sewers and water mains. Pavement materials which are removed, in conjunction with verification of existing site conditions and utility locations, shall be replaced in accordance with local, State and National regulations for ADA (American's with Disabilities Act) standards. Any costs associated with pavement removal and replacement and betterments necessary (i.e. - truncated domes, retaining walls, curb and gutter, additional grading, etc.) to meet ADA standards, for verification of existing site conditions and utility locations, shall not be paid for directly and shall be considered subsidiary to other items for which direct payment is made.

The Contractor shall verify the locations and depths to existing private or public utilities that may be within the limits of the new excavations, over-excavation, grading work or utility construction. This work shall be completed in advance of construction in the area of the utilities to allow adequate time for the utilities to relocate any utilities that are in conflict. The Contractor shall refer to the Status of Utilities section of these special provisions and request an update prior to construction to determine which utilities will be relocated ahead of project construction and which will be relocated concurrently.

Existing site verification work shall also include verifying the location and grades at existing pavements that will connect to the new construction. The Contractor shall report any discrepancies in the location, existing layout or grades at the proposed tie-in points prior to start of the work so that they can be reviewed and any adjustments made in the proposed alignment or grades for the new paving work (street paving as well as sidewalk, bike path and driveway pavements).

In addition, the Contractor shall verify the water main flowlines and hydrant length at the proposed hydrant locations with respect to the proposed top of curb elevations shown on the plans. The hydrants should be set with the bottom flange of the hydrant above the proposed grade as shown on the City of Lincoln Standard Plans.

The Contractor is responsible for continuously reviewing existing site conditions and constraints as the work progresses to ensure that the proposed work is compatible with the existing conditions. If discrepancies are discovered that may impact the proposed work, then the Contractor shall immediately report them to the City's Project Personnel for resolution prior to starting work in the particular area in question.

STATUS OF UTILITIES

The following information is current as of February 25, 2026. The Contractor should request a utility status update at the project pre-construction conference, and/or prior to starting work. The Contractor shall coordinate all construction activities with affected utilities that have identified relocations which are to be completed concurrent with the project.

Utilities known to have facilities in the project area:

- City of Lincoln Conduit / Fiber
- City of Lincoln Traffic Engineering
- City of Lincoln Wastewater System
- City of Lincoln Water System
- City of Lincoln Watershed Management
- Allo
- Black Hills Energy
- Lincoln Electric System
- Lumen
- Spectrum
- Uniti

City of Lincoln

The City of Lincoln has existing broadband infrastructure within the limits of the project along the west side of 9th Street, the west side of 10th Street, crossing 10th Street between G Street and H Street, and along the north side of H Street. This involves conduit, fiber, pull boxes, and splice enclosures. The Contractor performing the work on this infrastructure is required to be FOP approved and will be required to obtain a Fiber Optic Permit.

Contact: Greg Stohs
Phone: 402-416-5147

The City of Lincoln has existing Traffic infrastructure within the limits of the project. This involves signs, pavement markings, conduit, and pull boxes. The Contractor shall complete all work as indicated on the plans.

Signs/Markings Contact: Michal Lammler
Phone: 402-441-7701

Traffic Signals Contact: Jarred Whitsell
Phone: 402-417-3173

The City of Lincoln has existing wastewater mains within the limits of the project. This includes existing mains to be connected via the project and abandoned (filled) across the parking lot and a new main in 10th Street and a main running along the north side of H Street. The Contractor shall complete all work as indicated on the plans.

Contact: Brian Kramer
Phone: 402-441-7987

The City of Lincoln has existing water mains within the limits of the project. A main runs north-south along the east side of 9th Street, active and abandoned mains in H Street that will be impacted by the project, and mains along the north side of G Street. Any conflicts should be coordinated with LWS.

Contact: Andy Walker
Phone: 402-441-7571

The City of Lincoln has existing storm drainage facilities within the limits of the project. The Contractor will be required to perform work related to storm drainage facilities as identified on the plans.

Contact: Blayne Renner
Phone: 402-441-7548

Private Utilities

The following utilities are known to exist within the project limits. Some relocations are necessary as indicated below. The Contractor shall coordinate all conflicts with the utility and the Project Personnel.

Allo

Allo has facilities within the project area. Allo is within City conduit within the project area and should be coordinated through the City Broadband Office. No conflicts or relocations are anticipated.

Contact: Tom Gremel
Phone: 402-641-0050

Black Hills Energy (BHE)

BHE has existing lines within the project area. There are mains running north-south on the west side of 9th Street and the west side of 10th Street. There are also service lines that cross 10th Street north of G Street. BHE will be adjusting a line in the vicinity of 10th Street and H Street and will abandon the line running along the south side of H Street. The Contractor shall protect existing infrastructure in place and coordinate with BHE regarding relocation needs.

Contact: Kris McCoy
Phone: 402-430-7640

Lincoln Electric Systems (LES)

Lincoln Electric System has underground vaults and underground lines running through the project area. This includes electric and fiber lines running east-west in H Street and crossing 10th Street between G Street and H Street. No distribution conflicts or relocations are anticipated; the Contractor shall perform street light work as indicated on the plans.

Contact: Michael Weskamp (Distribution)
Phone: 402-467-6891

Contact: Eric Steffen (Lighting)
Phone: 402-473-3147

Contact: Kyle McCormick (Fiber)
Phone: 402-473-3465

Contact: Fredrick Rumery (Construction)
Phone: 402-473-3155

Lumen

Lumen has facilities within the project area. Lumen is in City conduit within the project area and should be coordinated through the City Broadband Office. No conflicts or relocations are anticipated.

Contact: Michael Unverzagt
Phone: 402-990-7498

Spectrum

Spectrum has facilities within the project area. There is conduit crossing 9th Street and 10th Street near the alley between G Street and H Street. Spectrum also runs across the site in the east/west alley area. No conflicts or relocations are anticipated.

Contact: Scott Wallace
Phone: 402-480-5734

Uniti

Uniti has facilities within the project area. There is conduit crossing 9th Street and 10th Street near the alley between G Street and H Street, and lines running along the west side of 10th Street. There is also an overhead line running east/west across the site. At the beginning of construction, Uniti will remove the overhead cable and pull it into existing conduit that runs east/west across the site. No other conflicts are anticipated.

Contact: Alan Codr
Phone: 402-363-9581

Direct payment shall not be made for removal of abandoned utilities that are six inch or smaller in diameter and that need to be removed to complete the work on the project unless otherwise shown on the plans. Removal of abandoned utilities six inches and smaller in diameter shall be subsidiary to other items for which direct payment is made. Abandoned utilities larger than six inches in diameter that are encountered and that are determined to be in conflict with the work shall be removed. Payment for removal of abandoned utilities larger than six inches in diameter shall be made at the contract price bid or if no pay item is included, then the removal shall be paid for as an "Extra Work" item as directed by the City's Project Personnel.

PERMITS AND LICENSES

Add the following to Article VI, Section M, PERMITS AND LICENSES:

The Contractor will obtain the following permits:

1. City of Lincoln Right of Way Permit
2. Lincoln Fiber Optic Permit (FOP licensed Contractor required)

The Contractor shall be responsible for complying with the requirements of all permits acquired by the Owner.

The total disturbed area for this project does not exceed one acre, therefore a SWPPP is not anticipated to be required. If the disturbed area exceeds one acre, the Contractor shall be responsible for acquiring a SWPPP plan, as well as designing, installing, maintaining, and removing all associated measures.

The Contractor shall acquire all permits required by Laws or Regulations.

ARCHAEOLOGICAL AND PALEONTOLOGICAL DISCOVERIES

Should the Contractor encounter any fossils, meteorites, Native American relics, or other articles of historical or geological interest, such articles shall become the property of the City. The City's Project Personnel shall be promptly notified when any such articles are uncovered, and the Contractor shall suspend operations in the area involved until such time that arrangements are made for their removal and preservation.

GENERAL MISCELLANEOUS ITEMS

MOBILIZATION

Mobilization for the ROW Improvements will be bid separately from the mobilization for the overall MMTC project. The maximum bid amount for this item shall be specific to the ROW Improvements bid item list and percentages for payment will be specific to the ROW Improvements portion of the project. It is anticipated that the Contractor will have other mobilization costs for the overall MMTC project and will include and associate that cost with the work on site (not within the ROW).

Article 1.00, Section B shall be replaced by the following:

No measurement is required. 50% of the bid item for mobilization will be paid with the initial pay estimate. The balance of the bid item for mobilization will be paid when 20% of the value of the Work has been completed. The bid amount for mobilization cannot exceed 10% of the total bid amount (including mobilization).

In the event the lowest responsible bidder exceeds the 10% mobilization percentage criteria, payments shall be as follows:

- 50% of the bid item for mobilization, not to exceed 5% of the total bid amount, will be paid with the initial pay estimate.
- Upon the completion of 20% of the Work, excluding mobilization, the City will pay up to 10% of the total bid amount.
- Upon final completion of the Work, the remaining balance of the bid for mobilization will be paid.

CONSTRUCTION STAKING

Construction Staking will not be bid or paid for specific to the ROW Improvements project. It is anticipated that the Contractor will include all construction staking costs elsewhere in the bid to cover all site and ROW work for the overall MMTC project.

EARTHWORK

TREE CLEARING

Tree clearing is prohibited during the time period between March 15 and October 31 unless approved by a qualified biologist and the City's Project Personnel. If trees are to be cleared during the prohibited period, field surveys for nesting birds along with information regarding the qualifications of the biologist performing the surveys shall be thoroughly documented and maintained on file by the Contractor until completion of the project. Migratory bird surveys and compliance with the Migratory Bird Treaty Act will not be paid for directly and shall be considered subsidiary to other items for which payment is made.

Removal of trees prior to Beginning of Work will not count against contract time allowance provided the Contractor submits a written request per City of Lincoln Standard Specifications Article VII, Section B.

TREE PROTECTION

The Contractor shall protect all trees that are not required to be removed in this project. Where necessary, the Contractor may have to hand dig around tree to prevent damage to roots.

Any form of protection chosen by the Contractor, such as fences, ropes, etc., shall be furnished, erected, and maintained by the Contractor. Any trees that appear to have significant root damage caused by excavation or any tree that needs trimmed in or from the public right-of-way, shall be coordinated with the Project Personnel or his representative who shall contact the City Arborist to verify any necessary actions in saving, trimming, or removing the damaged trees.

Tree protection completed in conformance with these Special Provisions and accepted by the City's Project Personnel, shall not be measured and paid for separately. Such costs shall be considered a part of the unit prices for which direct payment is made.

PAVING

SILICONE SEALANT

The silicone joint sealant shall be in accordance with Section 1014 the Nebraska Department of Transportation Standard Specifications for Highway Construction (2017 Edition). The Silicone sealant shall be gray in color or match the adjacent pavement color for pavements with integral color. Silicone sealant

shall be utilized for all sealing outside the roadway section and within the pedestrian space including between the back of curb and adjacent sidewalk.

Subsection 1014.01 of the NDOT Standard Specifications is amended to the following:

- Joint sealing filler shall be a cold applied silicone product.

Paragraph 1 of Subsection 1014.02, Subsection 1014.03, and Subsection 1014.04 of the NDOT Standard Specifications are void.

No direct payment shall be made for this product, and it shall be subsidiary to the adjacent surfacing.

TRAFFIC SIGNS

GENERAL

Article 14.00 shall be replaced by the following:

All tubular markers, signs, posts and associated hardware will be furnished and installed by the Contractor unless otherwise directed by the City Project Personnel.

This Work shall consist of all materials and labor necessary to provide, fabricate, and install traffic signs at the locations shown on the project plan set.

Traffic signs shall conform to the requirements of the current edition of the Manual on Uniform Traffic Control Devices for Street and Highways (MUTCD), Standard Highway Signs, and the Lincoln Standard Plans.

It shall be the Contractor's responsibility to utilize the "One-Call" system when required.

Prior to field installation, all Contractor furnished sign materials shall be submitted for a pre-inspection unless exempted or modified by the City's Project Personnel. Contractor shall allow for at least 7 days for inspection to be completed and shall only submit complete materials for inspection.

City traffic signal personnel shall be responsible for inspecting sign materials to be installed by the Contractor. All other activities associated with the installation, including but not limited to, labor, materials, tools, and transportation are the responsibility of the Contractor.

Any delay resulting from incomplete material submittals or contractor furnished materials failing inspection shall not be justification for the suspension or extension of the working days or calendar days on a project. City traffic signal personnel shall notify the Contractor when the sign material inspection is completed.

SIGNS

Article 14.03, Section A shall be replaced by the following:

A. MATERIAL SPECIFICATIONS

All blanks shall be new aluminum, meeting ASTM Specifications B209, Alloy 5052-H38 of the sizes as

shown in the Standard Highway Signs and the MUTCD. The gauges shall be as follows:

- Signs less than 4 square feet shall be 0.063 inches thick
- 4 square feet to less than 9 square feet shall be 0.08 inches thick
- 9 square feet or greater shall be 0.10 inches thick.

Overhead signs 18" in height or greater shall be 0.125 inches thick, with 2 1/2" radius corners.

All signs shall be smooth and free of burrs. Both sides of the blank shall be treated with an Alodine 1200 process or approved equivalent.

Reflective sheeting shall be applied without visible seams or joints. Reflective sheeting shall be mechanically applied as per manufacturer's recommended procedures and equipment. Silk screen, Digital ink and overlay films shall be the type recommended by the sheeting Manufacturer in the colors, size, and layout specified in the Contract Documents and in conformance with Standard Highway Signs.

Reflective background sheeting shall meet the MUTCD requirements of ASTM D4956 and the following additional minimum requirements:

- Post-mounted street name signs: High Intensity Prismatic Series 3930(HIP), All Overhead signs and pedestrian/school crossing (fluorescent yellow green) post-mounted signs: ASTM Type XI Diamond Grade
- Cubed Series 4000(DG3)
- All Post-mounted low priority signs: Advanced Engineer Grade Prismatic Series 7930(EGP);

All completed signs and sign faces shall be packed with sufficient quantity of cut slip sheeting to protect each face from sticking together or any other damage in shipping as recommended by the sheeting manufacturer.

TRAFFIC CONTROL

TRAFFIC CONTROL

Traffic Control will not be bid or paid for specific to the ROW Improvements project. It is anticipated that the Contractor will include all traffic control costs elsewhere in the bid to cover all site and ROW work for the overall MMTC project.

STORM DRAINAGE SYSTEMS

SPECIAL GRATE INLET, BEEHIVE

The Contractor shall construct an area inlet at the location shown on the plans and in accordance with the details shown. The area drain shall be set to the elevation specified in the plans with a beehive style grate inlet on top.

Area inlets shall be 24-inch drain basin, suitable for connection to PVC outlet piping, as manufactured by Advanced Drainage Systems (Nyloplast), Neenah R-4340, or approved equal. The area inlets shall be furnished with beehive/dome grates and the necessary fittings to connect to a 15-inch PVC outlet pipe. The work shall be completed in accordance with the requirements outlined in Chapters 20 and 21 of the City of Lincoln Standard Specifications.

Area inlets shall be measured and paid for at the contract unit price bid per each for the pay item "SPECIAL GRATE INLET, BEEHIVE". Said payment shall be full compensation for furnishing all labor, equipment, materials and incidentals required to construct the area inlet as shown on the plans and in accordance with these Special Provisions including, forming, reinforcing steel, concrete placement, consolidation, cast iron grate and frame, excavation, backfill, compaction and all other incidental items required to provide a complete and functional area inlet.

PVC STORM DRAIN

Polyvinyl chloride (PVC) storm sewer shall be constructed in accordance with the details show on the plans and the requirements of Sections 722 and 1038 of the NDOT Standard Specifications for Highway Construction (2017 Edition), the City of Lincoln Standard Specifications for Municipal Construction, and as modified by these Special Provisions.

All PVC storm sewer pipe shall be heavy wall pipe, minimum SDR 26 or Schedule 40 pipe. Deflection couplings shall not be paid for directly but shall be considered subsidiary to the pipe. All PVC pipe shall be bedded with a granular material to 12 inches above the top of the pipe. The Contractor shall exercise care so as not to damage the pipe during construction of the pavement and inlets.

PVC storm drain pipe shall be measured and paid for at the contract unit price bid per linear foot for PVC STORM DRAIN, 15". Said payment shall be full compensation for furnishing all labor, equipment, materials and incidentals required to construct the PVC storm sewer pipe as shown on the plans and in accordance with these Special Provisions including pipe, fittings, bends, transition couplings, bedding, trenching and backfill.

SANITARY SEWERS

REMOVE SANITARY PIPE

The "Chapter 23 – Water Mains" Standard Specification Article 23.04 "Removed Materials" shall apply to this item.

DIRECTIONAL DRILLING FOR 8" SANITARY PIPE

The "Chapter 20 – Construction for Utilities and Structures" Standard Specification Article 20.06 "Horizontal Directional Drilling" shall apply to this item.

Directional drilling shall be measured and paid for at the contract unit price for at the contract unit price bid per linear foot for DIRECTIONAL DRILLING FOR 8" SANITARY pipe.

WATER MAINS

MATERIALS

The "Chapter 23 – Water Mains" Standard Specification Article 23.01 "Materials Purchased from the City" shall be amended such that the Contractor will procure materials from a supplier and not be able to purchase them from Lincoln Water System.

GATE VALVE

The “Chapter 23 – Water Mains”, Article 23.01 “Materials Purchased From The City” shall be deleted in its entirety.

The “Chapter 23 – Water Mains” Standard Specification Article 23.08 “Installation of Valves and Hydrants” shall be amended to include the following:

C. MATERIAL

In an effort to minimize inventory of parts and to standardize valves within the Lincoln Water System, Kennedy Valve was the Basis of Design. Other manufacturers may be accepted provided they meet all specifications and contract requirements including Mueller, American Flow Control, Clow, or approved equal.

These specifications cover ductile iron body, bronze-mounted water works resilient-seated gate valves of the non-rising pattern, including tap valves.

Materials specified herein shall meet all requirements of the latest version of the American Water Works Association C515 Standard for Reduce Wall Resilient-seated Gate Valves.

All bronze for the various interior valve components which come in constant contact with water shall contain no more than 2% aluminum or 16% zinc.

All exterior bolts and nuts shall be constructed of corrosion-resistant stainless-steel Grade 304 minimum.

Resilient seat shall be Styrene Butadiene Rubber (SBR) or Ethylene Propylene Diene Terpolymer rubber (EPDM).

The gate shall be ductile iron or gray iron.

Tee-head bolts and hex nuts for M.J. accessories shall be stainless steel, “Cor-Ten” or “Ductile Durabolt”.

Valves shall be Non-Rising Stem (NRS) design.

Valves shall be designed for a minimum working pressure of 200 psi and be tested at a minimum hydrostatic pressure of 400 psi.

Seat and gate shall seat on both sides and the edge to form a double seat with no movement of the seat when compressed to shutoff.

Any cavities in the gate shall drain fully.

Ends shall be mechanical joint except where noted otherwise.

All valves shall be provided with a minimum of 2 “O” ring seals above the thrust collar and 1 below the thrust collar.

All valves, including tap valves, shall be furnished complete with all accessories to make both end connections.

Valves shall be wrench-nut operated.

All valves shall be opened by turning in a counterclockwise direction.

Operators shall be equipped with standard two-inch square operating nut.

“O” ring seals shall be replaceable under pressure with the valve in the open position.

All valves shall be coated with a fusion-bonded epoxy or two-part liquid epoxy meeting AWWA C550 and NSF61.

TEMPORARY HYDRANT

The “Chapter 23 – Water Mains” Standard Specification, Article 23.10 “Temporary Hydrants and Blow-off for Flushing and Disinfection”, Section A “General” shall be amended to include the following:

The temporary hydrant(s) for this project shall have threads that conform to Lincoln Standard Threads.

REMOVE OFFSET

The “Chapter 23 – Water Mains” Standard Specification Article 23.04 “Removed Materials” shall apply to this item.

CROSS, MJ, 16”X16”

The “Chapter 23 – Water Mains” Standard Specification Article 23.07 “Installation of Pipe and Fittings” shall apply to this item.

TRAFFIC SIGNALS, ITS, AND LIGHTING

TRAFFIC SIGNALS, ITS AND LIGHTING – APPROVED SPECIAL PROVISION

The “Chapter 24 – Traffic Signals, ITS and Lighting” Approved Special Provision effective 3/28/2024 shall replace the standard specification in its entirety. See Appendix A.

GENERAL

The “Chapter 24 – Traffic Signals, ITS and Lighting” Approved Special Provision effective 3/28/2024 Article 24.00 “General”, Section E “City Furnished Materials” shall be replaced by the following:

E. CONTRACTOR FURNISHED MATERIALS AND WARRANTY

1. CONTRACTOR FURNISHED MATERIALS

The Work covered in these Special Provisions shall include the furnishing of certain materials and equipment and the installation of all necessary materials and equipment to provide a traffic signal and/or a street light installation complete, in place and ready for operation; and/or the

modification, removal or salvage of existing traffic signal and/or street light components or systems; in conformance with the plans and these Special Provisions.

Prior to field installation, all Contractor furnished traffic signal materials shall be submitted for a 48-hour bench test period unless exempted or modified by the City's Project Personnel. Contractor shall allow at least 14 days for bench testing to be completed and shall only submit complete materials for bench testing.

City traffic signal personnel shall be responsible for bench testing traffic signal cabinets and controllers to be installed by the Contractor and shall field test each installed traffic signal cabinet prior to turn on. All other activities associated with the installation, including but not limited to, labor, materials, tools, and transportation are the responsibility of the Contractor.

Any delay resulting from incomplete material submittals or contractor furnished materials failing bench testing shall not be justification for the suspension or extension of the working days or calendar days on a project. City traffic signal personnel shall notify the Contractor when the bench testing is completed.

Traffic signal materials that pass bench testing shall be picked up at Traffic Operations storage locations between 8:00 a.m. to 3:00 p.m. weekdays with 24-hour notice, except for city holidays. Furnished Street Lighting materials shall be picked up at LES Storeroom at the Walter Canney Service Center at 27th and Fairfield Streets, between 7:30 a.m. to 4:00 p.m. weekdays, except for holidays. Further direction may be required within these Special Provisions for procedures to be followed in handling traffic signal materials and/or equipment.

The Contractor shall be responsible for all material or equipment from the time that it is picked up to the completion of work. The costs of damaged materials shall be deducted from the final payment.

The Contractor shall take all precautions to protect the cabinet from damage including any concrete splatters, dents, scratches or any other damage as noted by the City's Project Personnel. In the event of damage to the cabinet, the contractor shall remove the damaged cabinet and re-wire a new cabinet. The cost of the damaged cabinet shall be deducted from the final payment.

The Contractor shall furnish all other materials, including, but not limited to concrete, epoxy coated reinforcing steel, conduit, pull boxes, cable, splice kits, messenger cable and hardware, pole clamps and hardware, risers, down guys, ground rods and clamps, traffic signal poles, street light poles, luminaires, and all other miscellaneous materials and/or hardware necessary to complete the Work in conformance with the Plans, or the Special Provisions.

2. WARRANTY

The vendor shall be responsible for all repairs, including parts, labor and all shipping during the warranty period. One (1) copy of the warranty shall be furnished for each item listed below.

A standard manufacturer's ten (10) year warranty shall apply for the following Contractor furnished materials:

- a. LED 12" Circular and Arrow Traffic Signal Modules

A standard manufacturer's five (5) year warranty shall apply for the following Contractor furnished materials:

- a. Accessible Pedestrian Push Button
- b. LED Pedestrian Signal Countdown Modules

A standard manufacturer's three (3) year warranty shall apply for the following Contractor furnished materials:

- a. Accessible Pedestrian Signal Control Unit
- b. Video Detector Camera System
- c. Blank-out sign

A standard manufacturer's two (2) year warranty shall apply for the following Contractor furnished materials:

- a. Signal Heads, including all accessories and hardware
- b. Pedestrian Signal Heads, including all accessories and hardware

A standard manufacturer's one (1) year warranty shall apply for the following Contractor furnished materials:

- a. Accessible Pedestrian Push Button Frame

REMOVE WOOD POLE

The "Chapter 24 – Traffic Signals, ITS and Lighting" Approved Special Provision effective 3/28/2024 Article 24.01 "Remove or Relocate or Adjust" shall apply for this item.

CONDUIT 1 ¼"

The "Chapter 24 – Traffic Signals, ITS and Lighting" Approved Special Provision effective 3/28/2024 Article 24.03 "Conduit" shall apply for this item.

COMBINATION MAST-ARM POLE

The "Chapter 24 – Traffic Signals, ITS and Lighting" Approved Special Provision effective 3/28/2024 Article 24.08 "Steel Poles" shall apply for this item.

The following shall be added to Section C "Foundations, Poles, and Mast Arms, and Luminaire Arms", Paragraph 2 "Design Criteria":

An effective vibration mitigation device shall be installed on the mast arm poles designed to the 2013 AASHTO standard. The vibration mitigation device shall be submitted for pre-approval by the City of Lincoln prior to finalization of the signal pole design. The vibration mitigation device will not be paid for separately. The Contractor shall submit shop drawings including vibration mitigation device to the City's Project Personnel and shall receive approval prior to purchasing the poles.

FOUNDATION DESIGN

The “Chapter 24 – Traffic Signals, ITS and Lighting” Approved Special Provision effective 3/28/2024 Article 24.08 “Steel Poles” shall apply for this item.

FOUNDATION CONCRETE

The “Chapter 24 – Traffic Signals, ITS and Lighting” Approved Special Provision effective 3/28/2024 Article 24.08 “Steel Poles” shall apply for this item.

FOUNDATION STEEL

The “Chapter 24 – Traffic Signals, ITS and Lighting” Approved Special Provision effective 3/28/2024 Article 24.08 “Steel Poles” shall apply for this item.

PEDESTRIAN PUSH BUTTONS

The “Chapter 24 – Traffic Signals, ITS and Lighting” Approved Special Provision effective 3/28/2024 Article 24.10 “Detectors”, Section C “Pedestrian Push Buttons” and Section G “Basis of Payment” shall be replaced by the following:

C. ACCESSIBLE PEDESTRIAN PUSH BUTTONS

All Accessible Pedestrian Signal Control Units shall be Polara iCCU-S equipped with Polara iN25BB1-B Accessible Pedestrian Push Buttons (APPB).

1. Accessible Pedestrian Push Button (APPB)

- a. The APPB shall require less than 2-3 pounds of force for activation.
- b. The APPB shall operate within -30 to +165 degrees F.
- c. The APPB switch shall have an operating life of greater than 300 million operations.
- d. The APPB shall operate properly with NEMA standard controller inputs.
- e. The APPB shall be NEMA TS2 compliant for shock and vibration tolerances.
- f. The APPB shall provide programmable audio outputs of up to 100dB at 1 meter.
- g. The APPB shall provide automatic volume range to adjust volume over a 60dB range.
- h. The APPB shall provide locate tone volume adjustable from -24dB to +6dB ambient.
- i. The APPB shall provide standard and custom options for audio and tactile feedback to the user when the button is pressed. Contractor shall request approval for all custom audio messages from Traffic Engineering.
- j. The APPB shall provide standard and custom options for audio and tactile feedback to the user when the Walk indication is on. Contractor shall request approval for all custom audio messages from Traffic Engineering.
- k. The APPB shall include as an option, direct to pedestrian signal, 3 wire connection with no need for a control unit in the cabinet.

2. Accessible Pedestrian Push Button (APPB) Frame

- a. The APPB frame shall be constructed of cast aluminum and shall be compatible with the APPB.
- b. The APPB frame shall accommodate a five (5) inch wide by seven (7) inch tall instruction plate with braille instructions.
- c. The APPB frame shall be mountable on four (4) inch to twenty-four (24) diameter poles or on

- a flat surface.
- d. The APPB frame shall be powder coated, black in color.

3. Accessible Pedestrian Signal Control Unit (APSCU)

- a. The APSCU shall provide for up to 16 ADA compliant push button stations per system.
- b. The APSCU shall operate within the temperature range of -3 to +165 degrees F.
- c. The APSCU shall operate with standard voltage of 120VAC.
- d. The APSCU shall provide all voltage, control, and health checks to the accessible pedestrian detection system.
- e. The APSCU shall operate properly with a standard 2 wire push button installation with shared commons.
- f. The APSCU shall operate properly with NEMA controller inputs including an option for TS2 SDLC operation.
- g. The APSCU shall be programmable with an iOS device via Bluetooth or Wi-Fi.
- h. There shall be not substitutes for any of the items on the list without prior written approval from Traffic Engineering.

Each pedestrian push button furnished by the Contractor shall consist of push button assembly, instruction sign, frame, instruction sign screws and shims that shall only be used on the smaller poles to stabilize the Pedestrian Push Buttons. The shims shall not be used if they cause any separation from the pole to the Pedestrian Push Button.

Pedestrian push buttons shall be mounted on the correct pole face as shown on the plans, 3'-6" above the adjacent walk surface, taking care to place so that the flat side of pole is flush with the Pedestrian Push Button. The Contractor shall supply brass mounting screws for mounting the assembly to the pole. The pole shaft wire entrance shall be a 7/8" diameter deburred hole. When 2 push buttons are on the same pole shaft, the common (white) cables are spliced in the hand hole or base, not jumpered together at the push buttons.

G. BASIS OF PAYMENT

DETECTOR, APS PEDESTRIAN PUSH BUTTON and DETECTOR CAMERA, complete, in place, tested, and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item.

This price and payment shall be full compensation for furnishing and installing APS Pedestrian Push Button Detectors with Contractor supplied mounting screws and Vehicle Detector Cameras, pull-box, conduit as specified, loop wire, and for all labor, equipment, tools, testing, materials, and incidentals required to complete the Work.

CABINETS

The "Chapter 24 – Traffic Signals, ITS and Lighting" Approved Special Provision effective 3/28/2024 Article 24.11 "Cabinets" shall be replaced by the following:

A. GENERAL

This section refers to pole and pad mount Cabinets.

Upon completion of the Work, each cabinet shall be properly placed, mounted, wired, and connected to operate as per Traffic Engineering.

All cabinets shall be Econolite TS2, Type 1 Hybrid Cabinet equipped with the following components:

Description	Manufacturer	Model
333SD TS2, Type 1 Hybrid Cabinet	Econolite	
NEMA Solid State Discreet Load Switch	Reno	LS-200
LCD Diagnostic 2 Channel Rack Mtd Detector Card	Reno	G-200-SS
NEMA Solid State Discreet Flasher	Reno	FL-200
NEMA TS2 BIU	Reno	BIU/2
5A +24VDC Rack Mount Power Supply	Reno	TR-200
12" Cabinet Riser with Hardware	Econolite	
0.75" Anchor Bolts with Mounting Hardware	Econolite	
Plug Mounted Surge Suppressor	EDCO	SHA-1250
Bus Relay	Struthers-Dunn	418AXXL-120VAC
Malfunction Management Unit	EDI	MMU2-16LEIP
IP Addressable 120V Power Strip, 6 inline position	Cyber Power	PDU41001
Controller	Econolite	Cobalt

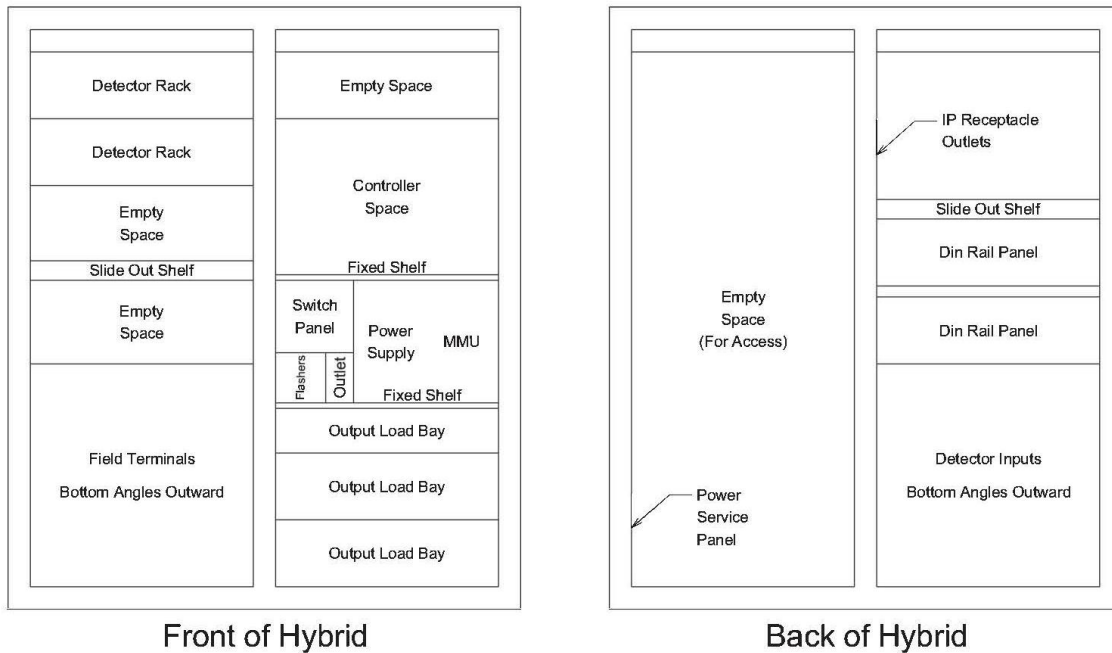
Unless otherwise noted, the cabinet, controller, auxiliary equipment, and mounting hardware will be furnished by Contractor to the City for inspection and bench testing prior to installation by the Contractor.

B. MATERIALS

1. 333SD TS2, Type 1 Hybrid Cabinet
 - a. The cabinet shall have dual front and dual rear doors with vents on the front left and rear left doors only.
 - b. The cabinet shall be constructed of 0.125" aluminum.
 - c. The cabinet exterior shall have a natural unpainted aluminum finish.
 - d. The cabinet shall have a NEMA P cabinet footprint.
 - e. The cabinet doors shall have a 3-point locking system using the industry standard traffic #2 key.
 - f. The cabinet shall have a "Police Access Panel" accessible from the outside that includes one switch for Normal / Flash operation, one switch that activates Manual Control Enable and one 0.25" plug that controls Manual Control operation.
 - g. The cabinet shall include a front facing switch panel that includes switches for Normal / Flash operations, Run / Normal / Stop Time operations, Controller ON / OFF operations and one Fan Test button or switch which turns the cabinet fans on regardless of thermostat condition. See cabinet layout figure for location.
 - h. The cabinet shall incorporate two (2) standard Electronics Industries Alliance (EIA) 19" racks.
 - i. The cabinet shall include two (2) rack-mounted, 10" deep din rail panels.
 - j. The cabinet shall include facilities and field terminals for 8 vehicular phases, 4 pedestrian phases and 4 overlaps.
 - k. Red, Yellow, or No Flash programming on any vehicle, pedestrian or overlap movement shall

- be accomplished by Molex Flash Plugs.
- l. The cabinet shall include 2 detector card racks wired for loop detectors in the Front Left side. See cabinet layout figure for location.
 - m. Detector racks shall be wired to operate with either 2 or 4 channel detector amplifiers.
 - n. Emergency Vehicle Preemption facilities shall be provided for in the detector card racks.
 - o. Stop time shall be automatically applied to the controller when any "Flash Operation" occurs via either malfunction or user switch selection.
 - p. The cabinet shall be compatible with a shelf mount NEMA TS2 Type 1 controller, or as an option, a rack mount NEMA TS2 Type 1 controller.
 - q. The cabinet shall include steerable, white LED lighting that illuminates the section of the cabinet exposed while any cabinet door is open.
 - r. All field input/output (I/O) terminals shall be identified by permanent alphanumeric labels. All labels shall use standard nomenclature per the NEMA TS2 specification.
 - s. All output load bay assemblies shall be pre-wired for a Type-16 Malfunction Management Unit.
 - t. All sockets shall be mounted with any existing flange on the outside of the mounting panel to afford stability when plugging and unplugging devices.
 - u. Two cabinet fans shall be installed on the ceiling of the cabinet. The ceiling of the cabinet must be spaced at least 1 inch from the top of the cabinet to allow the fans to vent air to the outside via down facing air outlet vents. The entire top of the cabinet will be covered by this "attic" to help prevent moisture condensation within the cabinet.
 - v. The cabinet shall include sixteen (16) NEMA discreet load switches that show input and output status for each color.
 - w. The cabinet shall include eight (8) LCD diagnostic, 2 channel, rack mounted detector cards.
 - x. The cabinet shall include two (2) NEMA discreet flashers.
 - y. The cabinet shall include eight (8) NEMA flash transfer relays.
 - z. The cabinet shall include one (1) +24VDC rack mount power supply for required cabinet voltages.
 - aa. The cabinet shall include one (1) 12" riser with mounting hardware. The risers shall have welded nuts for assembly to cabinet.
 - bb. The cabinet shall include four (4) anchor bolts and all necessary hardware.
 - cc. The cabinet shall include one (1) EDI Malfunction Management Unit.
 - dd. Field terminals shall be located on the Front Left side of the cabinet with the bottom of the panel angled out to provide ease of access. See cabinet layout figure for location.
 - ee. Detector input terminals shall be located on the Back Right side of the cabinet with the bottom of the panel angled out to provide ease of access. See cabinet layout figure for location.
 - ff. The cabinet shall include all BIU's to allow for maximum phase and function utilization for which the cabinet is designed.
 - gg. All terminal screws shall be "Phillips" type.
 - hh. The cabinet shall include one (1) electronic copy of the cabinet prints in PDF format.
 - ii. The cabinet shall be covered by a standard warranty of 3 years.
 - jj. There shall be no substitutes for any of the items on the list without prior written approval of the City's Project Personnel.

CABINET LAYOUT



2. Power Service Panel Assembly

A power panel shall be mounted on the left side of the cabinet. The power panel shall, at a minimum, include the following components and be wired per the NEMA TS2 specification. All power devices shall be mounted on the Power Service Panel in such a way as to be easily accessible without dismantling any portion of the cabinet.

- A plug mounted EDCO Model SHA-1250 Surge Suppressor
- Main Circuit Breaker 50A
- Aux Circuit Breaker 10A
- A normally open, 60A solid state Struthers-Dunn Bus Relay, model 418AXXL-120VAC, or equivalent.
- A minimum of two (2) 15-position Neutral Bus Bars capable of connecting three #12 wires per position.
- A minimum of two (2) 15-position Ground Bus Bars capable of connecting three #12 wires per position.

3. Controller/Local Software

All controllers shall be Econolite Cobalt ATC equipped with EOS local software.

- Controllers shall be modern, field hardened, shelf-mount units with Linux-based operating system (OS).
- Controllers shall satisfy the latest Advanced Transportation Controller (ATC) standard 5.2b and the proposed ATC standard 6.10.
- Controllers shall have hardened, touch screen to allow user friendly graphical interface for programming.
- Controllers shall allow for OS software updates via USB memory stick, SD card, or Ethernet utilizing installation application.
- Controller software shall allow for advanced, industry standard control and coordination

- features, multiple detector features and diagnostics, and logging features.
- f. Controller software shall provide advanced preemption configurations and priority sequences.
- g. Controller software shall have the ability to enable and/or install additional software functionality for TSP and Adaptive Signal Technology.
- h. Controllers shall be able to support Connected Vehicle Co-Processor module, including SpaT/MAP data messaging capabilities.
- i. Controllers shall be capable of being monitored and configured from a remote controller interface on tablet, laptop, or pc.

C. INSTALLATION

The Contractor shall mount or place each cabinet, base, and concrete pad as shown on the plans in conformance with the plans. Pad mounted cabinets shall have a 4'-2" x 4' x 4" concrete pad in front of the main door. If stated on the plans the cabinet shall also have a 4'-2" x 4' x 4" concrete pad on the opposite side of the main door. The Cabinet pad/s shall be level in both directions.

The Contractor shall connect all conductors for signal heads, detectors, grounds, Fiber Locate Cables, service cables, and fiber optics into the traffic signal cabinet. The Contractor shall connect the service cables and have the power panel energized.

All cables shall be routed to the cabinet and neatly trained to their destination in the cabinet utilizing industry standard Velcro ties, and shall be clearly identified using the labeling method as shown in "Cable labeling" section of these special provisions.

The Contractor shall work closely with Traffic Engineering in scheduling cabinet installations so as to minimize intersection down time.

D. BASIS OF PAYMENT

CABINET, SIGNAL, PAD MOUNT, furnished, installed, connected, cables labeled, tested and accepted by Traffic Engineering, shall be measured as a single unit and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for delivery/pick up and installing the cabinet, concrete pad, base, all connections, epoxy coated reinforcing steel, concrete, ground rod and for all labor, equipment, tools, materials, excavation, and incidentals required to complete the Work.

SIGNAL HEADS AND OVERHEAD SIGNS

The "Chapter 24 – Traffic Signals, ITS and Lighting" Approved Special Provision effective 3/28/2024 Article 24.13 "Signal Heads and Overhead Signs" shall be replaced by the following:

A. GENERAL

Signal heads and Overhead Signs are furnished by the Contractor and shall be delivered to Traffic Engineering staff for inspection prior to installation by the Contractor. The Contractor shall furnish mast arm clamp kit, shaft clamp kit, and down nipple extensions.

Traffic signal head adjustments shall be accomplished by adjusting the clamp kit and the connection

from the signal head arm to the Head or Sign. The set screws in the aluminum pipe shall never be adjusted.

The clamp kit shall be high tensile aluminum alloy with a high strength galvanized aircraft cable and stainless-steel swaged fittings. The Contractor shall take care in selecting the length of cable required. If there is cable remaining, the Contractor shall tie wrap the excess in a tight coil.

The clamp kit shall have 2 sides with 1 1/2" IPS (iron pipe size) signal hardware on one side and shall be adjustable on the other side to fit the traffic signal pole shaft or mast arm. The clamp kit shall attach to the pole shaft or mast arm by use of an adjustable stainless-steel cable and be able to rotate from horizontal to vertical in order to make the signal heads plumb or level. Installation shall be as per manufacturer's instructions.

B. MATERIALS

All Signal Heads shall meet the requirements set forth in the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD) and the latest edition of the Institute of Transportation Engineers (ITE) Equipment Standard for Vehicular Traffic Control Signal Heads.

1. Traffic Signal Heads

- a. Traffic signal heads shall be constructed of flat black colored polycarbonate material.
- b. Traffic signal heads shall be constructed with interchangeable sections that may be rearranged into City of Lincoln Signal Configurations shown in the special plans.
- c. Traffic signal heads shall be compatible with Astro-Brac mounting hardware available from PELCO Products, Inc or approved alternative.
- d. Traffic signal head material shall be colored to full depth. Cuts and scratches shall not uncover uncolored material.
- e. Mounting hardware for LED's shall be installed for later LED installation.
- f. Traffic signal head sections shall be factory assembled according to the configuration shown in the project plans.

2. Back Plates

- a. Back plates shall be constructed of flat black colored, one piece, vacuum formed polycarbonate material.
- b. Back plates shall have reinforcing flange on all edges.
- c. Back plate material shall be colored to full depth. Cuts and scratches shall not uncover uncolored material.
- d. Mounting hardware for back plates shall be included with all back plates.
- e. Back plates shall not be mounted to the traffic signal heads prior to delivery.

3. Visors

- a. Visors shall be tunnel type constructed of flat black colored, one piece polycarbonate material.
- b. Visors material shall be colored to full depth. Cuts and scratches shall not uncover uncolored material.

- c. Visors shall be mounted to the traffic signal head in vertical configuration.

4. Terminal Blocks

- a. Terminal blocks for traffic signal heads.
- b. Terminal blocks shall be mounted in the yellow section of a 3-section signal. Terminal blocks shall be mounted in the yellow, yellow arrow, and red sections of a 5-section signal.
- c. Terminal blocks for pedestrian signal heads shall be a 3 position barrier type constructed of Bakelite material with brass terminals and brass screws.

5. Pedestrian Signal Heads

- a. Pedestrian signal heads shall be constructed of flat black colored polycarbonate material.
- b. Pedestrian signal head material shall be colored to full depth. Cuts and scratches shall not uncover uncolored material.
- c. Pedestrian signal heads shall accommodate standard 16" X 18" Man/Hand Countdown LED indications.
- d. Pedestrian signal heads shall include an "egg crate" style visor mounted to the front of the signal.

6. Hardware

- a. Hinges shall be enclosed, solid non-corrosive metallic hinge pins.
- b. Doors shall be secured against gaskets via winged devices.
- c. Clam shells shall be factory mounted to pedestrian signal heads for either right or left side of pole mounting as shown in the plans.
- d. Mounting tube for the signal head shall be aluminum, gusseted tube of the appropriate length for the signal with plastic or vinyl insert.
- e. Mounting arms for the signal head shall be aluminum arm kits, appropriate for the style of the signal.
- f. Mounting clamps for the signal head shall be Pelco brand, Astro-Brac clamp or approved alternate, with steel cable appropriate for the size of the mounting structure.
- g. Closure kits for the pedestrian signal head shall be constructed of flat black colored polycarbonate material.
- h. Closure kits for the pedestrian signal shall be appropriately sized for the pedestrian signal head.

7. LED 12" Circular and Arrow Traffic Signal Modules

- a. LED traffic signal modules shall be fully compliant with the latest adopted version of ITE VTC SH LED Circular specifications.
- b. LED traffic signal modules shall meet or exceed ITE specifications for moisture intrusion and failed state impedance.
- c. The Contractor shall submit to the City reports from ETL / Intertek certifying full compliance with all ITE specifications listed.
- d. LED traffic signal modules shall operate within 80 VAC to 135 VAC.
- e. LED traffic signal modules shall operate properly with Eberle Design Inc (EDI) conflict monitors and MMU's.

- f. LED traffic signal modules shall fit in existing standard 12-inch traffic signals and shall be equipped with a rubber gasket.
- g. LED traffic signal module hookup wires shall be color coded to match indication color.
- h. LED traffic signal modules shall have quick connect terminals with tab/spade adapters for use on a barrier strip with #8 screws.
- i. LED traffic signal modules shall have an expanded view radiation pattern.
- j. LED traffic signal modules shall include clear abrasion resistance lenses.
- k. There shall be no substitutes for any of the items on the list without prior written approval of Traffic Engineering.

8. LED Pedestrian Signal Countdown Modules

- a. LED pedestrian signal countdown modules shall be fully compliant with the latest adopted version of ITE PTCSI LED Pedestrian Traffic Signal Module Specifications.
- b. LED pedestrian signal countdown modules shall be fully compliant with the latest adopted version of the MUTCD for countdown applications.
- c. The Contractor shall submit to the City reports from ETL / Intertek certifying full compliance with all ITE specifications listed.
- d. LED pedestrian signal countdown modules shall operate within 80 VAC to 135 VAC.
- e. LED pedestrian signal countdown modules shall operate properly with Eberle Design Inc (EDI) conflict monitors and MMU's.
- f. LED pedestrian signal countdown modules shall fit in existing standard 16-inch X 18-inch pedestrian signals and shall be equipped with a rubber gasket.
- g. LED pedestrian signal countdown module hookup wires shall be color coded to match indication color.
- h. LED pedestrian signal countdown modules shall have quick connect terminals with tab/spade adapters for use on a barrier strip with #8 screws.
- i. LED pedestrian signal countdown modules shall display standard Hand/Person icons with two 7 segment LED countdown displays.
- j. Countdown timer display shall start only at the beginning of the pedestrian change interval. After the countdown timer displays zero, the timer display shall remain dark until the beginning of the next countdown. The countdown timer shall display the number of seconds remaining until the termination of the pedestrian change interval.
- k. LED pedestrian signal countdown modules shall contain a microprocessor capable of changing the countdown display with changes in pedestrian change interval.
- l. LED pedestrian signal countdown modules shall not display numerals during the Walk or Don't Walk indications.
- m. There shall be no substitutes for any of the items on the list without prior written approval of Traffic Engineering.

9. Overhead Signs

Refer to Section TRAFFIC SIGNS for materials for overhead signs.

C. INSTALLATION

Traffic Signal Heads, Pedestrian Signal Heads, and Overhead Signs shall be installed as shown in the plans to the approval of Traffic Engineering. Each signal assembly shall be erected so that it is plumb,

securely attached with all fittings tight, and present a neat appearance. Traffic signal heads shall be installed in line and all the same relative heights above the crown of the street. Pedestrian Signal Heads shall be aimed at the center of the appropriate ramp for which a person would wait for walk indication.

The pole shaft wire entrances for the Pedestrian Push Buttons and Pedestrian Signal Heads shall be a 7/8" diameter deburred hole with none of the hole exposed outside of the Pedestrian Signal Head. The pole shaft wire entrances for the Traffic Signal Heads shall be a 1" diameter deburred hole with a 1" inside diameter rubber grommet. The pole mast arm wire entrances for the Traffic Signal Heads shall be a 1" diameter deburred hole with a 1" inside diameter rubber grommet.

The pole shaft wire entrance for the cable to the arm shall be a 1 1/2" diameter deburred hole with a 1 1/2" inside diameter rubber grommet.

Down nipple extension 1 1/2" in diameter, and of appropriate length, shall be furnished and installed by the Contractor so that all signals on the span will hang at the same elevation as illustrated on the special plans.

If, after the signal assemblies are erected and the street is open to public travel, the signal is not put immediately into operation, the signal faces shall be covered securely with signal covers specifically designed for all signal heads. Burlap, cardboard, or plastic 'trash style' bags shall not be accepted. All signal covers shall be approved by Traffic Engineering prior to use. No inoperative signals on a street which is open to the public shall be left uncovered under any circumstances. Traffic Signal Heads shall stay covered until the signal is ready to be placed in flash operation. Pedestrian Signal Heads shall stay covered until the signal is ready to be placed in full operation.

D. BASIS OF PAYMENT

HEAD, PEDESTRIAN SIGNAL and TRAFFIC SIGNAL, 3 SECTION, furnished, complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for delivery/pick up and installing the signal head and assembly (pipe and brackets), for furnishing and installing clamp kits, nipples, banding, pipe fittings, for all pole and mast arm modifications; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

SIGN, OVERHEAD, furnished, complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for furnishing, delivery/pick up and then installing the street name Overhead Sign and assembly (pipe and brackets) after inspection by City or installing the directional Overhead Sign provided by Contractor and assembly (pipe and brackets), clamp kits, nipples, banding, pipe fittings, for all pole and mast arm modifications; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

The furnishing, installing, maintaining and removal of any temporary covering for the signals during construction is considered subsidiary to the installation of the head. Such coverings remain the property of the Contractor after removal. All mounting hardware shall be considered subsidiary to the installation of the signal heads or overhead signs.

TRAFFIC MONITORING CAMERA

The “Chapter 24 – Traffic Signals, ITS and Lighting” Approved Special Provision effective 3/28/2024 shall be amended to include the following Article 24.16 “Traffic Monitoring Camera”.

A. GENERAL

Unless otherwise noted, the traffic monitoring camera, pole assembly extension, auxiliary equipment, and mounting hardware will be furnished by the Contractor.

Traffic Monitoring Cameras shall be installed at locations shown in the Contract Documents. Upon completion of the Work, each camera shall be properly placed, mounted, wired, and connected to operate as per Traffic Engineering. The attachment to the pole shall be by use of the clamp kit, as specified in these Special Provisions. The Contractor shall aim and adjust the camera under the supervision of Traffic Engineering. The pole mast arm wire entrance shall be a 1” diameter deburred hole with a 1” inside diameter rubber grommet.

Prior to final field installation, Contractor shall coordinate camera programming and configuration with Traffic Engineering staff.

B. MATERIALS

The City of Lincoln’s current traffic camera management software (Avigilon Control Center) provides monitoring and management capability for the current traffic camera network. All traffic monitoring cameras furnished by the Contractor shall be compatible and configurable with this current traffic camera management software. Traffic monitoring cameras requiring additional controlling software for configuration or operation shall not be accepted. All traffic monitoring cameras shall be furnished with wall mount pendant style bracket and Power over Ethernet (PoE) injector.

1. Image Performance

- a. Image Sensor: 1/2.8” progressive scan CMOS
- b. Minimum Active Pixels (H x V): 1980 (H) x 1080 (V)
- c. Minimum Imaging Area (H x V): 4.8mm x 2.7mm; 0.189” x 0.106”
- d. Minimum Illumination: 0.1 lux (F/1.6) in color mode; 0.03 lux (F/1.6) in monochrome mode
- e. Dynamic Range: 120+ dB
- f. Image Rate: Up to 60 fps
- g. Aspect Ratio (Resolution Scaling): Down to (16:9) 384 x 216 or (5:4) 320 x 256
- h. Includes 3D Noise Reduction Filter

2. Lens

- a. Lens: 4.3mm to 129mm, F/1.6 – F/4.7, autofocus
- b. Viewing Angle: 63.7° - 1.9°
- c. Zoom: 36x without image stabilization, 30x with image stabilization

3. Image Control

- a. Video Compression: H.264 HDSM SmartCodec, H.265 HDSM SmartCodec, Motion JPEG

- b. Streaming: Multi-stream H.264, Multi-stream H.265, Motion JPEG
- c. Motion Detection: Pixel motion: Selectable sensitivity and threshold. Classified object detection
- d. Electronic Shutter Control: Automatic, Manual (1/1 to 1/10,000 sec)
- e. Iris Control: Automatic, Open, Closed
- f. Day/Night Control: Automatic, Manual
- g. Flicker Control: 60 Hz, 50 Hz
- h. White Balance: Automatic, Manual
- i. Backlight Compensation: On/Off
- j. Privacy Zones: 3D, up to 64 zones
- k. Presets: 500 named presets
- l. Tours: 10 named tours
- m. Audio Compression Method: G.711, Opus
- n. Digital Zoom: Up to 100x when used with Avigilon ACC Client
- o. Electronic Image Stabilization
- p. Digital Defog: Adjustable/Off

4. Network

- a. Network: 100BASE-TX
- b. Cabling Type: CAT5e
- c. Connector: RJ-45
- d. ONVIF: ONVIF compliance version 1.02, 2.00, Profile S, Profile T, Profile G
- e. Security: Password protection, HTTPS encryption, digest authentication, WS authentication, user access log, 802.1x port based authentication, FIPS 140-2 L1
- f. Protocol: IPv6, Ipv4, HTTP, HTTPS, SOAP, DNS, NTP, RTSP, RTCP, RTP, TCP, UDP, IGMP, ICMP, DHCP, Zeroconf, ARP
- g. Device Management Protocols: SNMP v2c, SNMP v3

5. Peripherals

- a. Audio Input/Output: Line level input and output
- b. External I/O Terminals: 2 Alarm In, 2 Alarm Out
- c. Onboard Storage: 2 × microSD/microSDHC/microSDXC slot – minimum class 6; class 10/UHS-1 or better recommended.

6. Mechanical

- a. All cameras shall be furnished with pendant style mount and all hardware for mounting to signal vertical shaft.

7. Electrical

- a. Power Consumption: 51 W max with 24 VDC aux power, 75 VA with 24 VAC aux power, 51 W max with 60 W PoE++, 25.5 W max with 30 W PoE+
- b. PoE Power Source: 60 W PoE: IEEE 802.3bt Class 6 PoE++, 60 W Cisco UPoE, Microsemi 60 W or higher midspans 30 W PoE: IEEE 802.3bt, 802.3at Class 4 PoE+
- c. Power Connector: Red and Black input wires

- d. Real Time Clock Backup Battery: 3V manganese lithium

8. Environmental

- a. Operating Temperature: -30 °C to +60 °C (-22 °F to 140 °F)
- b. Storage Temperature: -10 °C to +70 °C (14 °F to 158 °F)
- c. Humidity: 0-95%, non-condensing

9. Certifications

- a. Certifications/Directives: UL, cUL, CE, ROHS, RCM
- b. Safety: UL 62368-1, CSA 62368-1, IEC/EN 62368-1
- c. Pendant Mount: IEC 62262 IK10 Impact Rating, UL/CSA/IEC 60950-22, IEC 60529 IP66 and IP67 Weather Rating, NEMA 4X
- d. Electromagnetic Emissions: FCC Part 15 Subpart B Class B, IC ICES-003 Class B, EN 55032 Class B, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2, EN 61000-3-3, EN 50121-4
- e. Electromagnetic Immunity: EN 55035, EN 61000-6-1, EN 50121-4

10. Supported Video Analytics at Home Position

- a. Objects in Area: The event is triggered when the selected object type moves into the region of interest.
- b. Object Loitering: The event is triggered when the selected object type stays within the region of interest for an extended amount of time.
- c. Objects Crossing Beam: The event is triggered when the specified number of objects have crossed the directional beam that is configured over the camera's field of view. The beam can be unidirectional or bidirectional.
- d. Object Appears or Enters Area: The event is triggered by each object that enters the region of interest. This event can be used to count objects.
- e. Object Not Present in Area: The event is triggered when no objects are present in the region of interest.
- f. Objects Enter Area: The event is triggered when the specified number of objects have entered the region of interest.
- g. Objects Leave Area: The event is triggered when the specified number of objects have left the region of interest.
- h. Object Stops in Area: The event is triggered when an object in a region of interest stops moving for the specified threshold time.
- i. Direction Violated: The event is triggered when an object moves in the prohibited direction of travel.
- j. Tamper Detection: The event is triggered when the scene unexpectedly changes.

11. Supported Classified Object Types

- a. Objects in Outdoor Mode: Vehicle, sub-types: Car, Truck, Bicycle, Motorcycle, Bus, Person
- b. Objects in Indoor Mode: Person

12. Avigilon Control Center (ACC) Versions Supported

- a. ACC Version 6.14.12 or higher: All supported analytic events with two types of classified objects: person or vehicle. Appearance search when paired with appropriate server hardware. H.265 supported.
- b. ACC Version 7.2 or higher: All supported analytic events with people and vehicles and all vehicle sub-types as classified objects. Appearance search when paired with appropriate server hardware. H.265 supported.

13. Power over Ethernet (PoE) Injector, Type 3, PoE++

- a. Number of Ports: 1
- b. Pass Through Data Rates: 10/100/1000 Mbps
- c. Data Pairs: 1/2 (-) and 3/6 (+)
- d. Spare Pairs: 7/8 (-) and 4/5 (+)
- e. Output Power Voltage: 55 VDC
- f. User Port Power: 60W over 4-pairs
- g. AC Input Voltage: 100 to 240 VAC
- h. AC Input Current: 1.5A @ 100-240 VAC
- i. AC Frequency: 50 to 60 Hz
- j. Dimensions: Nomimially 2.4in x 1.5in x 6.0in
- k. AC Power Indicator: Yellow
- l. Channel Power Indicator: Green
- m. Connectors: Shielded RJ-45, EIA 568A and 568B
- n. Operating Ambient Temperature: 14°F to 113°F @ 60W
- o. Operating Ambient Temperature: 14°F to 131°F @ 30W
- p. Operating Humidity: Maximum 90%, Non-condensing
- q. Mean Time Between Failures (MTBF): 240,000hrs @ 75°F
- r. Thermal Rating: 30 BTU/Hr (@100 VAC)
- s. IEEE 802.3at (PoE), RoHS Compliant, WEEE Compliant, CE
- t. FCC Part 15, Class B, EN 55022 Class B (Electromagnetic Emission), EN 55024 (Electromagnetic Immunity), VCCI
- u. UL Listed per EN 60950-1
- v. GS Mark per EN 60950-1

C. BASIS OF PAYMENT

CAMERA, TRAFFIC MONITORING, furnished, installed, connected, cables labeled, tested and accepted by Traffic Engineering, shall be measured as a single unit and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for furnishing and installing the camera with mounting bracket and PoE injector, coordination with City staff, all connections, grounding, and for all labor, equipment, tools, materials, and incidentals required to complete the Work.

BLANK-OUT SIGN

The “Chapter 24 – Traffic Signals, ITS and Lighting” Approved Special Provision effective 3/28/2024 shall be amended to include the following Article 24.17 “Blank-out Sign”.

A. GENERAL

Blank-out signs are furnished by the Contractor and shall be delivered to Traffic Engineering staff for inspection prior to installation by the Contractor. The Contractor shall furnish the approved Pelco Astro-brac clamp mounting kit and all necessary hardware.

Blank-out sign mounting adjustments shall be accomplished by adjusting the clamp kit and the connection from mounting surface to the blank-out sign. The set screws in the aluminum pipe shall never be adjusted.

B. MATERIALS

All blank-out signs shall meet the requirements set forth in the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD) and the latest edition of the Institute of Transportation Engineers (ITE) Equipment Standard for LED Signal Modules.

1. LED Blank-Out Signs

- a. The LED blank-out sign face shall measure 36in x 36in.
- b. The LED blank-out sign shall display a blank black face when not energized. When energized, the sign shall display an illuminated arrow that indicates "No Left/Right Turn".
- c. The LED blank-out sign shall utilize red and white LED's with a minimum viewing angle of at least 30 degrees.
- d. The LED blank-out sign shall operate with standard 90-120VAC, 60 Hz power input.
- e. The LED blank-out sign shall consist of LED's with a power factor less than 0.9 and low power consumption less than 105 Watts (less than 1 Amp).
- f. The LED blank-out sign shall consist of LED's with a minimum operating life of 100,00 hours.
- g. The LED blank-out sign shall have a minimum 6" sun visor.
- h. The LED blank-out sign shall utilize LED's mounted on modular printed circuit boards.
- i. The LED blank-out sign shall have an operating temperature range of -40°F to +165°F.
- j. The LED blank-out sign shall have screened weep holes for moisture evacuation.
- k. The LED blank-out sign shall be constructed of black powder-coated marine-grade aluminum with a minimum thickness of 0.125in.

C. INSTALLATION

Blank-out signs shall be installed as shown in the plans to the approval of Traffic Engineering. Each blank-out sign assembly shall be erected so that it is plumb, securely attached with all fittings tight, and present a neat appearance. Blank-out signs shall be installed at an appropriate height above the crown of the street or surrounding ground. Blank-out signs shall be aimed at the center of the appropriate lane where a vehicle would wait while the indication is activated.

The pole shaft wire entrances for the blank-out signs shall be a 1" diameter deburred hole with a 1" inside diameter rubber grommet. The pole mast arm wire entrances for the blank-out signs shall be a 1" diameter deburred hole with a 1" inside diameter rubber grommet.

If, after the blank-out sign assemblies are erected and the street is open to public travel, the blank-out is not put immediately into operation, the blank-out sign shall be covered securely with signal covers specifically designed for all blank-out signs. Burlap, cardboard, or plastic 'trash style' bags shall not be accepted. All covers shall be approved by Traffic Engineering prior to use. No inoperative blank-out

signs on a street which is open to the public shall be left uncovered under any circumstances. Blank-out signs shall stay covered until the signal is ready to be placed in flash operation.

D. BASIS OF PAYMENT

BLANK-OUT SIGN, furnished, complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for delivery/pick up and installing the blank-out sign and assembly (pipe and brackets), for furnishing and installing clamp kits, nipples, banding, pipe fittings, for all pole/shaft and mast arm modifications; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

The furnishing, installing, maintaining and removal of any temporary covering for the blank-out sign during construction is considered subsidiary to the installation of the head. Such coverings remain the property of the Contractor after removal. All mounting hardware shall be considered subsidiary to the installation of the blank-out signs.

DOWN GUY

Down guys shall be installed at locations designated on the plans and per these provisions.

A. MATERIALS

Guy wire shall be of the same diameter and tensile strength as the messenger cable supporting attachment to which they are linked and shall conform to the requirements of "Standard Specifications for Zinc-Coated Steel Wire Strand", ASTM Designation A-475.

B. INSTALLATION

Installation shall include a ground anchor that is a power screw-type, having an 8" minimum diameter and using a 7' x 5/8" diameter rod to minimize soil disturbance.

All ferrous metal line hardware items shall be galvanized and shall conform to the requirements of "Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware", ASTM Designation A153.

A guy guard shall be included and be high visibility plastic 8' in length.

Down guys shall not enter the ground less than 24" from the edge of the sidewalk unless otherwise shown on the plans.

C. BASIS OF PAYMENT

DOWN GUY, furnished, complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for furnishing the necessary materials and installing the down guy, and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

COMMUNICATIONS

COMMUNICATIONS – APPROVED SPECIAL PROVISION

The “Chapter 26 – Communications” Approved Special Provision 3/28/2024 shall replace the standard specification in its entirety. See Appendix B.

ITS FIELD SWITCH

The “Chapter 26 – Communications” Approved Special Provision effective 3/28/2024 Article 26.07 “Install ITS Field Switch” shall be replaced by the following.

A. GENERAL

ITS Field Switch shall be a field-hardened, Layer 2, Managed Ethernet switch provided by the contractor for installation at cabinet locations as part of Traffic Signal and ITS systems as indicated on the plans.

B. MATERIALS

1. Interfaces/Communications
 - a. I/O Ports: 8 x 10/100/1000BASE-T/TX RJ-45 Gigabit ethernet ports
4 x SFP (mini-GBIC) fiber ports
Auto-Negotiation, Full/Half Duplex Mod
Auto MDI/MDI-X Connection
 - b. Standards: IEEE 802.3 for 10BaseT
IEEE 802.3u for 100BaseT(X)/FX
IEEE 802.3ab for 1000BaseT(X)
IEEE 802.3z for 1000BaseSX/LX/LHX/ZX
IEEE 802.3x for Flow Control
 - c. PoE: Port 1 to Port 8: IEEE 802.3at/af
 - d. Console Port: RS-232 (RJ45)
 - e. Power: 6-pin screw Terminal Block (with relay)
2. Physical
 - a. Enclosure: Metal Shell
 - b. Protection Class: IP 30
 - c. Installation: DIN-Rail, Wall-mount
 - d. Dimensions (W x H x D): 2.91in x 5.98in x 4.13in
3. LED Indicators
 - a. System LED: PWR1, PWR2, SYS, Alarm, R.M.
 - b. Port LED: Link/Speed/Activity/PoE
4. Environment
 - a. Operating Temperature: -40°F to +167°

- b. Ambient Relative Humidity: 5 to 95% (non-condensing)
- c. Overload Current Protection: present
- d. Reverse Polarity Protection: present
- e. MTBF: minimum 1,000,000

5. Power

- a. Power Consumption: 0.25A at 48VDC
- b. Power Input: 48VDC (46VDC to 57VDC)
- c. Power Budget: 240W
- d. Fault Output: 1 Relay Output

6. Certifications

- a. Safety: UL61010-2-201
- b. EMI: CE, CISPR 32, FCC Part 15b Class A
- c. EMS: IEC 61000-4-2
IEC 61000-4-3
IEC 61000-4-4
IEC 61000-4-5
IEC 61000-4-6
IEC 61000-4-8
- d. EMC: EN 61000-6-2
EN 61000-6-4
- e. Shock: IEC 60068-2-27
- f. Freefall: IEC 60068-2-32
- g. Vibration: IEC 60068-2-6
- h. Traffic Control: NEMA TS-2
- i. Railway Trackside: EN50121-4

7. Switch Properties

- a. Capacity: 24Gbps
- b. Transmission Rate: 17.8 Mbps
- c. MAC Table Size: 8K
- d. Jumbo Frame: 1,0240 Bytes
- e. Packet Buffer Size: 4.1 Mb
- f. Max IGMP Group: 256
- g. Max VLAN Group: 256 (VLAN ID 1 to 4094)

8. L2 Features

- a. VLAN Arrange: 802.1Q Tag-based VLAN, 802.1ad QinQ VLAN Stacking
- b. Port Mirroring: 1 to 1, N to 1
Max Mirror Session: 4
- c. RSPAN: Remote Switched Port Analysis
- d. GARP: GVRP, GMRP
- e. IP Multicast: IGMP Snooping v1/v2/v3, MLD
Snooping, IGMP Immediate leave

- f. Storm Control: Broadcast, Multicast, Unknown unicast
 - g. LLDP: 802.1ab LLDP, LLDP-MED
 - h. Industrial Protocol: Modbus/TCP
 - i. Redundancy: IEEE 802.1D-STP, IEEE 802.1s-MSTP, IEEE 802.1w-RSTP, X-Ring Pro, with ultra high-speed recovery time less than 20ms, ERPS (G.8030)
9. QoS
- a. Priority Queue Scheduling: Weighted Round Robin (WRR), Strict Scheduling Priority (SP), Hybrid Priority Max, Priority Queues: 8
 - b. Class of Service: IEEE 802.1p Base CoS, IP TOS, DSCP base CoS
 - c. Rate Limiting: Ingress Rate limit, Egress Rate limit
 - d. Link Aggregation: IEEE 802.3ad Dynamic Port Trunking, Static Port Trunking

10. Security

- a. Port Security: Static/Dynamic MAC, Max. Learning Limit, MAC Violation Notice
- b. 802.1X: Port-based/MAC-based Authentication (MD5/PEAP/TLS/TTLS Encryption)
- c. MAB: MAC Authentication Bypass
- d. Authentication: RADIUS, TACAS+
- e. IP Security: IP Source Guard, DHCP Snooping, ARP Spoofing Prevention
- f. ACL: Access Control List (IP-ACL, MAC-ACL), Max ACL Entries 128

11. Management

- a. PoE: PoE system settings, port settings and status
- b. DHCP: Client Server, Option66/67/82, DHCP Relay
- c. Access: SNMP v1/v2c/v3, WEB, Telnet, RMON, Standard MIB-II, Private MIB, Ethernet-Like MIB, RMON MIB (Group 1, 2, 3, 9)
- d. Security Access: SSH2.0, SSL
- e. Software Upgrade: TFTP, SFTP, HTTP, Dual Image
- f. NTP: SNTP client

12. Power Supply

- a. Input Voltage: 88 VAC – 264 VAC, 60 Hz
- b. Output Voltage: 48VDC
- c. Rated Current: 2.5A
- d. Rated Power: 120W
- e. Peak Current: 3.75A
- f. Protection: Short circuit, overload, and over voltage, over temperature
- g. Air cooled
- h. Operating Temperature: -13°F to 158°F
- i. Ambient Relative Humidity: 5 to 95% (non-condensing)
- j. DIN rail TS-35/7.5 or 15
- k. LED indicator for power on
- l. DC OK relay contact

C. INSTALLATION

ITS Field Switch shall be installed at locations shown on the plans. Unless otherwise specified, the units shall be shelf-mounted in cabinets as indicated, for applicable connections to communications cable and equipment. Switches will be pre-programmed by City of Lincoln, Traffic Operations, with relevant SFP modules for installation. Proper power supplies shall also be installed on din rails and will be provided by City of Lincoln for contractor installation.

D. BASIS OF PAYMENT

ITS FIELD SWITCH, furnished, complete, in place, and accepted by the City's Project Personnel, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item only when called for. This price and payment shall be full compensation for furnishing and installing ITS Field Switch, all labor, equipment, tools, and incidentals necessary to complete the Work.

SEEDING AND SODDING

MATERIALS (GENERAL INFORMATION)

The "Chapter 30 – Seeding and Sodding" Standard Specification, Article 30.04 "Materials (General Information)", Section C "Sod (General)" shall be amended such that the Contractor will furnish only "Turf Type Tall Fescue" sod.

EROSION AND SEDIMENT CONTROL

SWPPP SIGN

SWPPP sign requirements will not be bid or paid for specific to the ROW Improvements project. It is anticipated that the Contractor will include all SWPPP sign costs elsewhere in the bid to cover all site and ROW work for the overall MMTC project.

APPENDIX

- A. CHAPTER 24 – TRAFFIC SIGNALS, ITS AND LIGHTING – APPROVED SPECIAL PROVISION 3-8-24
- B. CHAPTER 26 – COMMUNICATIONS – APPROVED SPECIAL PROVISION 3-8-24

CITY OF LINCOLN, NEBRASKA, STANDARD SPECIFICATIONS

CHAPTER 24

TRAFFIC SIGNALS, ITS AND LIGHTING

ARTICLE	TITLE	
24.00	GENERAL	2403
	A. STANDARDS	2403
	B. QUALIFIED PERSONNEL	2403
	C. MATERIAL TESTS	2403
	D. ELECTRICAL SERVICE APPLICATIONS	2404
	E. CITY FURNISHED MATERIALS	2404
	F. EXCAVATION AND BACKFILL	2405
	G. CONTRACTOR RESPONSIBILITY	2405
	H. GRADES	2406
	I. FOUNDATIONS AND BASES	2407
	J. DOWNTIME FOR TRAFFIC SIGNALS OR STREET LIGHTING	2408
	K. ENERGIZING OR DE-ENERGIZING TRAFFIC SIGNALS	2409
	L. ANTI-SEIZE COMPOUND	2409
	M. SUBSTANTIAL COMPLETION	2409
	N. INSPECTION COMPLETION	2410
	O. SIGNAL SUPPORT SPAN	2410
	P. RFID AND GIS INVENTORY UPDATE PROCEDURE	2410
24.01	REMOVE OR RELOCATE OR ADJUST	2411
	A. GENERAL	2411
	B. BASIS OF PAYMENT	2411
24.02	TEMPORARY TRAFFIC SIGNAL	2412
	A. GENERAL	2412
	B. BASIS OF PAYMENT	2412
24.03	CONDUIT	2413
	A. GENERAL	2413
	B. INSTALLATION	2413
	C. CONDUIT BORED	2415
	D. CONDUIT IN TRENCH	2416
	E. BASIS OF PAYMENT	2416
24.04	BLANK ON PURPOSE	2416
24.05	PULL BOXES	2417
	A. GENERAL	2417
	B. INSTALLATION	2417
	C. BASIS OF PAYMENT	2418
24.06	RISERS	2419
	A. GENERAL	2419
	B. INSTALLATION	2419
	C. BASIS OF PAYMENT	2419

CITY OF LINCOLN, NEBRASKA, STANDARD SPECIFICATIONS

CHAPTER 24

TRAFFIC SIGNALS, ITS AND LIGHTING

ARTICLE	TITLE	
24.07	ELECTRICAL METER PEDESTAL	2420
	A. GENERAL	2420
	B. INSTALLATION	2420
	C. BASIS OF PAYMENT	2420
24.08	STEEL POLES	2421
	A. GENERAL	2421
	B. STREET LIGHT POLES	2421
	C. FOUNDATIONS, POLES, AND MAST ARMS, AND LUMINAIRE ARMS	2423
	D. INSTALLATION	2429
	E. EMBEDDED STEEL POLE INSTALLATION	2430
	F. BASIS OF PAYMENT	2431
24.09	GROUND RODS	2432
	A. GENERAL	2432
	B. INSTALLATION	2432
	C. BASIS OF PAYMENT	2432
24.10	DETECTORS	2433
	A. GENERAL	2433
	B. LOOP DETECTORS	2433
	C. PEDESTRIAN PUSH BUTTONS	2434
	D. CAMERA DETECTOR	2435
	E. NON-INTRUSIVE DETECTOR	2435
	F. EMERGENCY DETECTOR	2435
	G. BASIS OF PAYMENT	2435
24.11	CABINETS	2436
	A. GENERAL	2436
	B. INSTALLATION	2436
	C. BASIS OF PAYMENT	2436
24.12	CABLE	2437
	A. TYPES AND CLASSES OF CABLE	2437
	B. INSTALLATION	2437
	C. SPLICES AND CONNECTIONS	2438
	D. LABELING	2440
	E. BASIS OF PAYMENT	2441
24.13	SIGNAL HEADS AND OVERHEAD SIGNS	2442
	A. GENERAL	2442
	B. INSTALLATION	2442
	C. BASIS OF PAYMENT	2443

CITY OF LINCOLN, NEBRASKA, STANDARD SPECIFICATIONS

CHAPTER 24

TRAFFIC SIGNALS, ITS AND LIGHTING

ARTICLE	TITLE	
24.14	STREET LIGHTING AND LUMINAIRES	2444
	A. GENERAL	2444
	B. MATERIAL AND DESIGN	2444
	C. LED STREET LUMINAIRE SPECIFICATIONS	2446
	D. INSTALLATION	2449
	E. BASIS OF PAYMENT	2450
24.15	CONCRETE POLES	2450
	A. GENERAL	2450
	B. INSTALLATION	2450
	C. BASIS OF PAYMENT	2450
24.16	BLANK ON PURPOSE	2451
24.17	BLANK ON PURPOSE	2451
24.18	WOOD POLES	2451
	A. GENERAL	2451
	B. INSTALLATION	2451
	C. BASIS OF PAYMENT	2451

CHAPTER 24

TRAFFIC SIGNALS, ITS AND LIGHTING

24.00 GENERAL

A. STANDARDS

Where NEMA Specifications are established, all electrical equipment shall conform to the standards of National Electrical Manufacturers Association (NEMA). In addition to the requirements of these Standard Specifications and the plans, all material and Work shall conform to the Standard Specifications of the following organizations: National Electric Safety Code (NESC); American Society for Testing and Materials (ASTM); American Standards Association (ASA); International Municipal Signal Association, Inc. (IMSA); Insulated Cable Engineers Association (ICEA); American Institute of Steel Construction (AISC); American Association of State Highway and Transportation Officials (AASHTO); Manual on Uniform Traffic Control Devices (MUTCD); and the ordinances of the City of Lincoln (City), insofar as they apply. Wherever reference is made in the Standard Specifications to the standard mentioned above, the reference shall be construed to mean the code or standard that is in effect on the date of advertising of the contract document.

Traffic Signal Poles shall reflect the 2013 AASHTO guidelines for pole design.

B. QUALIFIED PERSONNEL

A certified and qualified journeyman lineman shall be on the job site to supervise pulling of fiber, splicing of wire where permitted, and to perform the task of final connections in all signal indications, push buttons, detectors, cameras, dynamic message signs, and cabinets. The Contractor shall be IMSA Traffic Signal Construction Technician Level II certified. All workers on the job site shall have Work Zone Temporary Traffic Control certification. Proof of certification or license of individuals on job site shall be required at the pre-construction meeting.

C. MATERIAL TESTS

When any reference is made in the Standard Specifications to a standard, such as ASTM, ICEA, IMSA, etc., or a related Specification referred to by reference therein, which states that a certain test is to be made only at the request of the purchaser, it shall be considered that the City does request that such test be made. The tests shall be made at the Contractor's expense and a certified copy of each test shall be submitted to the City's Project Manager prior to the installation of such material.

Traffic Signal and/or Street Lighting poles require shop drawings and Manufacturer's certification of compliance. In the case of wood poles, the type, size, treatment, or certain unspecified situations shall require that in addition to the above, the Contractor furnish mill test data or design calculations.

The Contractor shall submit to the City's Project Manager 1 hard copy and 1 electronic (pdf) copy of a complete list of all equipment and materials they intend to install. Catalog cuts and/or Manufacturers model number shall be required for the materials furnished by the Contractor and incorporated into the project. There shall be no substitutes for any of the items on the list without prior written approval of the City's Project Manager.

24.00 GENERAL (Continued)

D. ELECTRICAL SERVICE APPLICATIONS

The Contractor shall make arrangements with Lincoln Electric System (LES) for power service. Any delay resulting from a Contractor's untimely request to the local utility for power service shall not be justification for the suspension or extension of the working days or calendar days on a project. Electrical services at the locations shown on the plans have been previously agreed to by the City and the Utility. The locations of all such services are subject to minor revisions in the field in order to adapt field requirements as may be determined by the Utility and the City's Project Manager.

E. CITY FURNISHED MATERIALS

The Work covered in this chapter shall include the furnishing of certain materials and equipment and the installation of all necessary materials and equipment to provide a traffic signal and/or a street light installation complete, in place and ready for operation; and/or the modification, removal or salvage of existing traffic signal and/or street light components or systems; in conformance with the plans and these Standard Specifications. When the item is furnished by the City the item of payment is prefaced by the word, "Install".

Furnished Traffic Signal Materials shall be picked up at Traffic Operations storage locations between 8:00 a.m. to 3:00 p.m. weekdays with 24-hour notice, with the exception of city holidays. Furnished Street Lighting materials shall be picked up at LES Storeroom at the Walter Canney Service Center at 27th and Fairfield Streets, between 7:30 a.m. to 4:00 p.m. weekdays, with the exception of holidays. Further direction may be required either by Special Provision or by the City's Project Manager. Refer to Section IV; "Control of Materials", Subsection E. "Materials Supplied By The City" of the General Provisions and Requirements for procedures to be followed in handling City-furnished materials and/or equipment.

RFID tags will be furnished by IS Broadband and can be picked up from IS Broadband or City project manager (Broadband will issue a bundle to Project delivery team for use on CIP projects). Please give a 24 hour notice and pick up times are between 7:30 a.m. and 4:00 p.m. weekdays with the exception of holidays. Each tag requires 2 concrete screws that are not provided for the installation.

The Contractor shall be responsible for all material or equipment furnished by the City from the time that it is picked up to the completion of work. The costs of damaged materials shall be deducted from the final payment.

The contractor shall take all precautions to protect the cabinet from damage including any concrete splatters, dents, scratches or any other damage as noted by the City's Project Manager. In the event of damage to the cabinet, the contractor shall remove the damaged cabinet and re-wire a new cabinet supplied by the City. The cost of the damaged cabinet shall be deducted from the final payment.

24.00 GENERAL (Continued)

E. CITY FURNISHED MATERIALS (Continued)

City traffic signal personnel shall be responsible for bench testing traffic signal cabinets to be installed by the Contractor, and shall field test each installed traffic signal cabinet prior to turn on. All other activities associated with the installation, including but not limited to, labor, materials, tools, and transportation are the responsibility of the Contractor.

The Contractor shall furnish all other materials, including, but not limited to concrete, epoxy coated reinforcing steel, conduit, pull boxes, cable, splice kits, messenger cable and hardware, pole clamps and hardware, risers, down guys, ground rods and clamps, traffic signal poles, street light poles, luminaires, and all other miscellaneous materials and/or hardware necessary to complete the Work in conformance with the Plans, Standard Specifications, or the Special Provisions.

F. EXCAVATION AND BACKFILL

Excavation for trenches, pull boxes or foundation removal shall be backfilled and compacted daily unless properly protected. All trenches for burial of electrical cable and conduit shall not exceed 6" in width.

All excavations shall be backfilled within 48 hours of excavation.

The first 4" of backfill for trenches shall consist of finely pulverized earth and shall contain no broken glass, rocks, or other sharp material that might damage the cable.

The remainder of the backfill material will normally be earth excavated from the trench unless such earth is water saturated or frozen. Backfill material shall be substantially dry, loose, clean earth free from rocks and debris. Excessively dry or excessively sandy material is not permitted.

Before backfilling, all standing water shall be removed from the trench. Tamping shall be done at no more than 12" backfill level intervals to ensure proper compaction throughout the depth of the void. The foot of the compressed air or hydraulic tamper to be used to compact the backfill shall be sized in conformance with the width of the trench. Hand tamping is not permitted. All excess backfill material shall be removed from the site within 48 hours.

G. CONTRACTOR RESPONSIBILITY

The Contractor is responsible to inform the City's Project Manager of any defect found in the existing electrical or communications systems. Such defects may include, but not be limited to existing improper splices or existing damaged cable or existing damaged conduit. The City's Project Manager and Contractor shall determine a plan and cost to correct said defect.

The Contractor is responsible to locate the signal system within the project area, until the final inspection is complete.

24.00 GENERAL (Continued)

H. GRADES

All work shall conform to line, elevation and grade as shown on the plans. If no grades are shown on the plans, the longitudinal grade for the improvement shall be the same as the grade of the top of the existing curb. If there is no curb, the longitudinal grade shall be considered as a straight line between points where elevations are shown on the plans.

The elevation of top of pull box and top of pole foundation shall be established according to conditions below. The elevation of the top of Cabinet Base shall be 3" above the grade listed unless the Cabinet Base is in the sidewalk, in which case it shall be at grade.

1. Existing curb with no sidewalk: The grade shall slope upward from the top of the back edge of the curb at the rate of 2%.
2. Existing curb with sidewalk: The grade shall be a straight line from the top of the back edge of the curb to the top of the curbside of the sidewalk.
3. Existing curb with adjoining sidewalk: The grade shall be the same as the grade of the top of the sidewalk.
4. If the lateral grade of the existing street exceeds 2.5%, the grade will be set by the City's Project Manager.

24.00 GENERAL (Continued)

I. FOUNDATIONS AND BASES

Foundations and bases shall be constructed and/or installed in conformance with Lincoln Standard Plans (LSPs) LSP 82 and 92, to the elevation as shown on the plans or directed by the City's Project Manager.

All foundations shall be poured within 48 hours of excavation.

Positioning of anchor bolts shall ensure that all access and relative position of the structure and its components are in the position shown on the project plans. Anchor bolts shall be set so that 2 bolts are placed in tension and 2 in compression.

Foundations and Bases will not be measured for payment separately, but are considered subsidiary to the installation or relocation of poles or traffic signal cabinets.

1. Reinforced Concrete

Forms shall be firmly braced and secured in place. Forms shall not be removed until the concrete has set, and at no time shall they be removed within 12 hours after the concrete has been placed.

Prior to pole and cabinet installation, anchor bolts and foundation holes shall be barricaded or suitably enclosed to protect the public from possible injury.

All reinforcement bars for concrete reinforcement shall be epoxy coated, Grade 40 or Grade 60 steel and shall conform to the requirements of "Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement", ASTM Designation A615, or "Standard Specifications for Raw Steel and Axle-Steel Deformed Bars for Concrete Reinforcement", ASTM Designation A 996. Bars shall be free from excess rust, scale or other substances which prevent the bonding of concrete to the reinforcement.

There shall, in all cases, be at least 3" of concrete between anchor bolts and epoxy coated steel reinforcing members at any edge of foundation or base.

No foundation or base shall be poured until they are free of water or debris including trash. The bottom of the foundations and bases shall rest securely on firm undisturbed ground. Both forms and excavations shall be thoroughly wet before placing concrete. An Observer shall be present for the pouring of all traffic signal foundations and bases. The Project Manager shall be contacted 24 hours in advance of the pour. Any foundations poured without the Observer present shall be subject to removal and replacement at the Contractor's expense.

The foundations and bases shall be L3500 concrete, poured monolithically and consolidated with a mechanical vibrator as it is placed, from the bottom to the top, in the form. No floating of steel allowed. The top and any exposed portion of the foundation or base shall be troweled smooth, true and level.

Anchor bolts shall protrude within the range shown on LSP 82 with the nuts and threads covered to protect them during pouring.

Grinding concrete to form a chamfer shall not be permitted.

24.00 GENERAL (Continued)

I. FOUNDATIONS AND BASES (Continued)

1. Reinforced Concrete (Continued)

After the foundation or base has been poured, no modification shall be made. If the anchor bolts, conduit, or any part of the foundation or base are installed in an incorrect manner, as determined by the City's Project Manager, the entire foundation or base shall be removed and a new foundation or base installed. The Contractor shall bear all costs of replacing work, including cost of anchor bolts, deemed unsatisfactory by the City's Project Manager.

Pole shafts shall not be set on the foundations until the concrete has achieved a compressive strength of 2500 psi or an age of 72 hours. Mast arms shall not be installed until the concrete has achieved a compressive strength of 3000 psi or an age of 7 days.

2. Power Installed Foundation

The Power Installed Foundation shall be of the size required by the luminaire mounting height as shown on LSP 92.

The Power Installed Foundation is not to be used in fill areas or where the soil bearing strength is less than 1,500 pounds per square foot or on slopes in excess of 5%.

Power Installed Foundations shall be installed in conformance with the manufacturer's instructions. The foundation shall be installed with its axis plumb. Cable entrance shall be parallel to the street unless indicated otherwise in the plans or directed by the City's Project Manager. Trenches for conduit or cable shall be as narrow as practical, but in no case shall the trench width exceed the diameter of the foundation shaft.

J. DOWNTIME FOR TRAFFIC SIGNALS OR STREET LIGHTING

When the described Work includes any task that renders the existing traffic signal system inoperable, the downtime necessary shall be coordinated with and approved by the City of Lincoln Traffic Engineering Division and the City Project Manager.

There shall be No night time disruption to existing street lighting at any time during the project. Any street light disruption shall be restored to full operation prior to other project work commencing.

24.00 GENERAL (Continued)

K. ENERGIZING OR DE-ENERGIZING TRAFFIC SIGNALS

It is the intent of this Standard Specification to minimize interruption to both vehicular and pedestrian traffic and activities in the area adjacent to the described Work.

A Traffic Signal or Pedestrian Signal shall only be turned off by City personnel.

The Contractor is responsible for contacting LES, to have LES energize or de-energize any Street Light Cable or energize Service Cable for Traffic Signal Equipment. Under no circumstance shall the contractor open any LES locked facilities, such as a Transformer or Pedestal.

Prior to a new or rebuilt signal being turned on, in flashing or permanent operation, the Contractor shall have completed all non-LES splices; including signal display, detection, power, pre-emption, and flash testing of the completed installation.

The Work shall be planned such that the City Traffic Engineering personnel are notified 48 hours prior to placing the signal in flash. In cases where multiple signals are involved, 48 hours for the first signal and 24 hours per additional signal shall be provided. Signal turn-ons shall occur between 9:00 a.m. and 2:00 p.m., Monday through Thursday.

New signalized locations shall be placed in pre-determined flashing operation for a minimum of 7 days, with the exception of new streets.

L. ANTI-SEIZE COMPOUND

The Contractor shall use an approved anti-seize compound everywhere metal screws into, onto or against metal.

M. SUBSTANTIAL COMPLETION

The traffic signal and/or street lighting portion of projects shall not be considered substantially complete until all items shown on the design plans or called for in any contract document are completed to the satisfaction of Traffic Engineering, excluding seed/sod if outside planting season. This substantial completion shall include all street lighting and communications systems components and the submittal of completed AS BUILT plans. The Contractor is responsible for identifying any changes in the construction from the original plans so that updated information can be documented in AS BUILT plans. The system shall be fully operational in conformance with the project plans, City of Lincoln Standard Specifications, and any special provisions.

Liquidated damages shall continue to accrue until such time as the Work is deemed to be substantially completed by Traffic Engineering.

24.00 GENERAL (Continued)

N. INSPECTION COMPLETION

Prior to the start of inspection, 1 hard copy and 1 electronic copy of as-built plans shall be provided to the City. These as-built drawings shall be labeled "AS BUILT", with the Contractors initials and date, as well as the pull box and conduit inventory information updated in GIS as part of the RFID pull box inventory process (See section P below).

Upon completion of a fully operational traffic signal, ITS, lighting, and communications system, and submittal of AS BUILT plans, an inspection shall be completed by the City. The Contractor shall correct any items as listed on the inspection forms, return inspection forms back to City, and correct any subsequent deficiencies identified by inspections until City accepts all work. The number of allowable calendar days, including the inspection process, and any associated liquidated damages shall be defined in the project contract documents.

O. SIGNAL SUPPORT SPAN

Span wire shall be 3/8", galvanized, 7 strand, high-strength grade steel wire strand. Signal support span wire shall, in all cases, have a minimum strength capable of supporting the maximum load to which they may be subjected. Tie wire shall be 1/4" diameter high-strength grade steel wire strand. Tie wire installed for any one span wire mounted location shall be the same diameter for all tie wire spans. Span wire and tie wire shall conform to the requirements of "Standard Specifications for Zinc-Coated Steel Wire Strand", ASTM Designation A-475.

All ferrous metal line hardware items shall be galvanized and shall conform to the requirements of "Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware", ASTM Designation A153. All hardware items shall have a minimum strength capable of supporting the maximum load to which they may be subjected.

Pole clamps used for signal support spans and messenger cable shall be installed in such a manner to prevent any rubbing or strain of the cable clamp against the pole clamp or its connecting bolt. 4 piece (90° separation) clamps shall be used.

Span wire shall be installed with 5% sag, +/- 1%, with traffic signals installed, and shall be adjusted on the poles so as to provide the proper mounting height indicated on the plans.

Tie wires shall be pulled snug to stabilize the traffic signal heads, but shall not support any of their weight. A tie wire safety link as described on the plans furnished by the City and installed by the Contractor shall be placed between the pole band and tie wire. Under no circumstances shall the tie wire be utilized to plumb poles.

P. RFID AND GIS INVENTORY UPDATE PROCEDURE

1. RFID tag will be provided by City IS Broadband and installed in the pull box as described in LSP 81 (Each tag will require 2- 1.25" concrete screw and will be subsidiary to a pull box).
2. Pull box inventory shall be done electronically as described in the "Vault Audit Quick Reference Guide". A quick reference sheet will be given out with RFID tags that are picked up.

24.01 REMOVE OR RELOCATE OR ADJUST

A. GENERAL

Existing traffic signal and/or street light components or systems shall be removed, relocated or adjusted in conformance with the plans and these Standard Specifications. All bases and foundations shall be removed completely. All poles or components indicated to be removed shall become the property of the Contractor except as noted on the plans or by the Special Provisions. Equipment designated for return shall be returned to the location shown on the plans. Retained equipment and material shall be protected to prevent damage. The cost of damaged equipment or materials shall be deducted from the final payment. The excavation remaining after the removal of an item from below grade shall be backfilled in conformance with Chapter 20 of these Standard Specifications.

B. BASIS OF PAYMENT

1. Remove

REMOVE (Rem) _____, completely removed and accepted by Traffic Engineering, shall be measured for payment as single units, except cable as linear feet and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for removing and disposal of all materials; removal of existing foundation, existing luminaire, ground rod or existing base, for all excavation and backfill; for the return of equipment designated for return and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work in conformance with the plans and these Standard Specifications.

2. Relocate

RELOCATE (Rel) _____, complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units, except cable as linear feet and shall be paid for at the contract unit price bid per each for the item. Relocate Poles and Cabinets includes removal of existing foundation or base, existing luminaire, excavation and backfill; new foundation or base and contractor supplied concrete, conduit stub-out, epoxy coated reinforcing steel, power installed foundations, pole setting foam, ground rods and anchor bolts. This price and payment shall be full compensation for all removal from original position and installation to proposed position, and for all labor, equipment, tools, materials, storage, and incidentals necessary to complete the Work in conformance with the plans and these Standard Specifications. Clamp Kit shall be provided by City if needed.

3. Adjust

ADJUST (Adj) _____, complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for all adjustments from the original position, orientation and installation to the proposed position, excavation and backfill; and for all labor, equipment, tools, materials, storage, and incidentals necessary to complete the Work in conformance with the plans and these Standard Specifications. Clamp Kit shall be provided by City if needed.

24.02 TEMPORARY TRAFFIC SIGNAL

A. GENERAL

Temporary traffic signal systems shall be installed as called for in the project contract documents. The City shall furnish the Contractor with traffic signal and pedestrian signal heads, traffic signal cabinet, luminaires, overhead signs, detectors and assemblies, complete with the correct hardware for the application, such as, hanger assembly and tether for span wire installation. All other materials shall be furnished and installed by the Contractor, unless otherwise noted.

The Contractor shall make arrangements with LES for power service for the temporary signals. Any delay resulting from a Contractor's untimely request to the Utility for temporary power service shall not be justification for the suspension or adjustment of the calendar days on a project. The Contractor shall be responsible for the utility costs to install or relocate the power service.

When the Temporary Traffic Signal is approved for removal by the City of Lincoln, the Contractor shall remove the traffic signal and return furnished materials to the City. The cost of the damaged material shall be deducted from the final payment.

B. BASIS OF PAYMENT

INSTALL AND REMOVE TEMPORARY _____, complete, in place, removed and accepted by Traffic Engineering, shall be measured as a single unit and shall be paid for at the contract unit price per each system. This price and payment shall be full compensation for furnishing all materials not furnished by the City, installing all materials, connecting, maintaining, and removing the temporary signal system, salvaging requested items from the temporary signal, and for all labor, equipment, tools, materials, excavation, and incidentals required to complete the Work.

24.03 CONDUIT

A. GENERAL

Conduit used for cable runs shall be rigid polyvinyl chloride (PVC) conforming to Underwriters Laboratories (UL) "Standard for Safety" UL-651, or in the case of HDPE, ribbed or smooth wall. Conduits for Fiber Optic Cable installation shall be orange and conduits for Electrical shall be black/gray.

1. Rigid Polyvinyl Chloride (PVC) Conduit, Schedule 40

Standard plastic couplings must be used to join conduit ends. The conduit may be formed or bent by warming until it is flexible and pliable enough to work easily. Wrinkles or buckling will not be permitted. Conduit must not be heated to the point of deterioration or damaging the material.

2. High Density Polyethylene (HDPE) Conduit, Schedule 40

All HDPE conduit shall have a tensile strength of 4000 psi. Either smooth wall or ribbed types are acceptable for traffic signal applications. All street light applications shall use smooth wall.

3. Main Line Conduit Group (MLCG), ASTM D 1248 Type III Class C, Grade P33, Category 5, SDR 11 unless otherwise specified in the Plans.

All Main Line Conduit Group shall consist of (6) 1-1/4" High-density polyethylene (HDPE) conduits in conformance with the requirements of NEMA TC7. Conduit shall be smooth wall coilduct meeting the requirements of ASTM D 1248 Type III Class C, Grade P33, Category 5, SDR 11 (direct bury), SDR 13.5 (installed within other conduits), SDR 15 (if allowed on specific project plans), unless otherwise specified in the Plans.

B. INSTALLATION

Electric (Street Light Only) Conduit shall be placed at a depth of 2'-6". Traffic Signal Conduit shall be placed at a depth of 3'-6". Fiber Optic Conduit shall be placed at a depth of 4'-6".

The routing of conduit as shown in the plans indicates, the location and direction of the conduit runs. If, due to obstructions or certain other field conditions encountered during construction, it is necessary to depart from the routing shown, Traffic Engineering will determine the new location in the field.

Conduits shall be secured in their permanent positions during the pouring and curing of the foundation or base or placement of rock in pull boxes. The installation of transformer base-type poles requires that the conduits shall be placed as near the door opening as possible.

Conduits terminating in pull boxes shall be routed under the pull box and cut parallel to the pull box lid (See LSP 81).

The individual conduits in the MLCG shall be bound together as one with a hose clamp at the bottom of the pull box line (See LSP 81).

A continuous length of polypropylene, 200-pound pull string shall be placed in City designated fiber conduit with 10' extra neatly secured at each end.

A continuous Fiber Locate Cable shall be placed in City designated fiber conduit (See LSP 81).

24.03 CONDUIT (Continued)

B. INSTALLATION (Continued)

The Contractor shall use 90° factory sweeps, with a 48" radius, in controller bases, the home run pull box (first electrical pull box to the cabinet) and in fiber pull boxes; in all other cases, the Contractor shall use 90° factory bends with a 16" minimum radius.

All joints and terminations shall be made in conformance with the manufacturer's instructions and good practice. Joints shall be watertight and mechanically sound. The conduit shall not contain debris or other foreign matter and shall have a constant circular cross-sectional area.

For communication system conduits, any fiber conduit entering the bottom of fiber pull boxes shall be located in the near right side corner of the box, as you approach, at least 6" from the side and end walls. The conduit shall be sloped towards the top far edge of the box to facilitate pulling of the cables. In applications where MLCG is utilized, the conduits shall be hose clamped together, 6" from the end of the conduits. The hose clamps shall be installed prior to rock backfill in the pull box. When long radius sweeps are needed to bring the MLCG into a pull box, a compression coupling capable of providing a watertight connection in buried or restrained applications shall be used. In the unusual event that the MLCG is shallow MLCG penetrations into the side wall of pull boxes shall be made using single conduit knockouts or cored entrances, this is also only allowed on retrofitting existing conduit not on newly installed conduit.

In special cases, only approved by Traffic Engineering, conduits entering through the side wall of pull box shall be located a minimum of 4" above and maximum 8" above the floor, 4" away from the pull box corner and shall extend 4" inside the box wall. The void between the knockout and the conduit shall be filled with mastic to form a watertight seal. This is only allowed on retrofitting existing conduit, not on newly installed conduit.

Excavation for trenches shall be backfilled and compacted daily unless properly protected. All excavations shall be backfilled within 48 hours of excavation. Any excavation required to be open longer than 48 hours will need approval by Traffic Engineering. The first 4" of backfill for trenches shall consist of finely pulverized earth and shall contain no broken glass, rocks, or other sharp material that might damage the conduit. The remainder of the backfill material will normally be earth excavated from the trench unless such earth is water saturated or frozen. Backfill material shall be substantially dry, loose, clean earth free from rocks and debris. Excessively dry or excessively sandy material is not permitted. Before backfilling, all standing water shall be removed from the trench. Tamping shall be done at no more than 12" backfill level intervals to ensure proper compaction throughout the depth of the void. Hand tamping is not permitted. All excess backfill material shall be removed promptly from the site.

24.03 CONDUIT (Continued)

C. CONDUIT BORED

When shown on the plans the jacking or directional boring of conduit is to be done with equipment designed and designated for that purpose or other approved methods where a constant pressure can be applied and controlled, and in conformance with approved procedures.

Pavement shall not be disturbed without the approval of the City's Project Manager. Jacking or directional boring shall be kept 24" from the edge of any type of pavement wherever possible. Excessive use of water which might undermine pavement or soften sub grade will not be permitted.

Determine all utility locations near the path of the proposed pushed (bore) conduit, including depth. Use this information to avoid damage to utilities and/or facilities within the work area. Provide this information, including the sources, to the City's Project Manager a minimum of five working days prior to boring. Do not bore until the City's Project Manager approves that submittal.

Prior to boring, expose all utilities for which it is customary and safe to do so.

The diameter of the drilled hole shall conform to the outside diameter of the conduit as closely as practical. Pressure grout as directed by Traffic Engineering, to fill any voids, which develop during the installation operation. Remove and replace any conduit damaged in directional drilling operations at no expense to the project.

Conduit logs detailing bore depth shall be presented to the City after all boring operations. Conduit logs shall include as built drawings of conduit and GPS location measurements of all pull box lids accurate to 10 digits. All conduit logs shall be electronic and of a format approved by the City of Lincoln.

Repairs to conduit shall use a coupling capable of providing a watertight/airtight connection in buried or restrained applications.

The use of water and other fluids in connection with the drilling operation will be permitted only to the extent necessary to lubricate cuttings. Jetting will not be permitted, and the use of water alone as a drilling fluid will not be permitted. Use a drilling fluid/slurry consisting of at least 10% high grade, processed Bentonite to consolidate excavated material, seal the walls of the hole, and furnish lubrication for subsequent removal of material and immediate installation of the pipe.

Provide a means of collecting and containing drilling fluid/slurry that returns to the surface, such as slurry pit, or a method approved by Traffic Engineering. Provide measures to prevent drilling fluids from entering storm sewer systems. Prevent drilling fluid/slurry from accumulating on or flowing onto sidewalks, other pedestrian walkways, driveways, or streets. Immediately remove any slurry that is inadvertently deposited on pedestrian walkways. Transport waste drilling slurry from the site and dispose of it. Do not allow slurry to enter wetlands. Protect wetlands using appropriate soil erosion control measures approved by Traffic Engineering.

24.03 CONDUIT (Continued)

C. CONDUIT BORED (Continued)

Boring fluid shall be appropriate for soil conditions. Waste oil and/or environmentally non-compatible polymers shall not be part of the drill fluid composition. Used boring fluid shall be properly, and legally, disposed of.

The contractor shall continuously monitor boring operations for possible frac-out of drill fluid. Any frac-out or surface uplifting shall be contained, cleaned up, and repaired.

Use a digital walkover locating system to track the drill head during the bore. At minimum, the locating system shall be capable of determining the pitch, roll, heading, depth, and horizontal position of the drill head at any point along the bore. During each drilling operation, locate the drill head every 10' along the bore and prior to crossing any underground utility or structure. Upon completion of the drilling operation and conduit installation, furnish the City's Project Manager with an as-built profile drawing and plan drawing for the drilled conduit showing the horizontal and vertical locations of the installed conduit.

D. CONDUIT IN TRENCH

Conduit in trench shall mean conduit which is directly buried in earth and shall be installed in suitable trenches in conformance with 24.00.F.

E. BASIS OF PAYMENT

CONDUIT, ____", BORED; CONDUIT, MAIN LINE GROUP BORED; CONDUIT, ____", TRENCHED; and CONDUIT, MAIN LINE GROUP TRENCHED, complete, in place and accepted by Traffic Engineering, shall be measured as lineal feet from and to centers of pull boxes, cabinets, and poles and shall be paid for at the contract unit price bid per linear feet for the conduit. This price and payment shall be full compensation for all excavation required; pulling string (in City fiber conduit), fiber locate cable (in City fiber conduit), conduit caps, hose clamps, backfilling and compacting; RFID tag installation and GIS inventorying; and for all labor, equipment, tools, materials, and incidentals required to complete the Work.

Pulling String and Fiber Locate Cable are subsidiary to City communication conduits. The installation of conduit stub outs for Traffic conduit only, not allowed for communication conduits as called for on the plans, including necessary couplings, elbows, sweeps and bends shall be considered part of those items for which payment is made and shall not be measured separately.

24.04 BLANK ON PURPOSE

24.05 PULL BOXES

A. GENERAL

Pull boxes, T6, T9, TR27, T36, T48, T60 and their lid are required to conform to all test provisions of ANSI/SCTE 77 "Specifications for Underground Enclosure Integrity" Tier 15 and labeled as such inside the pull box and on the top of the lid. All lids are required to have a minimum coefficient of friction of 0.5 in conformance with ASTM C1028. Independent third-party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this Standard Specification have been met are required with each submittal. Pull Box, T48 shall have a split lid (2-piece).

Pull box shapes and nominal dimensions shall conform to LSP 81.

Pull box lids shall also be labeled "ELECTRIC", "TRAFFIC", or "FIBER" on top as indicated on the Plans.

B. INSTALLATION

Pull boxes shall be installed at the locations shown on the plans.

The excavation for the pull box, T6 and T9 shall extend at least 12" below the bottom and 6" beyond the sides of the pull box. The pull box shall rest firmly on an aggregate base, meeting all of the requirements of coarse aggregate for concrete as described in Chapter 3 of the City of Lincoln Specifications.

Pull Boxes T6 and T9 shall have aggregate base that extends 12" below the bottom and at least 6" beyond the outside edges of the pull box. In addition, the aggregate base shall extend 6" up on the outer sides of the pull box, measured from the bottom of the box. The aggregate base shall be placed in 6" lifts and compacted with mechanical or hand methods to the satisfaction of Traffic Engineering. See LSP 81 for aggregate placement detail.

The remaining excavation shall be backfilled with soil and shall meet the requirements for backfill in Chapter 20 of the City of Lincoln Specifications.

The excavation for the pull box, TR27, T48, and T60 shall extend at least 12" below the bottom and 12" beyond the sides of the pull box. The pull box shall rest firmly on an aggregate base, meeting all of the requirements of coarse aggregate for concrete as described in Chapter 3 of the City of Lincoln Specifications.

Pull Boxes TR27, T48, and T60 shall have aggregate base that extends 12" below the bottom and at least 12" beyond the outside edges of the pull box. In addition, the aggregate base shall extend 12" up on the outer sides of the pull box, measured from the bottom of the box. The aggregate base shall be placed in 6" lifts and compacted with mechanical or hand methods to the satisfaction of Traffic Engineering. See LSP 81 for aggregate placement detail.

The remaining excavation shall be backfilled with soil and shall meet the requirements for backfill in Chapter 20 of the City of Lincoln Specifications.

Pull boxes shall not be placed in concrete unless specifically indicated on the plans or otherwise directed by Traffic Engineering.

Do not install pull box lid bolts.

Pull box edges, lid and lifting eye shall be kept clear of concrete and foreign material.

24.05 PULL BOXES (Continued)

C. BASIS OF PAYMENT

PULL BOX, _____, complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units for each type and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for all excavation required; for furnishing and installing the pull box and lid; for conduit, conduit bends or long radius sweeps and aggregate base; RFID tag and GIS inventorying; and for all labor, equipment, tools, materials, and incidentals required to complete the work.

24.06 RISERS

A. GENERAL

A riser is a conduit vertically attached to a pole or a building used to hold cable. The riser shall be Galvanized Rigid Steel (GRS) conforming to the UL "Standard for Safety" UL-6 and PVC, Schedule 40, conforming to UL "Standard for Safety: UL-651.

B. INSTALLATION

All risers shall be the size specified in the plans, at the location shown on the plans. The riser shall be GRS a full 10' from grade up without joints, installed on standoffs and grounded. Risers mounted on the side of building shall be located as close to any existing underground network riser as is practical in a manner acceptable to Traffic Engineering. The steel portion of the conduit riser shall be grounded at the top.

All pole risers shall be on standoff brackets provided by LES. These can be picked up at the LES store room. See 24.00.E for location and hours. See LSP 83 for spacing detail.

LES is to build the Riser above the 10' of GRS and provide the cable to the meter when a meter is required. If there is no meter, then the contractor is to build the riser to its needed height and provide the cables, including enough cable for LES to energize.

The bottom 3' of service risers installed on buildings shall be encased in concrete not less than 3" in thickness. Concrete shall be L3500 conforming to the requirements of Chapter 3 of these Standard Specifications.

C. BASIS OF PAYMENT

RISER, _____", complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units for the various sizes and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for all excavation required; for furnishing and installing the riser; for picking up and installing standoff, provided by LES installation, for conduit pipe clamps, ground wire, ground rod, concrete encasement, steel riser guards, meter socket, and incidentals are considered part of the riser assembly.

24.07 ELECTRICAL METER PEDESTAL

A. GENERAL

When placing an Electrical Meter Pedestal, the Contractor shall supply the pedestal. LES shall furnish and install KWH meter, cable from source to the meter and the upper part of the riser, when applicable. Metallic pedestals shall be bonded to the service neutral. A ground rod shall be installed at the pedestal and bonded to the service neutral. Meter socket shall be ring style. Meter socket is to have lugs to receive a 120/240 volts single phase 3 wire service.

B. INSTALLATION

Meter Pedestals shall be installed at the locations shown on the plans. See LSP 83 for installation detail.

C. BASIS OF PAYMENT

ELECTRICAL METER PEDESTAL, complete, in place and accepted by Traffic Engineering, shall be measured as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for the excavation and backfilling required, for furnishing and installing the pedestal, ground rod; for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

24.08 STEEL POLES

A. GENERAL

Street Light Pole Standard Specifications are found on LSP 92. Pedestal Pole Standard Specifications are found on LSP 90.

B. STREET LIGHT POLES

1. General

Poles shall conform in detail to the requirements set forth in this Standard Specification and as shown on the plans. Each pole shall consist of a steel shaft, grounding terminal, wire inlet, hand hole and handhole cover.

The following criteria shall be evaluated when designing these poles:

- a. Total weight of each luminaire - 40 pounds. Effective projected area for each luminaire shall be 1.4 square feet.
- b. Wind loads (gust factor of 104 MPH) shall be 23.5 pounds per square foot on all supported surfaces including projected area of luminaires, sign surface area of 8 square feet, and pole sections.
- c. Ice loads (unit weight of ice equal to 56 pounds per cubic foot) shall be assumed to be 1" of ice on the horizontal projection of all exposed surfaces including sign surface area of 8 square feet. A 1/2" radial ice coating shall be assumed on the vertical projection of all exposed surfaces.

2. Shaft

The shaft shall be of steel and shall be a continuously tapered tube fabricated from not less than No. 11 manufacturer's gauge thickness, best grade steel. The shaft shall have only 1 longitudinal welded joint and shall be free of intermediate horizontal joints or welds. Only 1 length of sheet steel shall be used which shall be formed into a continuously tapered shaft having a taper of approximately 0.14" per foot. The shaft shall then be cold rolled under enough pressure to flatten the weld and increase the physical characteristics of the shaft so that the metal will have a minimum guaranteed yield strength of 48,000 psi.

The cold rolling process shall form a round shaft with a top outside diameter of approximately 3". A 3" x 5" handhole with removable cover plate shall be centered approximately 18" above the ground line of the pole.

A grounding nut for accommodating a 1/2" 13 UNC threaded bolt shall be provided on the inside of the shaft so as to be easily accessible from the handhole opening.

The overall length of the shaft shall be such that the luminaire specified has its light center located per plan mounting height above the ground when mounted on the pole with the base of the pole to be a minimum of 4' below grade, when pole is embedded.

A wire opening with a minimum diameter of 1 1/2" shall be provided in the shaft. It shall be a grommeted, smooth surface opening to prevent damage to wire being drawn through the hole. The opening shall be approximately 24" below the ground line.

24.08 STEEL POLES (Continued)

B. STREET LIGHT POLES (Continued)

3. Pole Finish

After all welds have been completed on the pole shaft and arm, all parts shall be thoroughly cleaned of all loose scale and other foreign material and hot dip galvanized at the factory.

If painting is required as part of the project, after all welds have been completed on the pole shaft and arm, all parts shall be thoroughly cleaned of all loose scale and other foreign material and hot dip galvanized, then powder coated to specified paint color at the factory.

Care is to be taken during shipping and installation to protect the finish from any cuts or scrapes.

4. Modifications

The Contractor shall submit to the City's Project Manager for approval the name of the manufacturer and the type of pole he proposes to furnish. The Contractor or his representatives shall make no field modifications on any pole, or part thereof, without the written permission of the City's Project Manager.

Modifications shall be construed to mean any drilling, filing, tapping, cutting, bending, or any other operation that will change the physical, mechanical, or architectural qualities of the pole.

5. Festoon Outlet

Festoon outlet shall be wired with No 10 USE and fused at 2 amps at the base of the pole. Outlet covers shall be continuous use metal outlet covers.

24.08 STEEL POLES (Continued)

C. FOUNDATIONS, POLES, AND MAST ARMS, AND LUMINAIRE ARMS

1. GENERAL

This work includes furnishing and installing mast arm poles, combination mast arm/lighting poles, and all miscellaneous items as indicated in the Contract Documents.

Street Light Pole Standard Specifications are found on LSP 92. Pedestal Pole Standard Specifications are found on LSP 90.

2. DESIGN CRITERIA

Mast arm poles, combination mast arm / lighting poles, shall be galvanized steel or aluminum structures designed in accordance with the 2013 AASHTO Specifications for the Design and Construction of Structural Supports for Highway Signs, Luminaires and Traffic Signals, 6th Edition. A Structural Engineer currently licensed to practice in the State of Nebraska shall seal all designs. The design wind velocity shall be ninety (90) miles per hour.

The following design factors shall be used in the design of mast arm pole and combination mast arm / lighting poles:

- Wind Speed: 90 mph wind speed. (AASHTO Section 3.8.2, Figure 3.8.3)
- Wind Recurrence Intervals: 50 year recurrence interval. (AASHTO Section 3.8.3)
- Unreinforced & Reinforced Holes and Cutouts: Design structure unreinforced and reinforced holes to conform to section 5.14.6 (AASHTO Section 5.14.6)
- Fatigue Category: Fatigue Category 2 (AASHTO Section 11.6)
- Galloping Loads: Structure shall not be designed to resist galloping-induced cyclic loads.
- Natural Wind Gust: Structure shall be designed to resist a natural wind gust load of 11.2 mph, based on the yearly mean wind velocity. (AASHTO Section 11.7.1.2)
- Truck Loads: Structure shall not be designed to resist truck-induced gust loads. (AASHTO Section 11.7.1.3)

Design structures to support the required signal heads, lighting systems, signal and lighting cables, signage, other required items, and ten (10) pounds of ice per linear foot per tube for the location and span indicated in the Contract Documents. Use the area of the signs shown or as noted on the Contract Documents for the design calculations. Design all metal poles to support a twelve (12) foot luminaire arm and forty (40) pound luminaire. Once selected, use the same design patterns, materials, and basic member shape throughout the project unless otherwise indicated in the Contract Documents. Design mast arms to support the required signal or luminaire load and required signal and lighting cables. The maximum design wind velocity shall be ninety (90) miles per hour after installation.

24.08 STEEL POLES (Continued)

C. FOUNDATIONS, POLES, AND MAST ARMS, AND LUMINAIRE ARMS (Continued)

3. METAL POLES

Metal poles shall consist of a round, tapered pole shaft of galvanized steel fabricated in accordance with the Contract Documents. Metal poles shall have one (1) longitudinal automatic electric weld. After forming, flatten the weld. Steel shall be in accordance with ASTM A595, Standard Specification for Steel Tubes, Low Carbon, Tapered for Structural Use. Incorporate a lifting U-hook at the top of the shaft. The U-hook shall support the weight of the entire pole.

The pole shall be continuous from the base to the height necessary for luminaire arm attachment as indicated in the Contract Documents.

The pole manufacturer shall state the amount of pole rake necessary for the pole to set plumb under the required loading after installation. The manufacturer shall certify that the metal pole(s) and hardware meet the strength requirements for the anticipated loading. Secure a one (1) piece galvanized steel anchor base of adequate strength, shape, and size to the lower end of the shaft using two (2) continuous electric arc welds. The base shall telescope the shaft of the pole. Locate one (1) weld outside the base at the joint between the base top and the pole shaft.

Furnish all hardware necessary to complete the metal pole assembly in accordance with the pole manufacturer's instructions. Hardware shall include, but not be limited to, bolts, nuts, washers, removable pole tops, anchor bolts, anchor bolt covers, and transformer bases. Galvanize all exposed metal hardware. Removable pole tops shall consist of a galvanized positioning cap screw and galvanized pole cap. Furnish one (1) rubber grommet of one (1) inch inside diameter for each signal arm mounting location. Galvanizing shall be in accordance with ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

4. ANCHOR BOLTS

Anchor bolts shall be in accordance with ASTM F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength, and the Contract Documents. The manufacturer shall certify that the anchor bolts meet the strength requirements for the anticipated loading of the pole(s). The minimum yield strength shall be fifty-five thousand (55,000) psi. Thread the bolts a sufficient length to allow for proper installation.

Threads shall be full and sounds. Galvanize all exposed portions of the anchor bolt. Supply two (2) galvanized hexagon nuts and two (2) galvanized flat washers with each anchor bolt. Galvanizing shall be in accordance with ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

24.08 STEEL POLES (Continued)

C. FOUNDATIONS, POLES, AND MAST ARMS, AND LUMINAIRE ARMS (Continued)

5. MAST ARMS

Steel shall be in accordance with ASTM A595, Standard Specifications for Steel Tubes, Low Carbon, Tapered for Structural Use or ASTM 572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel. Galvanizing shall be in accordance with ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products. Mast arms shall consist of galvanized steel shaft with a mounting device suitable for attaching the arm at the height specified in the Contract Documents. Mast arms less than fifty-five (55) feet shall be one (1) piece arms. Mast arms fifty-five (55) feet or longer may be one (1) or two (2) piece arms. The mast arm mounting shall be structurally sound and neat in appearance. The mast arm shall be field adjustable or provide a minimum of two (2) and the maximum of four (4) degree rise.

Supply a mast arm cap for the free end of the mast arm. Furnish one (1) rubber grommet of one (1) inch inside diameter for each signal mounting location. The manufacturer shall certify that the mast arm(s) meet the strength requirements for the anticipated loading.

6. LUMINAIRE ARMS

Luminaire arms shall consist of the galvanized steel shaft with a mounting device suitable for attaching the arm at the height specified. Steel shall meet the requirements for two (2) inch Grade A or Schedule 40 pipe in accordance with ASTM A53, Standard Specification for Pipe, Steel, Zinc (Hot-Dip Galvanized) Coated, Welded and Seamless. The mounting shall be structurally sound and neat in appearance. The mating arm and pole steel simplex attachments shall meet the requirements for Grade 65-35 steel castings in accordance with ASTM A27, Standard Specifications for Steel Castings, Carbon, for General Applications.

Channel scrolls shall be one and one-half (1 ½) inch by one-eighth (1/8) inch commercial grade steel the manufacturer shall certify the luminaire arm(s) meet the strength requirements for the anticipated loading.

Unless otherwise indicated in the Contract Documents, Lincoln Electric System (LES) shall supply the luminaire(s).

7. GROUT

Grout shall be non-shrinking and non-rusting and comply with the requirements for Grade A Pre-Hardening Volume-Adjusting Grout in accordance with ASTM C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout.

8. ANCHORS AND ANCHOR RODS

Anchors shall be three-way (3-way) expanding malleable iron anchors having a minimum diameter of eight (8) inches. Malleable iron shall be in accordance with ASTM A47, Standard Specification for Ferritic Malleable Iron Castings. Anchor rods shall be eight (8) feet long, five-eighth (5/8) inch diameter galvanized steel rods with thimble eye end.

Galvanizing shall be in accordance with ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

24.08 STEEL POLES (Continued)

C. FOUNDATIONS, POLES, AND MAST ARMS, AND LUMINAIRE ARMS (Continued)

9. FOUNDATION CONSTRUCTION

The Engineer will provide a Foundation Design to the selected Bidder. It is anticipated that the Foundation Design will be provided to the selected Bidder prior to NTP. Construct reinforced PCC foundations in accordance with Standard Plans, Standard Specifications, Design, and Contract Documents. Excavate, dig, and/or bore holes at the locations indicated in the Contract Documents or as directed by the Engineer. The excavation shall be dry and free of any loose materials before placing PCC. Forms shall be used for any portion of the foundation that will be exposed above ground. Level and secure all forms before commencing PCC placement. Install and secure all reinforcing steel, conduit, and anchor bolts before commencing PCC placement.

Concrete shall be specified by the Contractor's Foundation Engineer. Consolidate the PCC throughout the full depth of the foundation by inserting and withdrawing a vibrator multiple times during PCC placement.

Finish the top of the foundation to be approximately two (2) inches above the adjacent ground or structure unless otherwise indicated in the Contract Documents. Finish the top of the foundation to be flush with adjacent sidewalk.

Form removal and surface finishing and grout installation shall be in accordance with Lincoln Standard Plans and Specifications.

Backfill the excavation and restore any areas disturbed by the foundation construction.

a. POLE FOUNDATIONS

Metal pole foundations shall be round with a square cap. The minimum dimension for the mounting surface shall be two and one-half (2½) inches greater than the pole base or transformer base on all sides. Pole foundations shall be constructed in accordance with the Standard Plans.

Install and secure anchor bolts within the reinforcing steel before commencing PCC placement. Center the bolt circle in the middle of the foundation and set the anchor bolts plumb at a projection distance above the finished surface in accordance with the manufacturer's recommendations. Conduit bends shall be ninety (90) degrees and shall exit the foundation a minimum of thirty (30) inches below the surrounding surface. Plug the ends of the conduit before commencing PCC placement.

24.08 STEEL POLES (Continued)

C. FOUNDATIONS, POLES, AND MAST ARMS, AND LUMINAIRE ARMS (Continued)

10. GROUND ROD INSTALLATION

Supply and install a ground rod in accordance with the Standard Plans, the Contract Documents, and NEC Article 250. Install a No. 6 AWG stranded copper wire attached to the ground rod using an appropriate clamp and connected to the splice box on the pole shaft. Use No. 6 AWG green insulated stranded copper wire for conduit installations.

Grounding shall be in accordance with the NEC, local ordinances, all applicable codes, and the requirements of the local utility company supplying electrical power. Do not connect any grounding connections to a breakaway device. The maximum measurable resistance between the ground rod and a test stake driven two (2) feet into the ground adjacent to the pole foundation shall not exceed twenty-five (25) ohms. If the resistance exceeds twenty-five (25) ohms, install additional ground rods greater than six (6) feet apart and connected using a No. 4 AWG bare copper wire. The number of additional ground rods shall be as needed to produce a measurable resistance of less than twentyfive (25) ohms.

11. MAST ARM SIGNAL POLE INSTALLATION

Install mast arm signal poles and mast arms at locations indicated in the Contract Documents and in accordance with the Standard Plans. The Contractor shall provide the required anchor bolts and hold down lugs as part of the cost to install a mast arm pole. Hold down lugs shall be provided for both the top and bottom sides of the bottom plate of the base. If the constructed foundation and anchor bolts do not fit the mast arm pole, then the Contractor shall construct a new foundation with the correct anchor bolt size and bolt circle at no additional cost to the City.

Install mast arms in accordance with the manufacturer's recommendations and such that the loaded arm has a minimum clearance of seventeen (17) feet from bottom of all signals to the crown of the street. Rake the pole back more than the calculated deflection, load the pole, and plumb the pole by adjusting the leveling nuts.

24.08 STEEL POLES (Continued)

C. FOUNDATIONS, POLES, AND MAST ARMS, AND LUMINAIRE ARMS (Continued)

12. MEASUREMENT AND PAYMENT

The Engineer shall measure mast arm signal poles for payment by the type of each mast arm signal pole supplied, installed, and accepted.

The Engineer shall measure combination mast arm signal / lighting poles for payment by the type of each combination mast arm signal / lighting pole supplied, installed, and accepted.

The following items are considered subsidiary to items for which the Contract provides direct payment: licenses, or associated permits; tree or shrub trimming; loading, hauling, and installing all materials, mounting hardware, ground rod(s), and miscellaneous hardware; installing wire and/or conduit into an existing base/foundation/pad; installing guy wires and guy anchor assemblies; and restoration of the surrounding ground surface.

Mast arms and luminaire arms are subsidiary to mast arm signal poles and combination mast arm signal / lighting poles.

Payment shall be made under the following unless otherwise indicated in the Contract Documents. The Contract Price shall be full compensation for furnishing all labor, materials, equipment, tools, transportation, permits, licenses, and all incidentals necessary to complete the work.

Contractor shall submit shop drawings for approval for all Poles prior to purchasing or performing work.

<u>Description</u>	<u>Unit</u>
Mast Arm Pole	Each
Combination Mast Arm Pole	Each
Foundation Concrete	Cubic Yards
Foundation Steel	Pounds (lbs)
Foundation Design	Each

24.08 STEEL POLES (Continued)

D. INSTALLATION

Poles, pole arms and/or pedestals are to be installed at the locations shown on the plans, unless permission to change the locations is given by the Project Manager. Poles shall be placed so that modifications and/or attachments are carefully oriented, as indicated on the plans.

The Traffic Signal Pole handhole shall be opposite the mast arm.

The Street Light Pole festoon outlet shall be located on the side opposite the street and the hand hole shall be 90° right of the luminaire arm.

A ground rod shall be set in undisturbed earth as shown on LSP 82 and 92. A continuous bare copper ground wire shall be connected from the ground rod to the grounding lug on the pole. When transformer bases are used, the pole shaft section and the transformer base section shall also be bonded to the ground rod.

Pole shafts must be erected so that they are plumb with their entire load in place. The mast arms shall be correctly oriented, as shown on the plans. Plumbing of pole shafts shall be accomplished by adjusting the leveling nuts on the foundation anchor bolts. Shims or similar devices for plumbing or racking will not be permitted except for leveling of the transformer base as per the manufacturer. The Contractor is responsible for additional nuts and washers for the Pedestal Pole if needed.

The Contractor shall notify the City of any damaged poles or surfaces before they pick up poles from pole storage site. The Contractor shall handle all poles in a manner to prevent damage to pole surface. All poles shall be clean after erection, and damaged surfaces shall be repaired to Traffic Engineering's approval.

If traffic signal pole construction requires the pinning of the mast arm to the vertical shaft, once the mast arms orientation and height are verified by Traffic Engineering, the Contractor shall pin the mast arms as soon as possible.

24.08 STEEL POLES (Continued)

E. EMBEDDED STEEL POLE INSTALLATION

Embedded steel poles shall be backfilled with pole setting foam. The Contractor shall coat the entire vertical pole butt surface with foam from base 6" below ground line. The poles shall be masked to 1" above the ground line to prevent splattering and provide a uniform edge.

All holes for poles shall be drilled, augured or vacuumed. The soil shall be removed from the holes mechanically or vacuumed. The diameter of the finished hole shall not exceed the pole diameter at ground line more than 4" nor less than 2". Depths of holes shall be determined by embedment length requirements of the pole.

In case of over-drilling, the holes shall be backfilled to proper depth with compacted soil. The Contractor shall take every precaution to prevent surface drainage from entering the holes.

A 6" layer of crushed rock shall be placed in the base of each hole. The crushed rock shall have been sieved after crushing to remove excessive fines and shall be so graded to meet the following requirements:

Total retained on 1-1/2" sieve	0-5%
Total retained on 1/2" sieve	90-100%

A small section of PVC conduit shall be used during backfilling application to assure access to the underground wire inlet after the backfilling process has been completed to allow installation of the underground wire thru the pole setting foam.

Poles shall be plumbed and held in stationary position for no less than 20 minutes (or as recommended by the foam manufacturer) after the foam has been applied. The masking shall be removed as soon as the foam expansion reaction has ceased. The remainder of the hole shall be backfilled with clean earth and tamped.

Application and use of the foam shall be in strict adherence to the manufacturer's instructions. A copy of the manufacturer's instructions shall be present on the job site and available to the Project Manager. The age of the pole setting foam components shall not have exceeded the manufacturer's recommended shelf life under the conditions by which the manufacturer defines shelf life.

After the recommended curing period, the foam shall have a core density of not less than 4.2 pounds per cubic foot and shall have a sheer strength not less than 38 psi. and shall have a compressive strength not less than 75 psi.

The foam shall be tested, when required by Traffic Engineering, in conformance with ASTM D 2856/ANSI K 65.152; ASTM D 1623/ANSI K65.32; and ASTM D 1621/ANSI K65.31.

24.08 STEEL POLES (Continued)

F. BASIS OF PAYMENT

POLE, INSTALL _____ complete, in place, and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for all excavation, for picking up and installing the pole, mast arm, luminaire arms, cable, conductors, span wire, tie wire, concrete, conduit stub-out, epoxy coated reinforcing steel, anchor bolts, concrete foundation, anchor bolt covers, power installed foundations, transformer base, breakaway base, pole setting foam, ground rods and clamps, and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

INSTALL MAST ARM, complete, in place, and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for picking up and installing the arm, all labor, equipment, tools, and incidentals necessary to complete the Work.

POLE, _____ complete, in place, and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each. This price and payment shall be full compensation for all excavation, for furnishing and/or installing the pole, luminaire arms, cable, conductors, span wire, tie wire, concrete, conduit stub-out, epoxy coated reinforcing steel, anchor bolts, concrete foundation, anchor bolt covers, power installed foundations, transformer base, breakaway base, pole setting foam, ground rods and clamps, and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

24.09 GROUND RODS

A. GENERAL

Ground rods shall be high strength steel rods with chemically-bonded copper coverings to provide high-conductivity and to prevent electrolytic action. The copperweld ground rods shall be placed as shown on the plans, 2' from the pole base, and oriented on the same side as the hand hole or in a pull box, if called for on the plans or LSPs; they shall have a nominal diameter of 5/8" and 15' long, except to a Street Light Pole shall be 10' long. For worker safety 5' lengths of ground rod screwed together are allowed. Ground wires shall be connected to ground rods with one-piece non-ferrous clamps which employ set screws as tightening devices. Connections to ground rods shall not be taped.

All ground wires shall be No. 6 AWG, bare solid annealed copper wire unless otherwise specified on the plans.

B. INSTALLATION

Each pole, or pedestal or traffic signal cabinet shall be firmly connected to the ground rod provided for each using the grounding terminal or terminal lugs. Placing the ground wire under an anchor bolt nut, anchor bolt cover, or similar device will not be permitted. The Contractor shall attach ground wire to base using terminal lugs. To attach the ground to the pedestal pole base, drill a hole in the pedestal base to accept the terminal lug.

Each pole or pedestal shall be connected to the traffic signal cabinet and the ground rod using a circuit grounding conductor of the size required on the LSP.

Each steel pole shall be connected to both the pole ground and a separately installed circuit grounding conductor of the size called for on the plans.

Ground Rods shall be installed in Pull Boxes where specified on the plans. Ground rods shall be centered on the side opposite the curb and installed 3" away from pull box side walls. The top of the ground rod shall be 10" below the bottom of the pull box lid. Ground Rods in Fiber pull Boxes shall include a Fiber Locate Cable attached to the Ground Bar and Bonding wire (Solid Bare #6) attached to the 8' ground rod 1" from the top of the rod with a compression clamp in the pull box.

C. BASIS OF PAYMENT

GROUND ROD, complete, in place and accepted by Traffic Engineering, shall be measured as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for furnishing and installing the Ground Rods; and for all labor, equipment, updating Inventory in GIS, Fiber Locate Cable, tools, materials, and incidentals required to complete the work.

No measurement or direct payment will be made for ground rods, ground wire, attachments to existing ground, or grounding clamps installed in conjunction with wood or steel poles, pedestal poles, or the pull box nearest the traffic signal cabinet. Ground rods and ground wire shall be considered subsidiary to and included in the bid price for the items for which direct payment is made.

24.10 DETECTORS

A. GENERAL

Detectors shall be inductance loops, detector cameras, non-intrusive detectors, emergency detectors or pedestrian push buttons as called for on the plans. All loop locations shall be marked on the pavement by the Contractor prior to installation and approved by Traffic Engineering. All camera detector, non-intrusive detector, and emergency detector locations shall be located as indicated on the plans. The locations for these detectors shall be coordinated with Traffic Operations and approved by Traffic Engineering. The pedestrian push button locations shall be marked on the pole shaft by the Contractor prior to installation and approved by Traffic Engineering. The Contractor shall review the installation drawing prior to scheduling operations, so as to expedite the installation process and cause a minimum of traffic interference and to ensure correct placement of loops.

The Contractor shall adhere to the specified detector locations including the leads and conduit as shown on the plans. Loops shall always be centered in their respective lanes as identified by final pavement markings shown on the plans. Care should be taken to ensure loops are centered properly within through lanes and left-turn lanes should variable lane widths exist. If some unforeseen condition necessitates repositioning a loop, the change must be approved by Traffic Engineering.

B. LOOP DETECTORS

Loop Detectors are described as either Sawed Under Overlay or Preformed Under Street. Sawed Under Overlay are placed in base of existing streets in a 3/8" wide slot. Preformed Under Street Loops may be placed in or on the subgrade prior to placing the surface, or placed beneath surfacing material, as shown on the plans. All loops shall be 6' x 6'.

1. Sawed Under Overlay

After identification of the loop locations, the Contractor shall perform the actual layout by means of either a template or chalk line. All Work related to the installation of a particular loop, with the exception of the layout task, shall be complete in the same Work day.

a. Saw Cutting

Saw cutting will be allowed only when the temperature is 32° F and rising. The concrete cutting equipment shall make use of a tank supplied water source which has sufficient pressure to act as a blade coolant, lubricant, and slot cleaner. Diamond cutting blades utilized for the saw cut shall, without damaging the adjacent areas, provide a clean, well-defined slot having a 3/8" width. On milled surfaces to be overlaid, depth of the saw cut shall be 2" from the lowest groove. The perpendicular saw cuts shall not meet at the corners. Diagonal cuts shall be required at all corners and where the loop wire exits from the actual loop. The saw cut waste shall be collected in a manner to keep from storm drainage.

b. Cleaning the Saw Cut

After the cutting operation, the slots shall be free and clear of moisture and debris, and the presence of any jagged edges or other protrusions which might damage the loop wire.

24.10 DETECTORS (Continued)

B. LOOP DETECTORS (Continued)

c. Wire Installation

Loop detectors shall consist of three turns of wire. Loop wire shall go directly from the loop to a pull box. IMSA 51-5 No. 14 AWG wire shall be used. The loop wire shall be a continuous length, no splicing allowed. The wire brought to the pull box shall be clearly tagged, identifying the loop number using the labeling method as shown in 24.12.D. During installation, the loop wire shall be held in place by lengths of compressible polyethylene or polyurethane foam sealant backer rod, not to exceed 6". The backer rod shall be of sufficient number and size to hold the wire in place while the sealant cures and is resilient over the temperature range of -40° to +160° F. The top of the backer rod shall be at least ½" beneath the surface of the pavement. On milled surfaces, the backer rod shall be at least ½" from the lowest groove.

d. Sealing the Saw Cut

The sealant used to cover the wires in the slots shall be an elastic epoxy resin compound. The epoxy shall have a tack-free curing time of not more than 1 1/2 hours at 75° F. The sealant shall be applied into the slot to half depth.

When both the loop and lead-in slots are half filled, a check shall be made for air bubbles and material pile-up and then the slots shall be filled to street level. Excess sealant shall be removed by means of squeegee. There shall be neither a trough nor a mound formed. The sealant, when applied into the saw cut, shall displace all the air, and completely fill the area of the slot. Sufficient time for sealant curing shall be allowed before traffic is permitted to move over the area.

2. Preformed Under Street Loop Detector

The Contractor shall furnish and install preformed under street loop detector loop detectors at a depth of 0" to 6" under new pavement. Care should be taken to prevent damage to the loop and lead in before and during the paving operation.

The preformed under street loop detector loop may be formed to be rigid or flexible, with 3 turns specified. The wire shall be a continuous length, no splicing allowed. The end of the wire brought to the pull box shall be clearly tagged identifying the loop number using the labeling method as shown in 24.12.D.

3. Loop Acceptance

Each loop shall be tested at the cabinet prior to termination and acceptance. All tests shall have the following result prior to acceptance.

New Loop = infinity

New Loop and New Feeder Cable = infinity

C. PEDESTRIAN PUSH BUTTONS

The pedestrian push button assembly will be furnished to the Contractor by Traffic Engineering. Each pedestrian push button shall consist of push button assembly, instruction sign, frame, instruction sign screws and shims that shall only be used on the smaller poles to stabilize the Pedestrian Push Buttons. The shims shall not be used if they cause any separation from the pole to the Pedestrian Push Button.

24.10 DETECTORS (Continued)

C. PEDESTRIAN PUSH BUTTONS (Continued)

Pedestrian push buttons shall be mounted on the correct pole face as shown on the plans, 3'-6" above the adjacent walk surface, taking care to place so that the flat side of pole is flush with the Pedestrian Push Button. The Contractor shall supply brass mounting screws for mounting the assembly to the pole. The pole shaft wire entrance shall be a 7/8" diameter deburred hole. When 2 push buttons are on the same pole shaft, the common (white) cables are spliced in the hand hole or base, not jumpered together at the push buttons.

D. CAMERA DETECTOR

Camera Detector shall be installed on the mast arm at the location shown on the plans. The attachment to the arm shall be by use of the clamp kit, as specified in these Standard Specifications. The Contractor shall aim and adjust the camera under the supervision of Traffic Engineering. The pole mast arm wire entrance shall be a 1" diameter deburred hole with a 1" inside diameter rubber grommet.

E. NON-INTRUSIVE DETECTOR

Non-Intrusive Detector shall be installed at locations shown on the plans. The mounting bracket for the detector shall be furnished by Traffic Engineering. The Contractor shall aim and adjust the detector in coordination with Traffic Engineering personnel. The pole wire entrance shall be a 1" diameter deburred hole with a 1" inside diameter rubber grommet. Changes in mounting or adjustment to locations shall be approved by Traffic Engineering.

F. EMERGENCY DETECTOR

The Emergency Detector shall be installed on the mast arm at the location as shown on the plans. The attachment to the arm shall be by use of the clamp kit furnished by Traffic Engineering. The pole mast arm wire entrance shall be a 1" diameter deburred hole with a 1" inside diameter rubber grommet.

G. BASIS OF PAYMENT

DETECTOR, LOOP, PREFORMED UNDER STREET; DETECTOR, LOOP, SAWED UNDER OVERLAY; DETECTOR, INSTALL NON-INTRUSIVE; DETECTOR, INSTALL PEDESTRIAN PUSH BUTTON; DETECTOR, INSTALL CAMERA; and DETECTOR, INSTALL EMERGENCY, complete, in place, tested, and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item.

This price and payment shall be full compensation for the furnishing and installing the Preformed Under Street Loop Detector and for furnishing and installing Sawed Under Overlay Loop Detector, including epoxy, and sawing, and for installing furnished Pedestrian Push Buttons with Contractor supplied mounting screws, Camera Detectors, Non-Intrusive Detectors, and Emergency Detectors with Emergency Detector Clamp Kit, clamp kits not included, pull-box, conduit as specified, loop wire, and for all labor, equipment, tools, testing, materials, and incidentals required to complete the Work.

In the event a Preformed Under Street Loop Detector does not meet requirements or was not placed as per plan, the Contractor shall remove the street to the nearest joint, place a new Preformed Under Street Loop Detector as per plan and replace street, all at Contractors expense.

24.11 CABINETS

A. GENERAL

This section refers to pole and pad mount Cabinets.

Upon completion of the Work, each cabinet shall be properly placed, mounted, wired, and connected to operate as per Traffic Engineering.

Unless otherwise noted, the cabinet, auxiliary equipment, and mounting hardware will be furnished to the Contractor by the City, ready for installation by the Contractor.

B. INSTALLATION

The Contractor shall mount or place each cabinet, base, and concrete pad as shown on the plans in conformance with the LSPs. Pad mounted cabinets shall have a 4'-2" x 4' x 4" concrete pad in front of the main door. If stated on the plans the cabinet shall also have a 4'-2" x 4' x 4" concrete pad on the opposite side of the main door. The Cabinet pad/s shall be level in both directions.

The Contractor shall connect all conductors for signal heads, detectors, grounds, Fiber Locate Cables, service cables, and fiber optics into the traffic signal cabinet. The Contractor shall connect the service cables and have the power panel energized.

All cables shall be routed to the cabinet and neatly trained to their destination in the cabinet utilizing industry standard Velcro ties, and shall be clearly identified using the labeling method as shown in 24.12.D.

The Contractor shall work closely with Traffic Engineering in scheduling cabinet installations so as to minimize intersection down time.

Pole mounted cabinets shall be mounted on the designated pole with the top at 7' above the ground.

C. BASIS OF PAYMENT

CABINET, INSTALL, ____, installed, connected, cables labeled, tested and accepted by Traffic Engineering, shall be measured as a single unit and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for picking up and installing the cabinet, concrete pad, base, all connections, epoxy coated reinforcing steel, concrete, ground rod and for all labor, equipment, tools, materials, excavation, and incidentals required to complete the Work.

24.12 CABLE

A. TYPES AND CLASSES OF CABLE

All classes of cable shall be on substantially constructed reels, plainly marked as to size, type, and insulation identification. Only 1 length of cable shall be shipped on each reel. All cable must be new. Damaged cable or repairs on damaged cable will not be permitted. All cables shall be stranded copper, unless otherwise noted.

1. Traffic Signal Cable

Traffic signal cable shall be IMSA Specification No. 19-1, No. 14 AWG.

2. Lead-In Cable

Lead-In Cable shall be IMSA Specification No. 50-2, No. 14 AWG.

3. Loop Detector Wire

Loop Detector wire shall be IMSA Specification No. 51-5, No. 14 AWG.

4. Service, Street Lighting, Circuit Grounding Cable and Pole Grounding Wire

The cable for underground circuits and pole grounding shall be single conductor, the size specified on the plans, type XLP USE-2, RHH/RHW-2 600 Volt, Copper Cable. UL 44 and UL 854, ICEA S-95-658/NEMA WC-70, C (UL) US Federal spec. A-A-59544. Pole ground wire shall be bare No. 6 AWG solid copper.

5. Emergency Detector Cable

Emergency Detector Cable shall be a shielded 3/c. The conductors shall be 20 AWG 7/25 BC 600Vac insulated. The colors shall be blue, orange, and yellow. The outside jacket shall be UV stabilized black polyethylene jacket, and have a total nominal outside diameter of 0.51".

6. Ethernet Communications Cable

Ethernet Communications Cable shall be Cat 6 or Cat 5E CMXT, Direct Burial, LSZH jacket, Shielded, w/Drain Wire, Waterproof Tape, 8-Conductor, Outdoor Jacket, 24AWG, Solid-Bare Copper and include connectors on each end of the cable.

7. RRFB Cable

RRFB Cable shall be IMSA Specification No. 19-1, 4 Conductor No. 18 AWG.

B. INSTALLATION

The installation of power cables shall, in general, conform to the NESC insofar as it applies, subject to the conditions and instruction of Traffic Engineering.

1. In Conduit

Prior to installation of underground cable, the Contractor shall insure that the conduit is open, continuous, free of water, and clear of debris.

24.12 CABLE (Continued)

B. INSTALLATION (Continued)

The cable shall be installed in such a manner and by such methods ensuring against harmful stretching of the conductor, injury to the insulation, or damage to the outer protective covering of the cable. An approved cable lubricant may be used to aid in pulling through conduit, when necessary.

Where more than 1 cable is to be installed in the conduit, all shall be pulled at the same time. 2' of extra cable shall be left on each lead extending beyond the hand hole in the base of all poles, above the top of all pull boxes, power pedestals, and each side of any splice. 6' of extra cable shall be left in the cabinet.

Under no circumstance will any cable be taped to another cable.

2. Pole Cable

The jacket of all pole shaft cables shall extend through the pole.

3. Direct Buried

Direct buried cable shall be installed in place with an approved cable plow at a depth of 30". In areas where trenching or plowing may damage utilities or the health of mature plants, the boring procedure shall be required.

C. SPLICES AND CONNECTIONS

No splices or joints will be permitted to be drawn inside the conduit, nor shall any splices or joints be made in any cable outside of pull boxes, pole bases or traffic signal heads.

Splices are not allowed in City furnished cable, Lead In Cable, Service Cable, Emergency Detector Cable, RRFB Cable and Ethernet Communications Cable. The only splice allowed in Traffic Signal Cable to heads or push buttons is at the pole hand hole. Street Lighting Cable and Circuit Grounding Cable shall be spliced only when a change in size or split of cables is shown on the plans.

Any cable end unused in a pull box shall be weather proofed with shrink tube or approved sealant, not tape.

All Traffic Signal splices and Street light splices below grade shall be made for continuous immersion in water.

Cable connections in signal heads or controller cabinets shall be made at the terminal boards provided for this purpose. All stranded wires inserted under a binder head screw shall be equipped with a solderless pressure-type spade connector with a pre-insulated shank. A crimping tool for insulated connectors shall be used. No bare wire or bare stud shall be exposed.

Service connections to the Cabinet shall be continuous from the power source.

All direct buried street lighting cable splices shall be inspected by LES before backfilling.

24.12 CABLE (Continued)

C. SPLICES AND CONNECTIONS (Continued)

1. Heat Shrink Splices

This splice shall be used to connect Traffic Signal Conductors in poles and Loop Detector splices in pull boxes. This splice shall be mechanically and electrically sound with bronze compression sleeve connection encapsulated in a permanent seal, waterproofing and insulating the electrical connection.

Wire ends must be thoroughly cleaned after the insulation is stripped off to ensure complete contact with another wire or the connector. If strands are damaged when the insulation is removed, the section of cable must be discarded. Nicked or damaged conductor strands will not be permitted inside of connectors. Loose wire ends shall not be used as “shims” to make a connection.

All connectors shall be designed for copper to copper connections. Only new connectors may be used. Connectors for compression sleeve splicing shall be of a type that when installed, the heat shrink products with proper mechanical and electrical properties may be utilized for all in-line splices of traffic signal control cable, loop feeder cable, traffic signal power supply cable, and other such applications.

The black heat shrink tubing shall be made of “thermally stabilized modified polyolefins” capable of minimum continuous use of 10,000 hours over an operating temperature range of -65° to +130° F.

The tubing shall be industry standard “thick wall type”, and shall have the ability to conform to severe configuration changes without splitting. It shall have a 3:1 shrink ratio.

The tubing shall be supplied with a factory applied sealant. When heat is applied, the sealant inside the product softens and flows around and over any irregularly-shaped configurations, filling voids and completely water sealing. The sealant shall remain in a semi-flexible state, assuring a complete moisture seal.

Heat sources for the shrinking process can be an electric heat gun or propane/butane gas torch capable of delivering at least 250° F. Scorched or burned splice components and/or sheathing will not be accepted.

2. Block Connectors

Street Light connectors to be used in poles shall be an approved 3- or 4-hole encapsulated connector.

3. Waterproof Block Connectors

This splice shall consist of a mechanically and electrically sound block connector encapsulated in a permanent gel capsule, waterproofing and insulating the electrical connection.

Splice connectors shall be an approved connector for use in a pull box. This connector shall be used only to connect tap wires to service cable, circuit ground and “in run” street light cables. Connectors shall be sized for the appropriate wire size and number of branch circuits.

24.12 CABLE (Continued)

C. SPLICES AND CONNECTIONS (Continued)

4. Direct Buried Splice

This splice shall consist of a mechanically and electrically sound compression sleeve encapsulated in an inline splice kit, waterproofing and insulating the electrical connection.

Splice the cable with a compression sleeve and wrap with an approved gel wrap for use in direct buried and secure with tie. This connector shall be used only to connect tap wires to service cable, circuit ground and “in run” street light cables.

5. Secondary Fuses and Fuse Holders

Secondary fuses for single luminaire circuits or in street light poles shall be an approved type KTK, 10 ampere. Secondary fuses for multiple luminaire circuits shall be an approved type KTK, 30 ampere. Fuse holders shall be an approved type HEB.

D. LABELING

Cables shall be identified by several wraps of colored tape at all access points. An approved colored tape shall be non-fading. Color code as follows:

Circuit Ground Cable:	Green
Traffic Service Cable:	
Neutral AC-	Yellow White
AC+	Yellow Blue
Street Light Cable:	
Neutral AC-	Red White
AC+ Phase 1	Red Blue
AC+ Phase 2	Red Blue Blue
AC+ Phase 3	Red Blue Blue Blue
Festoon Cable:	
Neutral AC-	Violet White
AC+ Phase 1	Violet Blue
AC+ Phase 2	Violet Blue Blue
AC+ Phase 3	Violet Blue Blue Blue
Metered Cable:	
Neutral AC-	Orange White
AC+ Phase 1	Orange Blue
AC+ Phase 2	Orange Blue Blue
AC+ Phase 3	Orange Blue Blue Blue

All other cables shall be identified with easy to read, good quality outdoor cable labeler.

Lead-In Cables shall be identified with phase and amplifier designation, both in the cabinet and the pull box where the loop detector is spliced. Traffic signal cables, push button cables, Ethernet Communication Cables, emergency detector cables shall be identified in the cabinet with the corresponding pole number using just the last digit (i.e. “POLE 1”). Communication cable and Fiber Locate Cable shall be identified in the cabinet with the direction of cable from the cabinet (i.e. “FIBER EAST”).

24.12 CABLE (Continued)

D. LABELING (Continued)

Since Fiber Locate Cable is so thin, labeling tape shall be placed on wire perpendicular to the wire like a flag.

E. BASIS OF PAYMENT

CABLE, _____ complete, in place and accepted by Traffic Engineering shall be measured as lineal feet from and to centers of pull boxes, cabinets, and poles, of such material of the size and type required and number of fibers or conductors. Cable shall be paid for at the contract unit price bid per linear feet.

This price and payment shall be full compensation for furnishing and installing cable, all necessary slack, testing, documentation, splices, connections, cable labeling, fuses and fuse holders, and all other materials, hardware, labor, equipment, tools, and incidentals necessary to complete the work.

Cable inside loops, foundations, poles, pull boxes, cabinets, and other such devices or structures shall be subsidiary to those items and shall not be measured for payment.

CABLE, INSTALL complete, in place and accepted by Traffic Engineering shall be measured as lineal feet from and to centers of pull boxes, foundations, cabinets, and poles, of such size and type of material furnished by Traffic Engineering. Cable shall be paid for at the contract unit price bid per linear feet.

This price and payment shall be full compensation for installing cable, all necessary slack, testing, documentation, splices, connections, cable labeling, and all other materials, hardware, labor, equipment, tools, and incidentals necessary to complete the work.

Cable inside loops, foundations, poles, pull boxes, cabinets, and other such devices or structures shall be subsidiary to those items and shall not be measured for payment.

24.13 SIGNAL HEADS AND OVERHEAD SIGNS

A. GENERAL

Signal heads and street name Overhead Signs are furnished to the Contractor by the City, ready for installation by the Contractor. The Contractor shall furnish the directional Overhead Sign for installation by the Contractor. The Contractor shall furnish mast arm clamp kit, shaft clamp kit, and down nipple extensions.

Overhead signs are furnished by the Contractor or furnished to the Contractor by the City, ready for installation by the Contractor. The Contractor shall furnish the mast arm clamp kit, shaft clamp kit, and down nipple extensions.

Traffic signal head adjustments shall be accomplished by adjusting the clamp kit and the connection from the signal head arm to the Head or Sign. The set screws in the aluminum pipe shall never be adjusted.

The clamp kit shall be high tensile aluminum alloy with a high strength galvanized aircraft cable and stainless-steel swaged fittings. The Contractor shall take care in selecting the length of cable required. If there is cable remaining, the Contractor shall tie wrap the excess in a tight coil.

The clamp kit shall have 2 sides with 1 1/2" IPS (iron pipe size) signal hardware on one side, and shall be adjustable on the other side to fit the traffic signal pole shaft or mast arm. The clamp kit shall attach to the pole shaft or mast arm by use of an adjustable stainless-steel cable and be able to rotate from horizontal to vertical in order to make the signal heads plumb or level. Installation shall be as per manufacturer's instructions.

B. INSTALLATION

Traffic Signal Heads, Pedestrian Signal Heads, Rectangular Rapid Flashing Beacons, Overhead Signs, and advanced flashers shall be installed as shown in the plans to the approval of Traffic Engineering. Each signal assembly shall be erected so that it is plumb, securely attached with all fittings tight, and present a neat appearance. Traffic signal heads shall be installed in line and all the same relative heights above the crown of the street. Pedestrian Signal Heads shall be aimed at the center of the appropriate ramp for which a person would wait for walk indication.

The pole shaft wire entrances for the Pedestrian Push Buttons and Pedestrian Signal Heads shall be a 7/8" diameter deburred hole with none of the hole exposed outside of the Pedestrian Signal Head. The pole shaft wire entrances for the Traffic Signal Heads shall be a 1" diameter deburred hole with a 1" inside diameter rubber grommet. The pole mast arm wire entrances for the Traffic Signal Heads shall be a 1" diameter deburred hole with a 1" inside diameter rubber grommet.

The pole shaft wire entrance for the cable to the arm shall be a 1 1/2" diameter deburred hole with a 1 1/2" inside diameter rubber grommet.

Down nipple extension 1 1/2" in diameter, and of appropriate length, shall be furnished and installed by the Contractor so that all signals on the span will hang at the same elevation as illustrated on the LSPs.

24.13 SIGNAL HEADS AND OVERHEAD SIGNS (Continued)

B. INSTALLATION (Continued)

If, after the signal assemblies are erected and the street is open to public travel, the signal is not put immediately into operation, the signal faces shall be covered securely with signal covers specifically designed for all signal heads. Burlap, cardboard, or plastic 'trash style' bags shall not be accepted. All signal covers shall be approved by Traffic Engineering prior to use. No inoperative signals on a street which is open to the public shall be left uncovered under any circumstances. Traffic Signal Heads shall stay covered until the signal is ready to be placed in flash operation. Pedestrian Signal Heads shall stay covered until the signal is ready to be placed in full operation.

C. BASIS OF PAYMENT

HEAD, INSTALL TRAFFIC SIGNAL, _____ SECTION, complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for picking up and installing the signal head and assembly (pipe and brackets), for furnishing and installing clamp kits, nipples, banding, pipe fittings, for all pole and mast arm modifications; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

SIGN, INSTALL OVERHEAD, complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for picking up and installing the street name Overhead Sign and assembly (pipe and brackets) provided by City or installing the directional Overhead Sign provided by Contractor and assembly (pipe and brackets), clamp kits, nipples, banding, pipe fittings, for all pole and mast arm modifications; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

SIGN, INSTALL OVERHEAD; ADVANCED FLASHER ON MAST ARM, INSTALL; ADVANCED FLASHER ON SHAFT, INSTALL; INSTALL SPEED INDICATOR ON SHAFT and RECTANGULAR RAPID FLASHING BEACON, INSTALL complete, in place and accepted by Traffic Engineering, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item. This price and payment shall be full compensation for picking up or furnishing and installing the Overhead Sign, and assembly (pipe and brackets), picking up and installing Advanced Flasher on Mast Arm and assembly (pipe and brackets), picking up and installing Advanced Flasher on Shaft and assembly (pipe and brackets), picking up and installing Speed Indicator on Shaft, and assembly (pipe and brackets), for furnishing and installing clamp kits, nipples, banding, pipe fittings, for all pole and mast arm modifications; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

The furnishing, installing, maintaining and removal of any temporary covering for the signals during construction is considered subsidiary to the installation of the head. Such coverings remain the property of the Contractor after removal. All mounting hardware shall be considered subsidiary to the installation of the signal heads.

24.14 STREET LIGHTING AND LUMINAIRES

A. GENERAL

The luminaire and components shall have been designed for street lighting and shall conform to all the applicable requirements of the National Electrical Safety Code.

B. MATERIAL AND DESIGN

1. General

The street luminaires shall be similar in appearance to the 'cobra head' type luminaire. The following Standard Specification detail the mechanical, electrical, and optical properties required for each style of luminaire.

All parts, exterior and interior, when in contact with one another shall have a potential difference no greater than 0.25 volts in order to prevent corrosion due to electrochemical reaction.

Non-aluminum metal parts shall also be treated with corrosion resistant finish.

The external finish of the luminaire shall be gray and shall be of such quality that it will not, under normal environmental conditions, blister, crack, fade, or peel for the functional life of the luminaire.

The finish shall not have runs, streaks or foreign materials on the surface and have been evenly and thoroughly applied.

2. Luminaire Housing Assembly

The luminaire housing shell shall be constructed from pressure die cast aluminum. There shall be no rough or jagged edges protruding in either the interior or on the exterior body or edges of the shell.

The luminaire shall be provided with a field identification marker on the lower external surface of the unit. The marker shall conform to the NEMA Standards for Field Identification of High-Intensity Discharge Lamps in Luminaires, Publication No. OD 150-1977.

The luminaire shall consist of 2 sections readily separable from one another. In general, this shall be an upper body and a lower body. All sections shall be well matched to one another and when fully assembled, the luminaire shall be solidly and tightly composed.

The lower body shall be hinge mounted to the upper body and when in the open positions shall allow access to the electrical and/or the optical compartments. The hinge shall be capable of retaining the lower body to the upper body unsupported under full ice load (1" on all horizontal properties) and wind loads with maximum gust velocity of 110 miles per hour.

The upper and lower bodies shall be locked in the closed position with a vibration proof latch which is readily accessible, designed to prevent accidental opening, and may be opened without the aid of tools.

24.14 STREET LIGHTING AND LUMINAIRES (Continued)

B. MATERIAL AND DESIGN (Continued)

2. Luminaire Housing Assembly (Continued)

The luminaire shall include an EMI-NEMA Standard 7-pin, twist lock type photo electrical control receptacle. The receptacle shall be an integral part of the luminaire and shall be gasketed.

All electrical components and connections shall have been pre-wired at the factory so the luminaire is ready for immediate installation.

3. Photometric Requirements

The luminaire shall have a 'cut-off' type light distribution characteristic as follows:

- 1) Vertical distribution: IES - Medium
- 2) Lateral distribution: IES - M.C. III as required on the plans
- 3) Control of the candlepower distribution: Maximum candlepower shall fall between 66°-75° (degrees projected angles above nadir).

4. Electronic Photoelectric Controls

a. General

All controls must meet or exceed ANSI C136.10 - 1988.

b. Electrical Rating

- | | |
|-----------------------------------|---|
| 1) Line Voltage Operating Range | 105-305 VAC 60 HZ (240 Volt) |
| 2) Load Rating | 1000 Watt |
| | 1800 VA Ballast |
| 3) Contact Rated Life | 15,000 Operations Minimum |
| 4) Contact Chatter on Opening | Less than 5 milliseconds |
| 5) Dielectric Strength | 5000V Between Current Carrying Parts & Metal Mounted Surfaces |
| 6) Photocontrol Power Consumption | 1.5 Watts Maximum |

c. Time Delay & Failure Mode

- | | |
|-----------------|-------------|
| 1) On Delay | None |
| 2) Off Delay | 2-4 Seconds |
| 3) Failure Mode | Fail On |

d. Photosensor & Level Setting

- | | |
|-----------------------------|------------------------------------|
| 1) Type | Sealed Cadmium Sulphide or Silicon |
| 2) Turn On | 1.5 +/- 0.3 Footcandles |
| 3) Turn Off - Turn on Ratio | 1.5:1 |

e. Surge Protection

- | | |
|------------------|----------------------|
| 1) Type | Metal Oxide Varistor |
| 2) Joules Rating | 640 Minimum |

24.14 STREET LIGHTING AND LUMINAIRES (Continued)

B. MATERIAL AND DESIGN (Continued)

5. Electronic Photoelectric Controls (Continued)

f. Housing and Markings

- | | |
|---------------------------------|---|
| 1) Color | Black |
| 2) Cover Material | High Impact & UV Stabilized |
| 3) Base Material | High Impact |
| 4) Housing Skirt Size | 3" + 1/8" Diameter |
| 5) Base Markings and Provisions | Year & Month of Manufacture, Provisions |
| 6) Cover Markings | Manufacturer's Logo & Year of Manufacture |
| 7) Cover/Base/Receptacle Seal | Cross-Linked Polyethylene Gasket |
| 8) Plug Blades | Brass, 3 Blade NEMA Twist Lock |
| 9) Cover Window | Clear, UV Stabilized & Sealed |

g. Quality Control & Calibration

- | | |
|--------------------------------------|------|
| 1) Production Calibration - | 100% |
| 2) Inspection After Final Assembly - | 100% |

h. Other Type Tests

- | | |
|--------------------------------|---|
| 1) Ambient Temperature Range - | -40° C to +65° C |
| 2) Moisture Resistance - | 98% |
| 3) Drop Test | Drop of 3 ft. to Concrete Floor Without Damage to Housing or Electrical Operation |

i. Warranty

- | | |
|----------------|------------------|
| 1) Length | 12 Years Minimum |
| 2) Replacement | One for One |

Contact Lincoln Electric System for current list of approved vendors.

j. Circuit Board

Silicone Coated

C. LED STREET LUMINAIRE SPECIFICATIONS

References for this section include ANSI/NFPA 70, National Electrical Code (NEC) or latest issue, IEEE C63.41, Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits, FCC 47 CFR Part 15, Federal Code of Regulation (CFR) testing standard for electronic equipment, IESNA LM-79, Electrical and Photometric Measurements of Solid State Lighting Products, IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Light Sources, IESNA TM-15, Luminaire Classification System for Outdoor Luminaires, UL1598, Standard for Safety of Luminaires and IEEE C2-2012, National Electric Safety Code or latest issue.

Luminaires shall be of uniform quality and appearance. Manufacturers of LED luminaires shall provide a report or certification from a testing laboratory detailing a suitable testing program incorporating high heat, water, and thermal shock test regimens to ensure system reliability and to substantiate lifetime claims. The use of IESNA LM-80 data to predict luminaire lifetime is not accepted. At time of manufacture, each luminaire shall be tested for functionality and shall utilize a unique serial numbering scheme.

24.14 STREET LIGHTING AND LUMINAIRES (Continued)

C. LED STREET LUMINAIRE SPECIFICATIONS (Continued)

Each luminaire shall utilize a unique serial numbering scheme. Luminaires shall be provided with a minimum of 10-year warranty against manufacturing defects covering LEDs, dimmable drivers, surge protectors, photo control receptacles, and mechanical components. Warranty period shall begin at date of delivery.

If a manufacturer other than the approved vendors is to be considered, they must conform to LES Specifications. Submittals shall include luminaire cut sheets, cut sheets for LED light sources; cut sheets for LED dimmable driver(s); diagrams illustrating light output and input power as a function of control for dimmable LED driver; cut sheets for surge protection device; instructions for installation and maintenance; summary of luminaire recyclability per the FTC Green Guides, expressed by percentage of luminaire weight; description of luminaire, LED light sources(s) and LED dimmable driver(s) and manufacturer shall supply part number for light bars, drivers, and surge protectors of the luminaires supplied. Calculations and supporting test data indicating a lumen maintenance life of not less than 100,000 operating hours. Lumen depreciation curved for each driver. A completed Appendix B for each Appendix A. If proposed luminaires are on the LES Standards Approved List, only the catalog cut of the luminaire with catalog number must be submitted.

Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of housing, LED array, 7-pin photo receptacle, terminal block, surge protector, and electronic dimmable driver (power supply).

Each luminaire shall be rated for a minimum operational life of 100,000 hours at an average operating time of 11.5 hours per night. This life rating must be conducted at 25° C ambient temperature. The rated operating temperature range shall be -30° C to +40° C. Each luminaire must be capable of operating above 100° F (37° C), but not expected to comply with photometric requirements at elevated temperatures.

Photometry must be compliant with IESNA LM-79 and shall be conducted at 25° C ambient temperature.

The LED array should be constructed such that each individual LED has a dedicated lens assembly. Chip on Board (i.e. multiple LED's clustered under a single lens assembly) shall not be permitted, except for high mast applications. A catastrophic failure of one LED shall not result in the loss of the entire luminaire or more than a 10% total reduction in illuminance.

Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires.

Luminaires must have an external label per ANSI C136.15 and an internal label per ANSI C136.22.

Electrically test fully assembled luminaires before shipment from factory.

Luminaires shall be designed for ease of component replacement and end-of-life disassembly. Manufacturer shall submit information regarding recycling and proper disposal of luminaire and all individual components as well as name and address of nearest recycling location for materials.

Painted or finished luminaire components exposed to the environment shall exceed a rating of six per ASTM D1654 after 1000 hours of testing per ASTM B117 and the coating shall exhibit no greater than 30% reduction of gloss per ASTM D523, after 500 hours of QUV testing at ASTM G154 Cycle 6.

24.14 STREET LIGHTING AND LUMINAIRES (Continued)

C. LED STREET LUMINAIRE SPECIFICATIONS (Continued)

Mechanical design of protruding external surfaces (heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation.

Minimum color rendering index (CRI): 70. Correlated Color Temperature (CCT) shall conform to table below.

Manufacturer-Rated Nominal CCT (K)	Allowable LM-79 Chromaticity Values	
	Measured CCT (K)	Measured Duv
4000	3710 to 4260	-0.005 to 0.007

All internal components shall be assembled and pre-wired using modular electrical components.

Luminaire shall have three-hole terminal blocks for incoming #10 AWG AC lines and a 7-pin photo control receptacle.

Access to internal components shall be latched and hinged in a manner to prevent accidental opening. Luminaire shall have ingress protection.

Maximum power consumption allowed for the luminaire shall be determined by application. The luminaire shall not consume power in the off state.

The luminaire shall operate from a 60 HZ AC line over a voltage ranging from 108 VAC to 305VAC. The fluctuations of line voltage shall have no visible effect on the luminous output. The luminaire shall have a power factor of 0.90 or greater. Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent. The luminaire circuitry shall include fused surge protection devices (SPD) to withstand high repetition noise transients as a result of utility line switching, nearby lightning strikes, and other interference. The SPD shall protect the luminaire from damage and failure for common mode transient peak voltages up to 10kv (minimum) and transient peak currents up to 5ka (minimum). SPD shall conform to UL 1449. SPD performance shall be tested per the procedures in ANSI/IEEE C62.41-1992 (or current edition) for category C (standard). The SPD shall fail in such a way that the luminaire will no longer operate. The SPD shall be field replaceable.

Each luminaire shall have integral UL listed Class I power supplies.

The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

Dimmable LED drivers must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.

Dimmable drivers shall have a Class A sound rating.

LEDs shall be provided with optical elements to provide IESNA Type II, III, IV or V distributions. Optical assemblies shall have a minimum efficiency of 85% regardless of distribution type. For Type II and Type III distributions, street side efficiencies shall be a minimum of 70%. All LEDs and optical assemblies shall be mounted parallel to the street surface. All LEDs shall provide the same optical pattern such that catastrophic failures of individual LEDs will not constitute a loss in the distribution pattern.

24.14 STREET LIGHTING AND LUMINAIRES (Continued)

C. LED STREET LUMINAIRE SPECIFICATIONS (Continued)

The luminaire shall have a minimum B.U.G. rating of 3-0-4 or better.

The luminaire shall not allow more than 10% of the rated lumens to project above 80° nor 2.5% above 90° from vertical.

Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature. The heat sink shall be aluminum.

Luminaires shall be capable of withstanding cyclical loading in (G = Acceleration of Gravity) a minimum level of 3.0 G peak sinusoidal loading with the internal driver installed, for a minimum of 100,000 cycles without failure of any luminaire parts. Testing is to be performed in three planes: a horizontal plane parallel to the direction of mounting, a horizontal plane perpendicular to the direction of mounting, and the vertical plane.

The housing shall be designed to prevent the buildup of water on the top of the housing. Exposed heat sink fins shall be oriented so that water can run off the luminaire freely, and carry dust and other accumulated debris away from the unit.

The optical assembly of the luminaire shall be protected against dust and moisture intrusion per the requirements of IP-66 (minimum) to protect all optical components.

The electronics/power supply enclosure shall meet the requirements for NEMA/UL wet locations.

Housing shall be fabricated from materials that are designed to withstand a 3,000-hour salt spray test as specified in ASTM Designation B117.

Each refractor or lens shall be made from UV inhibited high impact plastic such as acrylic and be resistant to scratching.

Polymeric material of enclosures containing either the power supply or electronic components of the luminaire shall be made of UL94VI flame retardant materials. The lens of the luminaire is excluded from this requirement.

All electronics and materials shall be lead free.

Luminaire shall have tool less entry.

Manufacturer or local sales representative shall provide installation and troubleshooting support via telephone and/or email and supply onsite support when requested.

Manufacturers must be a street luminaire manufacturer and have a minimum of 5 years documented experience in LED street luminaire manufacture. References shall be provided upon request of at least 3 municipalities that currently have manufacturer's fixtures installed and operating.

D. INSTALLATION

Unless otherwise indicated in the plans or directed by the City's Project Manager, luminaires shall be installed level in both horizontal axes.

24.14 STREET LIGHTING AND LUMINAIRES (Continued)

D. INSTALLATION (Continued)

Each completed street light circuit shall have a 72 hour burn test prior to acceptance.

E. BASIS OF PAYMENT

LUMINAIRE, ____, complete, in place and accepted by the City's Project Manager, shall be measured as single units and shall be paid for as at the contract unit price bid per each for the item. This price and payment shall be full compensation for furnishing and installing the Luminaires and for furnishing bulbs, labor, equipment, tools, materials, and incidentals necessary to complete the Work.

24.15 CONCRETE POLES

A. GENERAL

Concrete Pole Standard Specifications are found on LSP 94.

B. INSTALLATION

Concrete Poles are to be installed at the locations shown on the plans, unless otherwise approved by Traffic Engineering. Poles shall be placed such that modifications and/or attachments are carefully oriented, as indicated on the plans.

The Concrete Pole hand hole shall be located on the side opposite the street.

Concrete Pole must be erected so that they are plumb with their entire load in place.

Poles shall be set to a depth and backfilled as per LSP 94. No frozen earth shall be used in tamping holes.

The excavation for Concrete Pole shall be 36" in diameter and extend 6" below the butt of the pole. The Concrete Pole shall rest level and firmly on an aggregate base and be backfilled 42" from bottom of excavation with aggregate material. Aggregate material shall satisfy all of the requirements of coarse aggregate as described in Chapter 3 of the City of Lincoln Specifications.

The remaining excavation shall be backfilled with soil that satisfies City of Lincoln Specifications for backfill material and shall be tamped every 4".

The Contractor shall notify Traffic Engineering of any damaged poles or surfaces before they pick up poles from pole storage site. The Concrete Pole shall be lifted and supported during transportation and erection operations as per Concrete Pole manufacturer recommendations. Ensure that transportation, site handling, and erection are performed with acceptable equipment and methods, and by qualified personnel. All poles shall be clean after erection.

C. BASIS OF PAYMENT

POLE, INSTALL CONCRETE, DIRECT BURY complete, in place and accepted by the City's Project Manager, shall be measured as a single unit and shall be paid for at the contract unit price per each for the item. This price shall be full compensation for the excavation required; pole installation; backfilling and backfill material; conduit long radius sweeps; for ground rod and ground wire connections; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

24.16 BLANK ON PURPOSE

24.17 BLANK ON PURPOSE

24.18 WOOD POLES

A. GENERAL

Wood poles shall be dense Southern Yellow Pine, and shall meet all ASA requirements for the length and class shown on the plans. Preparation of the timber for treatment, the method and result, shall conform to the requirements of "Standard Specifications for Pressure Treatment of Timber Products", ASTM Designation D-1760. The finished poles shall be sufficiently dry on the surface so that no preservative will bleed out and drip off the poles.

Poles shall be approved by an independent commercial laboratory.

B. INSTALLATION

Poles shall be set to a depth of 10% of the pole length plus 24". When earth fill is specified, earth around the hole shall be tamped solid, and to the satisfaction of Traffic Engineering. No frozen earth shall be used in tamping holes. Holes shall be of sufficient size to permit tamping completely around the pole.

Fill, other than earth fill, shall be as specified in the Special Provisions.

Guy wires shall be of the same diameter and tensile strength as the messenger cable supporting attachment to which they are linked, and shall conform to the requirements of "Standard Specifications for Zinc-Coated Steel Wire Strand", ASTM Designation A-475.

Ground anchors shall be power screw-type, having an 8" minimum diameter and using a 7' x 5/8" diameter rod to minimize soil disturbance, unless otherwise shown on the plans.

All ferrous metal line hardware items shall be galvanized and shall conform to the requirements of "Standard Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware", ASTM Designation A153.

Guy guard shall be high visibility plastic 8' in length.

Down guys shall not enter the ground less than 24" from the edge of the sidewalk unless otherwise shown on the plans.

C. BASIS OF PAYMENT

WOOD POLE, ____ complete, in place and accepted by Traffic Engineering, shall be measured as a single unit and shall be paid for at the contract unit price per each for the item. This price shall be full compensation for the excavation required; for furnishing and/or installing the wood pole; for concrete as required, pole hardware, cable, conductors, span wire, tie wire, down guy, overhead guy; for ground rod and ground wire connections; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

CITY OF LINCOLN, NEBRASKA, STANDARD SPECIFICATIONS

CHAPTER 26

COMMUNICATIONS

ARTICLE	TITLE	
26.00	GENERAL	2601
	A. MATERIAL TESTS	2601
	B. CONTRACTOR RESPONSIBILITY	2601
	C. SUBSTANTIAL COMPLETION	2601
	D. INSPECTION COMPLETION	2602
	E. LOCATE SYSTEM	2602
	F. TESTING	2602
26.01	BLANK ON PURPOSE	2604
26.02	FIBER MARKER	2604
	A. GENERAL	2604
	B. INSTALLATION	2604
	C. BASIS OF PAYMENT	2604
26.03	BLANK ON PURPOSE	2604
26.04	EARTHING, BONDING & GROUND BAR	2605
	A. GENERAL	2605
	B. INSTALLATION	2605
	C. BASIS OF PAYMENT	2605
26.05	FIBER CABLES	2606
	A. TYPES AND CLASSES OF CABLE	2606
	B. INSTALLATION	2606
	C. BASIS OF PAYMENT	2608
26.06	FIBER CONNECTORS, ENCLOSURES AND ACCESSORIES	2609
	A. COMPONENTS	2609
	B. INSTALLATION	2613
	C. BASIS OF PAYMENT	2615
26.07	INSTALL ITS FIELD SWITCH	2616
	A. GENERAL	2616
	B. INSTALLATION	2616
	C. BASIS OF PAYMENT	2616
26.08	FIBER SYSTEM CAPACITIES AND LIMITATIONS	2616
	A. GENERAL	2616
	B. INSTALLATION REQUIREMENTS	2616
	C. BASIS OF PAYMENT	2616

CHAPTER 26

COMMUNICATIONS

26.00 GENERAL

A. MATERIAL TESTS

When any reference is made in these Special Provisions, or in the City of Lincoln Standard Specifications to a standard, such as ASTM, ICEA, IMSA, etc., or a related Specification referred to by reference therein, which states that a certain test is to be made only at the request of the purchaser, it shall be considered that the City does request that such test be made. The tests shall be made at the Contractor's expense and a certified copy of each test shall be submitted to the City's Project Manager prior to the installation of such material.

The Contractor shall submit to the City's Project Manager 1 hard copy and 1 electronic (pdf) copy of a complete list of all equipment and materials they intend to install. Catalog cuts and/or Manufacturers model number shall be required for the materials furnished by the Contractor and incorporated into the project. There shall be no substitutes for any of the items on the list without prior written approval of the City's Project Manager.

B. CONTRACTOR RESPONSIBILITY

The Contractor is responsible to inform the City's Project Manager of any defect found in the existing communications system encountered as part of this contract. Such defects may include, but not be limited to existing improper splices or existing damaged conduit. The City's Project Manager and Contractor shall determine a plan and cost to correct said defect.

The Contractor is responsible for locates within the project area, until the final inspection is complete.

C. SUBSTANTIAL COMPLETION

The communications system shall not be considered substantially complete until all items shown on the proposal or called for in any contract document are completed to the satisfaction of the City's Project Manager excluding seed/sod if outside planting season. The system shall be fully operational in conformance with the Plans and Standard Specifications and these or any other Special Provisions included as part of the project.

Liquidated damages shall continue to accrue until such time as the Work is deemed to be substantially completed by the City's Project Manager. However, the Contractor may submit a written request to the City's Project Manager for approval to suspend Work to allow additional time for completion of minor items of the Work. Granting the request for additional time by the City's Project Manager shall not relieve the Contractor of responsibilities for the completion of those items for which the suspension is requested.

26.00 GENERAL (Continued)

D. INSPECTION COMPLETION

Upon completion of a fully operational fiber optic communications system (including inventory process for all pull boxes, conduit and fiber being placed, removed and/or added; locate system, fiber cable, and all communications equipment, where applicable), an inspection shall be completed by the City. The Contractor is allowed a defined number of calendar days to complete the following: correct any items as listed on the Inspection Form, return Inspection Form back to City, and correct any subsequent deficiencies identified by inspections until City accepts all work. The Contractor is responsible for providing an electronic format set of plans (as-built drawings) compatible with GIS and/or CAD format, detailing any changes made during construction from the original design. In addition, electronic format of any fiber optic communications system schematics, fiber splice diagrams, and cabinet equipment and connections shall also be provided in above-stated format as acceptable to the City of Lincoln.

Prior to the start of inspection, 1 hard copy and 1 electronic (pdf) copy of as-built plans shall be provided to the City. These as-built drawings shall be labeled "AS BUILT", with the Contractors initials and date.

The number of days for the inspection process is as follows: For the conduit system: 45 calendar days are allowed for the entire conduit system Inspection and Correction process. The City is allowed 14 calendar days for the initial inspection and 7 calendar days for each additional inspection needed thereafter.

Initial and subsequent City inspections shall be included as part of the calendar days allowed. If the Contractor has not corrected all items on the conduit Inspection form to the satisfaction of the City and has not received final acceptance from the City within the allotted time, the Contractor shall be assessed liquidated damages of \$500 per calendar day until all work is completed and deemed acceptable.

E. LOCATE SYSTEM

The locate system is comprised of ground rods, ground bars, fiber locate cable and fiber markers. This system is used by the locate technician to locate communication cables in conduits and indicate where fiber pull boxes are.

All locate system components shall be installed where indicated on the plans.

Ground Bars provide a field wiring terminal for the connection of Fiber Locate Cable.

F. TESTING

1. General

The overall communication system testing shall include a bare end fiber test after installation of the fiber optic cable, and a follow-on test after all final splicing and termination work is completed. On a per project basis, this test procedure may include measuring the loss of fiber installed by others before splicing to it. For each fiber optic link, including spare fibers, determine whether the optical loss is within the limits permitted by these specifications. A link is a continuous segment of fiber between one connector (or unterminated end) and another connector (or unterminated end). When testing links that do not have connectors on both ends, use a mechanical splice to attach a pigtail to the unterminated fiber for the duration of the test.

26.00 GENERAL (Continued)

G. TESTING (Continued)

1. General (Continued)

Acceptance Testing is incidental to the Fiber Optic Cable and will not be paid for separately.

2. Procedures

For each fiber link, follow this procedure:

If the link includes fiber installed by others, use an optical loss test set to measure and record the optical loss over that portion of the link before it is spliced to new fiber.

Calculate the maximum allowable loss for the completed link, both at 1310 nm and at 1550 nm. Use the following formula:

Maximum link loss = Measured loss over portion installed by others
+ (Fiber length in km) x (0.35 for 1310 nm and 0.25 for 1550 nm)
+ (Number of fusion splices) x (0.05)
+ (Number of mechanical splices [for temp. connection]) x (0.3)
+ (Number of connections) x (0.5)

Provide this calculation to the engineer along with the test results.

If the measured loss exceeds the calculated maximum, use an optical time domain reflectometer and other test equipment to troubleshoot the link. Take whatever corrective action is required, including cable replacement, to achieve a loss less than the calculated maximum.

Test Result Documentation. Prepare a diagram showing all of the links tested in this project. For the portions installed in this project, show the equipment cabinets, splices, and pigtails. On each line representing a link, show the maximum allowable loss and the actual loss. The actual loss shall be the one measured after all corrective actions have been taken. Submit an electronic copy of this diagram to the engineer, along with the calculations for the maximum allowable loss. Submit the diagrams and calculations in an electronic format acceptable to the engineer.

Documentation. Provide the engineer mark-ups of the plans, neat and legible, illustrating as-built versions of the splice and connection diagrams that are contained in the plans.

Certifications. The fiber optic cable shall be factory certified to meet the requirements in this specification. In addition, the manufacturer shall certify that the fiber optic cable has a life expectancy of 20 years.

Guarantee. All items covered by this specification shall carry a two-year guarantee from the date of acceptance against any defects in workmanship or materials.

26.01 BLANK ON PURPOSE

26.02 FIBER MARKER

A. GENERAL

Fiber Marker shall be a 66" long x 3.9"+, flexible fiberglass post with tapered triangular end for ground installation. Fiber Marker shall have 14" long x 2.8"+ label, that is non-reflective, outdoor-durable, vinyl, with "Warning, Fiber Optic Cable, City of Lincoln, before digging in this area call 402-441-6855". Fiber Marker shall be standard APWA orange color and have a post durability rating for 20+ years outdoor.

B. INSTALLATION

Fiber Marker shall be installed at locations as indicated on the plans by inserting the base end into the soil at a depth of 24", as per the manufacturer's recommendation. Fiber Marker shall be installed within 1' of back edge of the pull box where applicable.

C. BASIS OF PAYMENT

FIBER MARKER, complete, in place and accepted by the City's Project Manager, shall be measured as a single unit and shall be paid for at the contract unit price per each for the item. This price shall be full compensation for furnishing and/or installing the fiber marker; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

26.03 BLANK ON PURPOSE

26.04 EARTHING, BONDING & GROUND BAR

A. GENERAL

1. Ground Bar

Ground Bar shall be 1-UL listed, ANSI Certified, CSA Listed. Ground Bar shall be 10 position. Ground Bar shall be insulated/isolated from the pull box utilizing plastic or nylon standoffs. Ground bars are incidental to new pull boxes and will not be paid for separately, if retrofitting a box call out as a line item.

Ground Bars shall be all copper construction, 6" L x 1/2" H x 1/4" W, with no less than 5 x 3/16" mounting holes. Grounding bar shall be mounted to the side of the pull box using standoffs and shall be placed no less than 6" from the ground rod and 10" from the bottom of the pull box lid on the center of the pull box wall opposite the curb.

2. Locate Wire

Fiber locate wire shall be a new single conductor #14 AWG type THHN 600-volt, stranded copper. Insulation jacket color shall be orange. UL 44 and UL 854, ICEA S-95-658/NEMA WC-70, C (UL) US Federal spec. A-A-59544. Fiber locate cable shall be terminated to the ground bar and is incidental to the communications conduits installed and will not be paid for separately.

3. Bonding Wire

Bonding wire to be a bare #6 AWG, bare solid annealed copper wire (long enough to go from ground bar to bottom of pull box over to ground rod and up ground rod to attach with in 1" of the top of the ground rod). The bonding wire is incidental to new pull boxes and will not be paid for separately, if retrofitting a box, call out as a line item.

B. INSTALLATION

Ground Bars shall be installed at locations as indicated on the plans and shall be mounted at the center point of the sidewall of the Pull Box T48 & T60 opposite the curb, 6" below the top rim. Ground Bar insulators will need to be mounted with 2 stainless steel machine screws through the sidewalls of the pull box, with 2 stainless steel washers on the outside of the pull box. Ground Bars shall then be mounted to the insulators such that they are insulated from the pull box.

C. BASIS OF PAYMENT

GROUND BAR, complete, in place and accepted by the City's Project Manager, shall be measured as a single unit and shall be paid for at the contract unit price per each for the item. This price shall be full compensation for furnishing and/or installing the ground bar; for standoffs; and for all labor, equipment, tools, materials, and incidentals necessary to complete the Work.

26.05 FIBER CABLES

A. TYPES AND CLASSES OF CABLE

All classes of cable shall be on substantially constructed reels, plainly marked as to size, type, and insulation identification. Only 1 length of cable shall be shipped on each reel. All cable must be new. Damaged cable or repairs on damaged cable will not be permitted. All cables shall be stranded copper, with the exception of the bonding wire (from ground rod to ground bar) which shall be a solid bare # 6 AWG as described in previous section.

1. Fiber Locate Cable

Fiber Locate Cable shall be a new single conductor #14 AWG type THHN 600-volt, stranded copper. Insulation jacket color shall be orange. UL 44 and UL 854, ICEA S-95-658/NEMA WC-70, C (UL) US Federal spec. A-A-59544. Fiber Locate Cable is incidental to the communications conduits installed and will not be paid for separately.

2. Single Mode Fiber Cable

All Single-Mode Fiber Cable fiber shall be single-mode conforming to ITU-T G652.D. Single-Mode Fiber Cable shall conform to ANSI/ICEA S-87-640 Standard for Optical Fiber Outside Plant Communications Cable. Cable type shall be non-armored, all Dielectric suitable for lashed aerial and duct installation. Single-Mode Fiber Cable shall contain water swellable tape to prevent water intrusion. Strength member of the Single-mode Fiber Cable shall be of a non-conductive type and shall provide strength sufficient for installation and residual loads. The cable sheath shall have length markings in feet and shall indicate that the unit of measure is feet. The cable shall have an operating temperature range of -40 degrees C to 70 degrees C. Number of single-mode fibers within the Single-mode Fiber Cable shall be specified on the project plans. The cables shall be constructed with twelve fibers per tube.

All fibers shall be suitable for transmission using both 1310 nm and 1550 nm wavelengths. Attenuation shall not exceed 0.35 dB/km and 0.25 dB/km for 1310 nm and 1550 nm signals, respectively.

B. INSTALLATION

1. Fiber Locate Cable

Each locate cable shall be terminated at the conductor terminals on the insulated, isolated Ground Bar affixed to the inside of the pull box and to the ground buss in the cabinet.

2. Single Mode Fiber Cable

Single-Mode Fiber Cables shall be installed in such a manner and by such methods ensuring against harmful stretching of the optical fiber, injury to the jacket, damage to the outer protective covering of the cable, or cable crushing. An approved cable lubricant may be used to aid in pulling through conduit.

26.05 FIBER CABLES (Continued)

B. INSTALLATION (Continued)

2. Single Mode Fiber Cable (Continued)

To provide proper slack in cable, a maximum of 20' (16.5' is preferred) of extra fiber cable shall be neatly coiled and secured in each pull box with Velcro fasteners. For pull box locations with Splice Enclosures, this means a maximum of 20' (16.5' is preferred) of additional cable on each side of the Splice Enclosure for a maximum total 40' (33' is preferred) of slack. Under no circumstance shall any cable be taped or otherwise bound to another cable. Fiber cable shall be installed in conduit with a suitable cable feeding method to protect the cable and guide it into the duct. Break away pulling swivels rated at 600 lbs. shall be used to ensure that the maximum tensile force for the cable is not exceeded and to prevent cable twisting. Ensure that no residual tension remains on the cable after installation, except the weight of the cable.

Do not install conductors carrying AC power in the same wiring harness as cables carrying control or communications signals.

No splices or joints will be permitted to be drawn inside the conduit, nor shall any splices or joints be made in any cable outside of pull boxes or cabinets.

Single-Mode Fiber Cable shall be installed within the ambient temperature limits specified by the manufacturer.

Arrange all fiber cabling, including fiber optic pigtails, so that any removable assembly can be removed without disturbing cabling that is not associated with the assembly being removed.

Prior to installation, perform such tests as indicated in this provision to confirm that the cable is in good condition and complies with the specifications. Any defects found after installation will be deemed the fault of the contractor.

Install the cable such that the optical and mechanical characteristics of the fiber are not degraded. Do not violate the minimum bend radius or the maximum tension, both during and after installation. During cable installation, keep the bend radius at a minimum of twenty times the outside diameter of the cable.

Cables shall be neatly coiled in fiber optic pull boxes and coils shall stand vertically/upright and secured, or hung on cable racks as available for organized storage and ease of future access.

Before any cable installation is performed, provide the engineer with a copy of the cable manufacturer's recommended maximum pulling tensions for each cable size. These pulling tensions shall be specified for pulling from the cable's outer jacket. Also, provide a list of the minimum allowable cable bending radius and the cable manufacturer's approved pulling lubricants. Only those lubricants approved by the cable manufacturer will be permitted.

If the cable is pulled by mechanical means, use a clutch device to ensure the allowable pulling tension is not exceeded. Also, attach a strain gauge to the pulling line at the cable exit location, and at a sufficient distance from the take-up device, such that the strain gauge can be read throughout the entire cable pulling operation.

26.05 FIBER CABLES (Continued)

B. INSTALLATION (Continued)

2. Single Mode Fiber Cable (Continued)

Do not leave the let-off reel unattended during a pull, in order to minimize the chance of applying excess force, center pull, or back feeding.

Use an approved lubricant, in the amount recommended by the cable manufacturer, to facilitate pulling the cable. After the cable has been installed, wipe the exposed cable in a pull box, junction box, or cabinet clean of cable lubricant with a cloth before leaving the pull box, junction box, or cabinet. After installation, cut off and discard the first 10 feet of the cable. These 10 feet are not included in the quantities and are considered incidental to the fiber work. Seal the fiber optic cable ends to prevent the escape of the filling compound and the entry of water.

All fiber optic cables installed in pull boxes or cabinet locations shall be neatly and definitively labeled using fiber cable tags provided by the City of Lincoln. These fiber optic cable tag labels shall be labeled by the contractor with the number and direction of fiber cables (to/from) and which fibers are spliced, if any.

All fiber optic cable, new or relocated, shall be tested by the Contractor with an Optical Time Domain Reflectometer (OTDR). Testing shall be performed after all connectors are complete if the Contractor is expected to perform the connectorization. If the contractor is not expected to perform the connectorization then a bare end test of the fiber shall be performed to test cable integrity after contractor installation. In the case of separate contractors for Fiber Optic Cable install and Fiber connectorization an additional OTDR test will be required of the connectors by the connector contractor after all specified connectors are complete. Testing of fiber optic cable shall be conducted in conformance with the Acceptance Testing section of these provisions.

C. BASIS OF PAYMENT

CABLE, FIBER OPTIC, ___ STRAND, SINGLE MODE complete, in place and accepted by the City's Project Manager shall be measured as lineal feet from center to center of pull boxes, cabinets, or enclosures plus slack coil amounts furnished and installed as specified on the plans of such material of the size and type required and number of fibers. Cable shall be paid for at the contract unit price bid per linear feet. All fibers shall have in/out numbers on final as built.

This price and payment shall be full compensation for furnishing and installing cable, all necessary slack, testing, documentation, inventorying, connections and all other materials, hardware, labor, equipment, tools, and incidentals necessary to complete the work.

Additional slack cable required inside pull boxes, cabinets, and other such devices or structures, not quantified or indicated on the plans shall be subsidiary to those items and shall not be measured for payment.

26.06 FIBER CONNECTORS, ENCLOSURES AND ACCESSORIES

A. COMPONENTS

1. Fiber SC or LC Connector

All Fiber SC or LC Connectors shall be temperature rated for -40 C to 70 C or better, and shall be compliant with ANSI/TIA-568-B.3 and TIA/EIA-604-3. Fiber SC or LC Connectors shall be SC or LC type compatible with single-mode fiber and shall be terminated using an appropriate Fiber Fan Out Kit. Fan Out Kits are incidental to fiber termination work.

All Fiber SC or LC Connectors shall be installed using the method recommended by the connector manufacturer, and shall be installed compatible with both Fiber Distribution Rack Mount Enclosures, and Fiber Distribution Wall Mount Enclosures.

2. Fiber SC or LC Panel Pigtail

Fiber SC or LC Panel Pigtail shall be temperature rated for -40 °C to 70 °C and shall conform to Design and Test Criteria GR-3152, GR-771. Fiber SC or LC Panel Pigtail shall have 12 SC or LC UPC single mode ports in a housing with an outdoor single mode pigtail of appropriate length for the application. Fiber SC or LC Panel Pigtail shall be wall, or din rail mountable.

3. Fiber Optic Cable Fusion Splice

When a buffer tube is required to be opened in order to perform fusion splicing, cut only the fibers to be terminated/spliced at a location according to the Plans. Unused fibers or fibers that are continuous through a splice location (expressed fibers) are to be coiled, and neatly routed around the inside edges of the splice tray. Fusion splicing will ensure alignment is via fiber cores and splicing equipment shall be fully automated X, Y, and Z axis (3-axis) alignment using a light injection/detection system. Use splicing equipment that has an auto fusion time control to monitor the power level through the splice to complete the fusing process when splice loss is a minimum. Provide splice losses that average less than or equal to 0.05dB/splice between any two optical ports, and do not exceed the same level for any splice. Protect all splices with a thermal shrink sleeve, 60 mm long. Place the completed splices in a splice tray.

4. Fiber Optic Cable Splice Enclosures

Fiber Optic Splice Enclosures shall be listed in the latest edition of the Rural Utilities Service (RUS), List of Materials Acceptable for Use on Telecommunications Systems of RUS Borrowers, category pl, closure design e, suffix B; or be of brand Coyote Fiber Optic Closures, or approved equal. They shall include all materials necessary to make, organize, and protect the splices.

Fiber Optic Splice Enclosure housing shall be non-metallic resistant to solvents, stress cracking, and creep.

Fiber Optic Splice Enclosure shall be re-enterable not requiring encapsulation or potting to resist water penetration.

26.06 FIBER CONNECTORS, ENCLOSURES AND ACCESSORIES (Continued)

A. COMPONENTS (Continued)

4. Fiber Optic Cable Splice Enclosures (Continued)

The Fiber Optic Splice Enclosure shall be of a size sufficient to accommodate the number of Single-Mode Fiber Cables and splices specified on the project plans. Fiber Optic Splice Enclosures shall be furnished and installed as either “small” or “large” as defined on the project plans and specs. Fiber Optic Splice Enclosure, Small; shall be able to accommodate a minimum of 48 splices. Fiber Optic Splice Enclosure, Large; shall be able to accommodate a minimum of 144 splices. The Fiber Optic Splice Enclosure shall provide a clamping mechanism to prevent pistoning of the central strength member and to prevent cable sheath pullout.

The Fiber Optic Splice Enclosure shall have appropriate hardware and installation procedures to facilitate the bonding and grounding of metal components in the enclosure and the armored cable sheath. The cable bonding hardware shall be able to accommodate a copper conductor equal to or larger than a No. 6 AWG.

The Fiber Optic Splice Enclosure shall accommodate and include splice trays suitable for single fiber, single fiber heat shrink, mechanical, or ribbon heat shrink splices, and shall accommodate the number of splices specified in the project plans.

A bond clamp shall remain firmly attached to the cable armor sheath while under a tensile load of 9-kg (20 lbf). Following removal of the load, there shall be no evidence of clamp loosening or damage to the cable sheath, armor, or clamp that would reduce its current carrying capacity as required by the AC fault test.

The electrically conductive path used for continuity and grounding of the splice enclosure metallic components shall be capable of withstanding an AC current of 1000 Amperes for 20 seconds.

The cable clamping and sealing hardware used to terminate optical fiber cable shall not cause an attenuation change greater than ± 0.05 dB per fiber, when tested with a source operating at $1550\text{nm} \pm 20\text{nm}$.

An axial load of 100 lbf, individually applied to each cable, shall not cause mechanical damage to the cable or clamping hardware. The load to the optical fiber cable shall not cause an attenuation change greater than ± 0.05 dB per fiber, when tested with a source operating at $1550\text{nm} \pm 20\text{nm}$.

Subjecting the closure/cable interface to 90° flexing for 8 cycles at ambient temperatures of $-18^\circ\text{C} \pm 2^\circ\text{C}$ ($0^\circ\text{F} \pm 3.6^\circ\text{F}$) and $40^\circ\text{C} \pm 2^\circ\text{C}$ ($104^\circ\text{F} \pm 3.6^\circ\text{F}$) shall not cause any mechanical damage to the cable or clamping hardware. In addition, flexing of the optical fiber cable shall not cause an attenuation change greater than ± 0.05 dB per fiber, when tested with a source operating at 1550 ± 20 nm.

Subjecting the closure/cable interface to 10 cycles of torsional loading at ambient temperatures of $-18^\circ\text{C} \pm 2^\circ\text{C}$ ($0^\circ\text{F} \pm 3.6^\circ\text{F}$) and $40^\circ\text{C} \pm 2^\circ\text{C}$ ($104^\circ\text{F} \pm 3.6^\circ\text{F}$) shall not cause any mechanical damage to the cable or clamping hardware. In addition, torsional loading of the optical fiber cable shall not exceed allowable attenuation changes.

26.06 FIBER CONNECTORS, ENCLOSURES AND ACCESSORIES (Continued)

A. COMPONENTS (Continued)

4. Fiber Optic Cable Splice Enclosures (Continued)

The enclosure shall not exhibit any mechanical damage after being subjected to a vertical drop from a height of 0.75 m (30") at temperatures of $-18^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($0^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) and $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($104^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$).

The diameter of the optical fiber splice enclosure shall not permanently deform more than 10%, nor temporarily deform more than 20%, when it is compressed by a uniformly distributed load of 300 lbf. Additionally, the compressive load shall cause no mechanical damage to the enclosure or its contents.

The enclosure shall not exhibit any mechanical damage after being subjected to mechanical impact of 100 lbf (136 Nm) at temperatures of $-18^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($0^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) and $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($104^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$).

The enclosure central member clamp shall prevent movement (e.g. bowing, pistoning, or breaking) of the cable central member (CM) when the CM exerts a force of 100 lbf on the clamp.

Sealing components (gaskets, grommets, O-rings) used in an enclosure, shall not permit the entry of water into the enclosure after thermal aging at $90^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($194^{\circ}\text{F} \pm 1.8^{\circ}\text{F}$) for 720 hours (30 days).

The enclosure shall be capable of safe and proper assembly at temperatures of $0^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($32^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) and $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($104^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) using materials and procedures specified by the manufacturer.

The enclosure shall not exhibit any mechanical damage or corrosion following 30 days of severe temperature and humidity cycling from $65^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($150^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) and 95% relative humidity to $-40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($-40^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) and uncontrolled humidity. Additionally, at the midpoint of the temperature cycle, re-entry and re-assembly of the enclosure shall be done. If the enclosure has a hinged cover, it shall be flexed 25 times.

The enclosure shall show no evidence of water intrusion into the compartment containing fiber splices after it is immersed in water and subjected to 10 freeze/thaw cycles.

The splice enclosure shall show no evidence of water penetration following exposure to a 20' waterhead for a period of 7 days.

An enclosure shall show no evidence of corrosion following exposure to acidified saltwater for a period of 90 days.

The enclosure shall show no change in sealing ability after submersion in a specified chemical test fluid for 7 days. The mechanical integrity of the enclosure shall be confirmed by performing the compression and impact tests. The enclosure seal shall also be checked by performing the water immersion test. Additionally, samples of external, nonmetallic enclosure materials shall neither experience a change in weight greater than 10%, nor experience a reduction in tensile strength or elongation properties greater than 20%, after immersion in the chemical test fluid.

26.06 FIBER CONNECTORS, ENCLOSURES AND ACCESSORIES (Continued)

A. COMPONENTS (Continued)

4. Fiber Optic Cable Splice Enclosures (Continued)

Samples of external, nonmetallic enclosure materials shall not have a reduction in tensile strength or elongation properties greater than 20% of their original value, after being exposed to a UV-B type ultraviolet light source with a peak emission at 313 nm for 2,160 hours (90 days).

Samples of polymeric enclosure materials shall not support fungus growth when tested per ASTM G 21. A rating of 0 is required.

5. Fiber Distribution Wall Mount Enclosure

Fiber Closet Connector Housing shall be a wall mountable housing capable of housing 4 Fiber SC or LC Closet Pigtailes. Closet Connector Housing shall be compatible with SC or LC Closet Pigtailes. Closet Connector Housing shall have storage for appropriate splice trays. Closet Connector Housing shall have a hinged door to provide convenient access to installed SC or LC Closet Pigtailes and splice trays.

6. Fiber Distribution Rack Mount Enclosure

Fiber Rack Mount Connector Housing shall be a 19" rack mountable housing capable of housing 4 SC or LC Closet Pigtailes. Fiber Rack Mount Connector Housing shall be compatible with SC or LC Closet Pigtailes. Closet Connector Housing shall have storage for appropriate splice trays. Rack Mount Connector Housing shall have a hinged door to provide convenient access to installed SC or LC Closet Pigtailes and splice trays.

7. Factory Terminated Patch Panel w/ Pigtail

Factory terminated patch panels with pigtailes will provide for connectivity between field cabinets and fiber optic cable in pull boxes. The factory terminated end will be mounted in the traffic signal or ITS cabinet, and the opposite end of the pigtail shall be spliced in the Fiber Splice Enclosure located in the T48. A fiber splice schematic indicating the fusion splice plan will be provided by the City. The factory terminated patch panels with pigtailes shall be provided in either 4-step, skinny (8 fiber port) or 6-step, skinny (12 fiber port) configurations and have type SC or LC connectors. They shall have the following characteristics:

Test	Single mode
Test wavelength	1550nm
Insertion loss	0.2dB typical, 0.5dB max.
Reflectance	<-55dB (apc connector)
Durability	500 matings, <0.2dB change
Tensile strength - straight pull (cable tail)	50lbs (220N), <0.2dB change
Temperature range	-40 to +70C
Ferrule polish	UPC
Connector Type	SC or LC

The Factory Terminated Patch Panel w/ Pigtail, whether 4-step or 6-step, shall be provided with a minimum pigtail length of 75' unless otherwise noted in special cases.

26.06 FIBER CONNECTORS, ENCLOSURES AND ACCESSORIES (Continued)

A. COMPONENTS (Continued)

8. Junction Box

Junction Box shall be 2' x 2' x 6" Powder coated steel. Junction Box shall be NEMA 3R rated and shall be lockable.

9. 3", 3 Cell Fabric Innerduct

3", 3 Cell Fabric Innerduct shall be 3", 3 cell polyester/nylon textile innerduct. Fabric Innerduct shall be capable of accommodating up to a 1" diameter cable per cell. Fabric Innerduct shall contain 1250 lb. polyester flat woven pull tape.

B. INSTALLATION

1. Fiber SC or LC Connector

For Single-Mode Fiber Optic Cable the below table specifies minimum acceptable SC or LC Connector performance:

Loss Mode	Maximum Acceptable Loss (dB)
Single-Mode SC or LC connector (dB loss/connector)	.50 dB max

All OTDR test shall be performed using appropriate launch and receive cables. OTDR submitted test results shall use the full scale of the OTDR display, shall include 2 point loss from launch cable to launch cable, and shall include Optical Return Loss. When testing connectors, a 2 point loss measurement across the connector shall be performed. All testing shall be performed at 1310nm and 1550nm wavelengths.

2. Fiber SC or LC Panel Pigtail

SC or LC Panel Pigtail shall be securely installed where indicated on plans. SC or LC Panel Pigtail shall be mounted in such a way so as to allow easy access. SC or LC Panel Pigtail shall be spliced into existing fiber using a fusion splice. Finished splice shall be housed in a Fiber Splice Enclosure. After installation the SC or LC Panel Pigtail shall be tested with an Optical Time Domain Reflectometer using appropriate launch and receive cables. SC or LC Panel Pigtail shall meet or exceed the below parameters:

Loss Mode	Maximum Acceptable Loss (dB)
SC or LC Connector Insertion Loss (Per Connector)	.50 dB Max
SC or LC Panel Pigtail Fusion Splice (Per Splice)	≤ 0.30 Db

26.06 FIBER CONNECTORS, ENCLOSURES AND ACCESSORIES (Continued)

B. INSTALLATION (Continued)

3. Fiber Optic Cable Fusion Splice

Fiber Optic Cable Fusion Splice shall be cleaved, cleaned, aligned and spliced according to the fiber splice machine specifications.

Splice shall be protected with either Butterfly or heat shrink splice protection and shall be secured in a splice tray designed for fusion splices

4. Fiber Optic Cable Splice Enclosure

Installation of Fiber Optic Cable Splice Enclosure shall follow manufacturer's directions. Installation of Fiber Optic Cable Splice Enclosures in underground Fiber Pull Boxes shall be done in conformance to manufactures directions. Fiber Optic Cable Splice Enclosure shall be neatly stored upright/vertical and secured within the T48 or T60 pull boxes along with excess fiber coils. No Fiber Optic Cable Splice Enclosures shall be permitted for direct burial or in conduit splicing. No splice case will be allowed in any pull box smaller than a T48.

5. Fiber Distribution Wall Mount Enclosure

Fiber Distribution Wall Mount Enclosure shall be securely installed where indicated on plans and shall use appropriate mounting hardware. Closet connector housing shall be mounted in such a way as to provide easy access to connector housing access door and the connection points.

6. Fiber Distribution Rack Mount Enclosure

Fiber Distribution Rack Mount Enclosure shall be securely installed where indicated on plans and shall use appropriate mounting hardware. Rack Mount Enclosure shall be mounted in such a way as to provide easy access to components, doors and connection points as mounted within ITS cabinets.

7. Factory Terminated Patch Panel w/ Pigtail

Installation of the Pigtails shall follow manufacturer's instructions.

8. Junction Box

Junction Box shall be installed where indicated on plans and shall be securely fastened to building using 4 fastening points. Building entrances shall be PVC conduit of a size specified on the plans and shall use weather tight bulkheads on all entrances to the Junction Box. All entrances to building shall be sealed with mastic to prevent water intrusion.

9. 3", 3 Cell Fabric Innerduct

Fabric Innerduct shall be installed from Pull Box to Pull Box or where specified on plans using continuous unspliced lengths. Fabric Innerduct shall be installed using the manufacturers specified installation procedure. After installation, Fabric Innerduct and pull tape shall be secured following the manufacturer's recommended method.

26.06 FIBER CONNECTORS, ENCLOSURES AND ACCESSORIES (Continued)

C. BASIS OF PAYMENT

FIBER SC or LC CONNECTOR; FIBER SC or LC PANEL PIGTAIL; FIBER OPTIC CABLE FUSION SPLICE; FIBER OPTIC CABLE SPLICE ENCLOSURE, ____; FIBER DISTRIBUTION WALL MOUNT ENCLOSURE; FIBER DISTRIBUTION RACK MOUNT ENCLOSURE; FACTORY TERMINATED PATCH PANEL W/PIGTAIL, ____-STEP and JUNCTION BOX, 2' X 2' complete, in place and accepted by the City's Project Manager, shall be measured as a single unit and shall be paid for at the contract unit price bid per each. This price and payment shall be full compensation for furnishing and installing the items; all fiber OTDR testing is covered as part of splicing, and for all labor, equipment, tools, materials, and incidentals required to complete the Work.

For City of Lincoln furnished items: FIBER SC or LC CONNECTOR, INSTALL; FIBER SC or LC PANEL PIGTAIL, INSTALL; FIBER OPTIC CABLE SPLICE ENCLOSURE, ____, INSTALL; FIBER DISTRIBUTION WALL MOUNT ENCLOSURE, INSTALL; FIBER DISTRIBUTION RACK MOUNT ENCLOSURE, INSTALL and FACTORY TERMINATED PATCH PANEL W/PIGTAIL, ____-STEP; complete, in place and accepted by the City's Project Manager, shall be measured as a single unit and shall be paid for at the contract unit price bid per each. This price and payment shall be full compensation for installing the items as provided by City of Lincoln; and for all Fiber testing (OTDR), labor, equipment, tools, materials, and incidentals required to complete the Work.

3", 3 CELL FABRIC INNERDUCT, complete, in place and accepted by the City's Project Manager, shall be measured as lineal feet from center to center of pull boxes, or where specified on plans, of such material of the size and type require and shall be paid for at the contract unit price bid per linear feet. This price and payment shall be full compensation for furnishing and installing 3", 3 Cell Fabric Innerduct, pulling tape, all necessary slack, documentation; and for all labor, equipment, tools, materials, and incidentals required to complete the Work.

26.07 INSTALL ITS FIELD SWITCH

A. GENERAL

ITS Field Switch shall be a field-hardened, Ethernet switch provided by the City of Lincoln for installation in cabinet locations as part of Traffic Signal and ITS projects as indicated on the plans.

B. INSTALLATION

ITS Field Switch shall be installed at locations shown on the plans. Unless otherwise specified, the units shall be shelf-mounted in cabinets as indicated, for applicable connections to communications cable and equipment. Switches will be pre-programmed by City of Lincoln, Traffic Operations, with relevant SFP modules for installation. Proper power supplies shall also be installed on din rails, and will be provided by City of Lincoln for contractor installation.

C. BASIS OF PAYMENT

INSTALL ITS FIELD SWITCH, complete, in place, and accepted by the City's Project Manager, shall be measured for payment as single units and shall be paid for at the contract unit price bid per each for the item only when called for. This price and payment shall be full compensation for picking up and installing ITS Field Switch, all labor, equipment, tools, and incidentals necessary to complete the Work.

26.08 FIBER SYSTEM CAPACITIES AND LIMITATIONS

A. GENERAL

When a reference is made about Fiber system capacities it will be in reference to the following:

1. # of conduit per pull box size
2. # and size of splice enclosures allowed per pull box size

B. INSTALLATION REQUIREMENTS

T6, T9, TR27 and T36 (reserved for Traffic only no fiber)

T48 & T60 are only sizes allowed for new fiber installations

T48 limited to 12-1.25" conduits or 4-4" conduits

T48 may have a maximum of 2 splice cases

If any of the above are exceeded the pull box will need upgraded to a T60 or an additional box will need placed to accommodate.

T60 limited to 16-1.25" conduits or 5-4" conduits

T60 may have a maximum of 3 splice cases

If any of the above is exceeded an additional box will need to be placed to accommodate.

C. BASIS OF PAYMENT

All costs associated with upgrading or adding additional boxes will be at the cost of the requester for the plan set.

END OF SECTION