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MSCAA Design Guide - Construction Standards
MSCAA Comprehensive Storm Water Pollution Prevention Plan
Geotechnical Report Dated March 30, 2021

END OF SECTION 00010

DIVISION 0 – SECTION 00405

PROPOSAL

Project Identification: **Glycol Management Program - Control Facility - Construction**

Contract Number: MSCAA Project No. **08-1260-05**

For Overnight Courier (FedEx/UPS), or Hand Delivery Submit to:

Memphis-Shelby County Airport Authority
Memphis International Airport
Procurement Department
4150 Louis Carruthers Drive
Memphis, Tennessee 38118

1. The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an agreement with Owner in the form included in the Contract Documents to perform and furnish all Work as specified or indicated in the Contract Documents for the Contract Price and within the Contract Time indicated in this Bid and in accordance with other terms and conditions of the Contract Documents.

2. Bidder accepts all of the terms and conditions of the Legal Notice to Bidders and Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for thirty (30) days after the day of Bid opening. Bidder will sign and submit the Construction Contract with the Bonds and other documents required by the Bidding Requirements, within ten (10) days after the date of Owner's Notice of Award.

3. In submitting this Bid, Bidder represents, as more fully set forth in the Contract that:

   (a) Bidder has examined copies of all the Bidding Documents and of the following Addenda (receipt of all which is hereby acknowledged):

Date	Number

   (b) Bidder has familiarized itself with the nature and extent of the Contract Documents, Work, site, locality, and all local conditions and Laws and Regulations that in any manner may affect cost, progress, performance or furnishing of the Work.

(c) Bidder has studied carefully all reports and drawings of subsurface conditions and drawings of physical conditions which are identified in Division 0 and Division 1 Specifications, and accepts the determination set forth in General Provision Section 20 paragraph 20-06 of the extent of the technical data contained in such reports and drawings upon which Bidder is entitled to rely.

(d) Bidder has obtained and carefully studied (or assumes responsibility for obtaining and carefully studying) all such examinations, investigations, explorations, tests and studies (in addition to or to supplement those referred to in (c) above) which pertain to the subsurface or physical conditions at the site or otherwise may affect the cost, progress, performance or furnishing of the Work at the Contract Price, within the Contract Time and in accordance with other terms and conditions of the Contract Documents, including specifically the provisions of General Provision Section 20 paragraph 20-06; and no additional examination, investigations, explorations, tests, reports or similar information or data are or will be required by Bidder for such purposes.

(e) Bidder has reviewed and checked all information and data shown or indicated on the Contract Documents with respect to existing Underground Facilities at or contiguous to the site and assumes responsibility for the accurate location of said Underground Facilities. No additional examinations, investigations, explorations, tests, reports or similar information or data in respect of said Underground Facilities are or will be required by Bidder in order to perform and furnish the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents.

(f) Bidder has correlated the results of all such observations, examinations, investigations, explorations, tests, reports and studies with the terms and conditions of the Contract Documents.

(g) Bidder has given Owner or Engineer written notice of all conflicts, errors or discrepancies that it has discovered in the Contract Documents and the written resolution thereof by Owner or Engineer is acceptable to Bidder.

(h) This Bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid: Bidder has not solicited or induced any person, firm or corporation to refrain from bidding; and Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over Owner.

4. Bidder will complete Base Bid Work for the following price(s).

UNIT PRICE SCHEDULE – BASE BID

ITEM NO.	DESCRIPTION	UNIT	QUANT.	TOTAL PRICE
1	GLYCOL CONTROL FACILITY	LS	1	$
2	UTILITY ALLOWANCE	ALLOW	1	$125,000
3	INTERIOR FURNISHINGS	ALLOW	1	$25,000
4	IT ALLOWANCE	ALLOW	1	$150,000
5	MOBILIZATION (FIXED COST)	LS	1	$500,000
6	DEMOBILIZATION (FIXED COST)	LS	1	$300,000
TOTAL BASE BID (TOTAL OF LINE ITEMS 1-6)				**$**_____

CONTRACT BASE BID TOTAL (TOTAL OF LINE ITEMS 1-6):

_____

(use words)

_____

($_____)

5. The Owner reserves the right to reject any or all bids in whole or in part and to waive any informalities, technicalities, or omissions therein.

   It is intention of the Owner to award a contract based upon the lowest responsive bid on the lump sum base bid. Bidder understands and agrees that, after a review of all the bids, the Owner will select the lump sum base bid that best suits the Owner's needs within the sole discretion of the Owner.

6. Bidder agrees that the Work: will be completed and ready for final payment within the calendar days (as described in Section 01100) after the date when the Contract Time commences to run. Bidder accepts the provisions of the Contract as to liquidated damages in the event of failure to complete the Work on time.

7. See Section 00200, INSTRUCTIONS TO BIDDERS, for a complete list of documents that are made a condition of this Bid.

8. Communications concerning this Bid shall be addressed to: _____
   (Printed Name)

   The address of Bidder indicated above, or

   the following address: _____

   email address: _____

9. The terms used in this Bid which are defined in General Provision Section 10 of the Specifications included as part of the Contract Documents have the meanings assigned to them in the Division 0 and Division 1 Specifications.

   Submitted on _____, 20_____.

10. The undersigned Bidder confirms that (1) neither Bidder nor any of Bidder's potential subcontractors or suppliers have pending claims or litigation, arbitration, or other dispute resolution proceedings where the Owner and Bidder or Bidder's potential subcontractors or suppliers are parties; or (2) such claims or proceedings are pending and Bidder is disclosing same through its own writing and/or the writing of Bidder's potential subcontractors or suppliers and submitting same to Owner with this proposal submittal.

If Bidder is:

An Individual

_____
(Individual's Printed Name)

_____
(Individual's Signature)

doing business as: _____

Business address: _____

_____

Phone No.: _____ FAX No. _____ E-Mail _____

A Partnership

_____
(Firm Name)

By: _____
(Signature of General Partner and Printed Name)

Business address: _____

_____

Phone No.: _____ FAX No. _____ E-Mail _____

A Corporation

_____
(Corporation Name)

By:_____ Title:_____
(Signature of person authorized to sign)

_____
(Printed Name)

(Corporate Seal)

Attest:_____
(Signature of Secretary) (Printed Name)

_____
(State of Incorporation)

Business address:_____

_____

Phone No.:_____ FAX No. _____ E-Mail_____

A Joint Venture

_____
(Joint Venture)

By:_____
(Signature of Joint Venturer) (Printed Name)

_____
(Address)

Phone No.:_____ FAX No. _____ E-Mail_____

By:_____
(Signature of Joint Venturer) (Printed Name)

_____
(Address)

Phone No.:_____ FAX No. _____ E-Mail_____

(Each joint venturer must sign. The manner of signing for each individual, partnership and corporation that is a party to the joint venture should be in the manner indicated above).

END OF SECTION 00405

DIVISION 1 – SECTION 01100

SUMMARY OF THE WORK, SEQUENCE OF CONSTRUCTION & LIQUIDATED DAMAGES

PART 1 GENERAL

Related Work:

1. Documents affecting work of this Section include, but are not necessarily limited to Division 0 and Division 1 and other Sections of these Specifications.

1.01 SUMMARY

SUMMARY OF WORK

A. The "Project," of which the "Work" of this Contract is a part, is titled Glycol Management Program - Control Facility - Construction, MSCAA Project 08-1260-05.

B. The "Work" of this Contract is defined in the Contract Documents to include, but not be limited to, site preparation, site drainage, water main installation, sanitary sewer, concrete and asphalt paving driving services, and fencing. Building Work consists of concrete and steel structural members, masonry, glazing, drywall, acoustical tile ceilings, carpentry, painting, electrical, plumbing, HVAC, fire protection, data cabling, camera and door security, and specialty equipment as detailed in the construction documents.

C. FAA Inspection and Review: The Contractor shall allow any authorized representative of the FAA to inspect and review any work or materials used in the performance of this contract.

D. Subcontracts: The Contractor shall insert in each of his subcontracts the provisions contained in paragraphs C of this section and also a clause requiring the subcontractors to include these provisions in any lower tier subcontracts which they may enter into, together with a clause requiring this insertion in any further subcontracts that may in turn be made.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.01 PROJECT PHASING AND COMPLETION

A. This is a fixed-duration Contract required to be substantially completed within one hundred and twenty (335) calendar days from the Notice to Proceed ("NTP") date. The project scope of work is as stated in Paragraphs 1.01 (A) and (B) above. Final Completion of the project shall be within forty-five (45) days of the Substantial Completion Date.

"Substantial Completion" of the project shall be defined as the stage of construction when work is substantially completed and excludes all minor punch list items, record drawings, O&M manuals, lien waivers, maintenance training, warranties, consent of surety to final payment, and all other required closeout documentation.

"Final Completion" of the project shall be defined as work that is 100% complete including all minor punch list items, record drawings, O&M manuals, lien waivers, maintenance training, warranties, consent of surety to final payment, and all other required closeout documentation. Final Completion shall include Demobilization.

"Demobilization" shall consist of all activities by the Contractor and subcontractors necessary for 100% completion of the work and final contract closeout as listed above and all cleanup work and operations, including but not limited to, removal of personnel, equipment, contractor-owned stockpiles, supplies, and incidentals from the project site; return of any and all airport-issued security identification badges; cleanup of all offices, buildings, batch plant, staging/lay-down areas, and other facilities; and restoration of all areas to preconstruction condition or better or to other condition as stipulated in the project plans and specifications; completion and delivery to the Owner of all contract closeout documentation and any other documentation request by Owner, including but not limited to, Operations and Maintenance Manuals, Warranties, Final Lien-waivers, Owner Controlled Insurance Program closeout paperwork, DBE paperwork, Final Project Record Documents and finalization of any and all punch list items. The Demobilization lump sum amount becomes fixed and will not change for the duration of contract.

B. The actual NTP date will be negotiated and mutually agreed by both parties (Owner and Contractor) prior to issuance of the NTP. If mutual agreement cannot be reached between the parties, the Owner reserves the right to establish the actual Notice to Proceed date. The NTP letter will state the date on which the Contractor will begin construction and from which date contract time will be charged. Contractor shall be able to start mobilization efforts on the date stated in the Notice to Proceed.

C. "Mobilization" shall consist of all preparatory work and operations needed to begin construction activities on the date mutually agreed including but not limited to, badging, submittals, material procurement, movement of personnel, equipment, stockpiles, supplies and incidentals to the project site; the establishment of all offices, buildings, batch plant, staging/lay-down areas and other facilities necessary for work on the project; all other work and operations which must be performed or costs incurred prior to beginning work on the various items on the project site, and utility services for all offices, buildings, batch plant, staging/ lay-down areas, and other facilities. The Mobilization lump sum amount becomes fixed and will not change for the duration of contract.

D. All days are calendar days.

E. The work site will be available as described on the plans and applicable sections of these specifications. Work is permitted 24 hours per day, 7 days per week except that only non-noise producing activities shall be permitted between 11:00 PM and 6:00 AM, except with prior written approval of the Owner.

F. The Contractor shall proceed with the work at such rate of progress to ensure full completion within the specified duration. It is expressly understood and agreed, by and between the Contractor and the Owner, that the contract time for the completion of the work described herein is a reasonable time, taking into consideration the average climatic and economic conditions and other factors prevailing in the locality of the work.

G. If the Contractor experiences weather related delays, he shall submit a report documenting the weather conditions and delays, if any, experienced during any calendar month.

H. If the Contractor is prevented from working due to any other legitimate reason he shall notify the Owner in writing as per the Lump Sum Construction Contract of the delay and request a corresponding increase in the number of contract days.

I. The Owner shall be the sole judge as to whether or not a request for a contract time extension is legitimate.

J. The Owner reserves the right to adjust limits of construction to accommodate the Owner's requirements for maintenance of Airport Operations and Public Traffic with minimum interruption during the construction of this project. Any required adjustment of limits of construction will be at

no additional cost to the Owner.

3.02 LIQUIDATED DAMAGES

A. The OWNER and the CONTRACTOR recognize that time is an essential element of this contract and that delay in completing this project will result in damages due to public inconvenience, obstruction to aviation and vehicular traffic, interference with businesses both on and off the airport, increased operational costs to airport users, and increased costs to the OWNER associated with engineering services, inspections, testing, and project administration. It is therefore agreed that in view of the difficulty of making a precise determination of such damages, the CONTRACTOR will pay the OWNER, sums of money in the amounts herein stipulated, not as a penalty, but as Liquidated Damages for not meeting the schedule for specific critical Project Milestones.

B. If the CONTRACTOR fails to deliver equipment or materials, or perform any services within the times and dates specified in this Contract to achieve the established Milestones, or any extensions granted in writing, the CONTRACTOR shall pay to the OWNER as Liquidated Damages, the sums specified in Table 1, below:

Table 1

Milestone	***Completion Date***	***Liquidated Damages***
Substantial Completion	335 days	$5,000 per Day or any portion thereof
Final Completion and Demobilization Phase	45 days	$1,000 per Day or any portion thereof

D. Application of Liquidated Damages is not a Change to the Contract. The application of any Liquidated Damages to one Milestone shall not effect a change in the subsequent Contract Milestone dates or relieve CONTRACTOR of his responsibility to meet all construction schedules. If multiple Milestone dates are missed, Liquidated Damages for more than one Milestone will be imposed concurrently.

E. If Liquidated Damages are imposed, the OWNER shall deduct the same from any amounts due the CONTRACTOR at the time Liquidated Damages are imposed. If sufficient amounts are not due to the CONTRACTOR to cover such Liquidated Damages, then the OWNER shall invoice the CONTRACTOR for the amounts due to the OWNER. Such invoices shall become due and payable immediately upon receipt by the CONTRACTOR.

F. In the event that the substantial completion date is missed and caused solely by documented material/supply chain delays, Liquidated Damages will not be assessed.

G. Liquidated Damages are in addition to any other damages or penalties which may be assessed and withheld under other provisions of this contract.

3.03 COMPLETION BONUS

NO completion bonus has been budgeted for this project.

END OF SECTION 01100

SECTION 21 32 13
ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vertical in-line fire pumps.
   2. Fire-pump accessories and specialties.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.

C. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each fire pump, from manufacturer.

E. Source quality-control reports.

F. Field quality-control reports.

G. Operation and maintenance data.

1.4 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. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

A. Description: Factory-assembled and -tested fire-pump and driver unit.

B. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.

C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

2.2 VERTICAL, IN-LINE FIRE PUMPS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings <FPP-1> or comparable product by one of the following:

1. A-C Fire Pump Systems; a business of ITT Industries.
2. Patterson Pump Company; a subsidiary of the Gorman-Rupp Company.
3. Peerless Pump, Inc.
4. Pentair Pump Group; Aurora Pump.
5. S.A. Armstrong Limited.

B. Pump:

1. Standard: UL 448, for in-line pumps for fire service.
2. Casing: Radially split case, cast iron with ASME B16.1 pipe-flange connections.
3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
4. Wear Rings: Replaceable bronze.
5. Shaft and Sleeve: Steel shaft with bronze sleeve.
    a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
    b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
6. Mounting: Pump and driver shaft is vertical, with motor above pump and pump on base.

C. Coupling: None or rigid.

D. Driver:

1. Standard: UL 1004A.
2. Type: Electric motor; NEMA MG 1, polyphase Design B.

E. Capacities and Characteristics:

1. Rated Capacity: 750 gpm.
2. Total Rated Head: 40 psig.
3. Inlet Flange: Class 250.

4. Outlet Flange: Class 250.
5. Suction Head Available at Pump: 45 psig.
6. Motor Horsepower: 40 Hp.
7. Motor Speed: 1800 rpm.
8. Electrical Characteristics:

    a. Volts: 460.
    b. Phase: Three.
    c. Hertz: 60.

2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

C. Relief Valves: Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

F. Discharge Cone: Closed or open type.

G. Hose Valve Manifold Assembly:
1. Standard: Comply with requirements in NFPA 20.
2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
4. Automatic Drain Valve: UL 1726.
5. Manifold:
    a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
    b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
    c. Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
    d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
    e. Escutcheon Plate: Brass or bronze; rectangular.
    f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
    g. Exposed Parts Finish: Rough.
    h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.4 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink and recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
   1. Verification of Performance: Rate fire pumps according to UL 448.

B. Fire pumps will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.

B. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section “Miscellaneous Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

D. Support piping and pumps separately so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Division 21 Section "Fire-Suppression Standpipes."

F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Division 21 Section "Fire-Suppression Standpipes."

G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.

H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

J. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.3 ALIGNMENT

A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.4 CONNECTIONS

A. Comply with requirements for piping and valves specified in Division 21 Section "Fire-Suppression Standpipes." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect relief-valve discharge to drainage piping or point of discharge.

D. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Division 21 Section "Controllers for Fire-Pump Drivers."

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
   2. Test according to NFPA 20 for acceptance and performance testing.
   3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

G. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

PART 4 METHOD OF MEASUREMENT

4.01 No separate measurement will be made for items required by this section.

PART 5 BASIS OF PAYMENT

5.01 No separate payment will be made for items required by this section.

Payment will be made under:

CDF Control Facility – per lump sum

END OF SECTION

SECTION 21 39 00
CONTROLLERS FOR FIRE-PUMP DRIVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Full-service, full-voltage controllers rated 600 V and less.
2. Controllers for pressure-maintenance pumps.
3. Remote alarm panels.

1.2 DEFINITIONS

A. ATS: Automatic transfer switch(es).

B. ECM: Electronic control module.

C. MCCB: Molded-case circuit breaker.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-pump controllers and alarm panels shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each type of product indicated. Include dimensioned plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.

1. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.
2. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For each type of product indicated, from manufacturer.

C. Manufacturer's factory test reports of fully assembled and tested equipment.

D. Source quality-control reports.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.

B. 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.

C. Comply with standards of authorities having jurisdiction pertaining to materials and installation.

D. Comply with NFPA 20 and NFPA 70.

E. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

PART 2 - PRODUCTS

2.1 FULL-SERVICE CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aquarius Fluid Products, Inc.
2. ASCO Power Technologies, LP; Firetrol Products.
3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Hubbell Incorporated; Hubbell Industrial Controls.
5. Joslyn Clark Corporation.
6. Master Control Systems, Inc.
7. Metron, Inc.
8. Tornatech.

B. General Requirements for Full-Service Controllers:

1. Comply with NFPA 20 and UL 218.
2. Listed by an NRTL for electric-motor driver for fire-pump service.
3. Combined automatic and nonautomatic operation.
4. Factory assembled, wired, and tested; continuous-duty rated.
5. Service Equipment Label: NRTL labeled for use as service equipment.

C. Method of Starting:

1. Pressure-switch actuated.

a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
b. System pressure recorder, electric ac driven, with spring backup.
c. Programmable minimum-run-time relay to prevent short cycling.
d. Programmable timer for weekly tests.

2. Magnetic Controller: Autotransformer type.
3. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

D. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.

E. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.

F. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.

G. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:

a. Microprocessor-based logic controller, with multiline digital readout.
b. Membrane keypad.
c. LED alarm and status indicating lights.

3. Local and Remote Alarm and Status Indications:

a. Controller power on.
b. Motor running condition.
c. Loss-of-line power.
d. Line-power phase reversal.
e. Line-power single-phase condition.

4. Audible alarm, with silence push button.
5. Nonautomatic START and STOP push buttons or switches.

H. ATS:

1. Complies with NFPA 20, UL 218, and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.

3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
6. Local and Remote Alarm and Status Indications:

    a. Normal source available.
    b. Alternate source available.
    c. In normal position.
    d. In alternate position.
    e. Isolating means open.

7. Audible alarm, with silence push button.
8. Nonautomatic (manual, nonelectric) means of transfer.
9. Engine test push button.
10. Start generator output contacts.
11. Timer for weekly generator tests.

2.2 CONTROLLERS FOR PRESSURE-MAINTENANCE PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aquarius Fluid Products, Inc.
2. ASCO Power Technologies, LP; Firetrol Products.
3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Hubbell Incorporated; Hubbell Industrial Controls.
5. Joslyn Clark Corporation.
6. Master Control Systems, Inc.
7. Metron, Inc.
8. Tornatech.

B. General Requirements for Pressure-Maintenance-Pump Controllers:

1. Type: UL 508 factory assembled, -wired, and tested, across-the-line; for combined automatic and manual operation.
2. Enclosure: UL 508 and NEMA 250, Type 2 for wall-mounting.
3. Factory assembled, wired, and tested.
4. Finish: Manufacturer's standard color paint.

C. Rate controller for scheduled horsepower and include the following:

1. Fusible disconnect switch.
2. Pressure switch.
3. Hand-off-auto selector switch.
4. Pilot light.
5. Running period timer.

2.3 REMOTE ALARM PANELS

A. General Requirements for Remote Alarm Panels: Comply with NFPA 20 and UL 218; listed by an NRTL for fire-pump service.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aquarius Fluid Products, Inc.
2. ASCO Power Technologies, LP; Firetrol Products.
3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Hubbell Incorporated; Hubbell Industrial Controls.
5. Joslyn Clark Corporation.
6. Master Control Systems, Inc.
7. Metron, Inc.
8. Tornatech.

C. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested.

D. Supervisory Control Voltage: 480-V ac; single source.

E. Audible and Visual Alarm and Status Indications:

1. Driver running.
2. Loss of phase.
3. Phase reversal.
4. Supervised power on.
5. Common trouble on the controller.

F. Audible and Visual Alarm and Status Indications: Manufacturer's standard indicating lights; push-to-test.

1. Engine running.
2. Controller main switch turned to the off or manual position.
3. Supervised power on.
4. Common trouble on the controller or engine.
5. Common pump room trouble.

G. Audible alarm, with silence push button.

2.4 ENCLOSURES

A. Fire-Pump Controllers, ATS, and Remote Alarm Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.

1. Indoor, Dry and Clean Locations: Type 1 (IEC IP10).
2. Other Wet or Damp, Indoor Locations: Type 4X (IEC IP56).

B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".

C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

D. Floor stands, 12 inches (305 mm) high, for floor-mounted controllers.

2.5 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.

1. Verification of Performance: Rate controllers according to operation of functions and features specified.

B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 CONTROLLER INSTALLATION

A. Install controllers within sight of their respective drivers.

B. Connect controllers to their dedicated pressure-sensing lines.

C. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, and bottom of enclosure not less than 12 inches (305 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

D. Floor-Mounting Controllers: Install controllers on 4-inch (100-mm) nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in Section 033053 "Miscellaneous Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

E. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

G. Comply with NEMA ICS 15.

3.2 REMOTE ALARM PANEL INSTALLATION

A. Install panels on walls with tops not higher than 72 inches (1829 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For panels not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

3.3 POWER WIRING INSTALLATION

A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Comply with NECA 1.

3.4 CONTROL AND ALARM WIRING INSTALLATION

A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."

B. Install wiring between remote alarm panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."

C. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Section 283111 "Digital, Addressable Fire-Alarm System."

D. Bundle, train, and support wiring in enclosures.

E. Connect remote manual and automatic activation devices where applicable.

3.5 IDENTIFICATION

A. Comply with requirements in NFPA 20 for marking fire-pump controllers.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Inspect and Test Each Component:

    a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
    b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
    c. Test continuity of each circuit.

2. Verify and Test Each Electric-Driver Controller:

    a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify Construction Manager and Owner before starting the motor(s).
    b. Test each motor for proper phase rotation.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Field Acceptance Tests:

1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Construction Manager, Owner and authorities having jurisdiction.
2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
3. Engage manufacturer's factory-authorized service representative to be present during the testing.
4. Perform field acceptance tests as outlined in NFPA 20.

D. Controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. Perform startup service.

G. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust controllers to function smoothly and as recommended by manufacturer.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.

C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

D. Set field-adjustable pressure switches.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controllers and remote alarm panels, and to use and reprogram microprocessor-based controls within this equipment.

PART 4 METHOD OF MEASUREMENT

4.01 No separate measurement will be made for items required by this section.

PART 5 BASIS OF PAYMENT

5.01 No separate payment will be made for items required by this section.

Payment will be made under:

CDF Control Facility – per lump sum

END OF SECTION

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SECTION 22 11 23
DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.
2. Duplex, vertically mounted, in-line, close-coupled multistage pumps

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Operation and maintenance data.

1.3 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Armstrong Pumps Inc.
2. Bell & Gossett Domestic Pump; ITT Corporation.
3. Grundfos Pumps Corp.
4. TACO Incorporated.
5. WILO USA LLC - WILO Canada Inc.

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Casing: Bronze, with threaded or companion-flange connections.
3. Impeller: Plastic.
4. Motor: Variable speed, unless otherwise indicated.

2.2 DUPLEX, VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED MULTISTAGE PUMPS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Armstrong Pumps Inc.
   2. Bell & Gossett Domestic Pump; ITT Corporation.
   3. Grundfos Pumps Corporation, U.S.A.
   4. Aurora Pump.

B. Description: Factory-assembled and -tested, in-line, multistage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

C. Pump Construction:

   1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 3 pipe connections and flanged connections for pumps with NPS 3 pipe connections.
   2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
   3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
   4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
   5. Bearings: Oil-lubricated; bronze-journal or ball type.
   6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

D. Motor: Multi-speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

E. Capacities and Characteristics:

   1. Capacity: 85 gpm (L/s).
   2. Total Dynamic Head: 196 feet.
   3. Casing Material: Stainless Steel.
   4. Impeller Material: Stainless steel.
   5. Minimum Working Pressure: 175 psig (1200 kPa).
   6. Maximum Continuous Operating Temperature: 225 deg F (107 deg C).
   7. Inlet and Outlet Size: 3 NPS.
   8. Pump Control: Pressure
   9. Pump Speed: 3600.
   10. Motor Horsepower: 5.
   11. Electrical Characteristics:

      a. Volts: 460.
      b. Phases: Three.
      c. Hertz: 60.
      d. Full-Load Amperes: 7.5.
      e. Maximum Overcurrent Protection: 15 A.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F (18 to 93 deg C).
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120 V, ac.
7. Settings: Start pump at 105 deg F (41 deg C).

B. Timers: Electric, for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.
2. Enclosure: NEMA 250, Type 1 suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120 V, ac.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

2.5 INTEGRATED CONTROLS (VARIABLE SPEED DRIVES)

A. Integrated controls shall have the following features:

1. VVC-PWM type providing near unity displacement power factor (cos ø) without the need for external power factor correction capacitors at all loads and speeds.
2. DC link chokes for the reduction of mains borne harmonic currents to reduce the DC link ripple current thereby increasing the DC link capacitors lifetime.
3. UL and C-UL Listed and CE Marked showing compliance with both the EMC directive 89/336/EEC and the Low Voltage directive 72/23/EEC.
4. RFI filters incorporated within the drive to ensure it meets the emission and immunity requirements of EN61800-3 to the 1st Environment Class C1 (EN55011 unrestricted sales class B).

B. Integrated controls and motor protection shall include:

1. Motor phase to phase fault.
2. Motor phase to earth fault

3. Loss of supply phase.
4. Over voltage, under voltage.
5. Motor over temperature.
6. Inverter overload, over current.

2.6 BASE AND PANEL SUPPORT

A. Material of construction of Base and Panel support shall be carbon steel.

2.7 INSTRUMENTATION

A. The Domestic Water Booster system shall be supplied with manifold mounted liquid filled pressure gauges for indicating suction and discharge pressure.

2.8 CONTROL PANEL

A. The control panel shall be of the programmable logic controller (PLC) type.

B. The complete control panel assembly and all internal devices shall be UL508 labelled.

C. The panel shall be complete with NEMA Type 4 Painted Steel Enclosure (STD) and allowing for both indoor and outdoor use and as such will remain undamaged by ice formation on the enclosure. The panel shall include door interlocked main disconnect, water tight LCD interface, windblown dust and falling dirt protection, fused drive connections, adjustable time delays, Hand-Off-Auto selector for each pump and minimum run timers.

D. The control circuit shall include fault relay circuit to turn on the next pump should the lead pump fail.

E. The controller must be capable of controlling 2 pumps, with a 4-20 mA analogue signal using pressure as the control variable.

F. Controller design shall include provisions for:
1. Low flow energy savings.
2. Soft fill mode for gradual filling of pipes at system start up or after maintenance.
3. Pressure setback as a built-in software logic as per ASHRAE 90.1,2010 section 10.4.2(a).
4. Emergency power mode for limiting pumps during power cut off.
5. Alternate set points, for easy setup of multiple duty points.
6. End of pump curve protection.
7. 24-hour operation automatic alternation of pumps.
8. Built-in pump on-delay and minimum run timers.
9. Re-settable pump elapsed run time meters, smooth pump starting and sequencing.
10. On-screen field modifiable control and alarm parameters.
11. High suction pressure shutdown.

12. No-flow shutdown as per ASHRAE 90.1, 2010 section 10.4.2(c) with drawdown tank/system optimization (the system would build additional pressure, typically 5 psi, in the draw down tank before it shuts down to limit the short cycling of pumps).
13. On-screen alarm display with alarm identification shall be incorporated with the following alarms included:
    a. Low and high system pressure shutdown
    b. Low suction pressure or level shutdown
    c. Pump failure
    d. Drive fault
    e. Suction and discharge pressure sensor failures
14. On-screen display shall be incorporated with the following data included:
    a. Energy consumption display and profiling:
        1) Instantaneous Kw
        2) Monthly/Yearly kW consumption
        3) Capacity for reset of data
    b. Flow Estimation and profiling:
        1) Max. drawn flow based on history of logged data
        2) Current flow
        3) Data profiling to show consumption versus time

G. The controller shall include on-screen fault description and possible cause information with alarm horn for alarms.

H. The control panel shall be equipped with a user-friendly screen mounted on the panel front door. The interface screen shall have:
1. Touch screen
2. Provisions to type in easily any setting number
3. Multilanguage capability in any of the following languages as a minimum (English, Spanish)
4. Display history of alarms

I. Non-volatile factory set parameters must be capable of being restored at any time in the field without requiring any programming device or connection to an external source.

J. The controller must hold software in FLASH memory storage which prevents accidental loss of data due to voltage surge or spike.

K. All controls to be factory pre-wired and tested in accordance with provisions of the national electrical code. All control wires shall be individually numbered and each component shall be labelled accordingly. All internal wiring shall be Copper stranded, A.W.G. with a minimum 90°F rating. The controller shall bear the UL508 label for industrial controls.

2.9 PUMP SEQUENCING

A. The pump designated as the lead pump shall start following a 5 second On-Delay time after sensing a drop in the system pressure 5 PSI below the desired set point value.

B. The pump controller shall compare a signal from the discharge pressure transducer to the set point value and the lead pump speed shall ramp up in order to satisfy the set point pressure.

C. Pump Construction:
   1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
   2. Casing: Bronze, with threaded or companion-flange connections.
   3. Impeller: Plastic.
   4. Motor: Variable speed, unless otherwise indicated.

D. The lag pump shall ramp down in speed and turn off when the pumps that are running are operating at a point below the BOP and the lag pump minimum run timer has expired. The lead pump shall continue to operate and meet system requirements based on the set point value.

E. The lead pump shall alternate every 24 hrs of operation where the second pump shall start and run for a period of 5 seconds, both pumps shall operate, the first pump on shall ramp down and the new lead pump shall continue to operate as above to meet system requirements.

2.10 LEAD PUMP SHUTDOWN CONTROLS

A. All systems are equipped with a 'No-Flow' shutdown that will stop the pumps when the pump controller determines there has been a 'No-Flow' condition for a continuous 5-minute period.

B. The lead pump will start again once a drop-in pressure of at least 5 psi is measured on the discharge of the system.

C. The system can be manually operated by means of the virtual Hand-Off-Auto (HOA) selector buttons provided on the operator interface.

2.11 NAMEPLATES

A. Each Domestic Booster system shall have a nameplate permanently attached to the control panel or any other visible location.

B. The nameplate shall include as a minimum, the following data stamped on the face of the nameplate:
   1. Booster System Serial number
   2. Booster Model
   3. Maximum pressure
   4. Booster Capacity
   5. Flow
   6. Total Motor HP
   7. Electrical source

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

C. Install continuous-thread hanger rods and spring hangers of size required to support pump weight.

1. Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.

2. Comply with requirements for hangers and supports specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Install thermostats in hot-water return piping.

E. Install timers on wall.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, close-coupled centrifugal pumps.

b. Comply with requirements for flexible connectors specified in Division 22 Section "Domestic Water Piping."

2. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Division 22 Section "Domestic Water Piping Specialties."

3. Install pressure gage at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

D. Comply with Division 26 Sections for electrical connections, and wiring methods.

E. Connect thermostats and timers to pumps that they control.

3.3 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

PART 4 METHOD OF MEASUREMENT

4.01 No separate measurement will be made for items required by this section.

PART 5 BASIS OF PAYMENT

5.01 No separate payment will be made for items required by this section.

Payment will be made under:

CDF Control Facility – per lump sum

END OF SECTION

DIVISION 23 - SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 – GENERAL

1.1 BMS Description

A. The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.

B. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operation's terminal. The primary point of interface on these PCs will be a standard Web Browser providing access to MSCAA's intranet framework.

C. The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.

D. The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.

E. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

F. Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.

G. The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:

1. Operator information, alarm management and control functions.
2. Enterprise-level information and control access.
3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
4. Diagnostic monitoring and reporting of BMS functions.
5. Offsite monitoring and management access.
6. Energy management
7. Standard applications for terminal HVAC systems.

2.1 Quality Assurance

A. General

1. The Building Management System Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems.
2. The BMS Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.
3. The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer's latest standard of design at the time of bid.

3.1 Warranty

A. Standard Material and Labor Warranty:

1. Provide a one-year labor and material warranty on the BMS.
2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.
3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor's normal business hours.

PART 2 – PRODUCTS

2.1 General Description

A. Acceptable Manufacturers

1. Johnson Controls – Metasys as installed by Johnson Controls Memphis Branch office. Contact: Todd Glenn (901) 383-5734.

2. Connect all new work to the existing BAS at MSCAA as a seamless extension of it. New system for the project, including interface to existing BAS, shall operate and function as one complete system with one database of control point objects and graphics. Modify existing BAS as necessary to accommodate the additional control points for this project.

B. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

C. The Building Management System shall consist of the following:

1. Standalone Network Automation Engine(s)
2. Field Equipment Controller(s)
3. Input/Output Module(s)
4. Local Display Device(s)

5. Distributed User Interface(s)
6. Other components required for a complete and working BMS

D. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

E. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
   1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
   2. The System shall maintain all settings and overrides through a system reboot.

F. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

2.2 BMS Architecture

A. Automation Network
   1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
   2. All BMS devices on the automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
   3. Network Automation Engines (NAE) shall reside on the automation network.
   4. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

B. Control Network
   1. Network Automation Engines (NAE) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
      a. BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9
         i. The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
         ii. The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
      b. LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
      c. The Johnson Controls N2 Field Bus.
   2. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
   3. DDC Controllers shall reside on the control network.
   4. Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

5. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
6. The PICS shall be submitted 10 days prior to bidding.

2.3 User Interface

A. Dedicated Web Based User Interface

1. Where indicated on plans the BMS Contractor shall provide and install a personal computer with 27" (or larger) monitor for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability. BMS Contractor shall also provide one service laptop to the Facility Maintenance HVAC manager. The laptop shall be preloaded with all software specified in the customer's software subscription and be ready to connect to the building's BMS controllers for commissioning, troubleshooting and programming.
2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third-party applications suppliers, including but not limited to Microsoft Office Applications. Specifically, it must be implemented to conform to the following interface standards.
   a. Microsoft Internet Explorer for user interface functions
   b. Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions
   c. Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
   d. Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries
3. Dynamic Color Graphics
   a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
   b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
   c. Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
      ◊ All graphics shall be fully scalable
      ◊ The graphics shall support a maintained aspect ratio.
      ◊ Multiple fonts shall be supported.
      ◊ Unique background shall be assignable on a per graphic basis.
      ◊ The color of all animations and values on displays shall indicate the status of the object attribute.

- ◊ Graphics that represent buildings or systems shall allow natural links and transitions between related detailed tabular views of data that complement the graphic.

ii. Operation from graphics – It shall be possible to change values (setpoints) and states in system-controlled equipment directly from the graphic.

iii. Floor Plan graphics – The user interface shall provide graphic applications that summarize conditions on a floor. Floor plan graphics shall indicate thermal comfort using dynamic colors to represent zone temperature deviations from zone setpoint(s). Floor plan graphics shall display overall metrics for each zone in the floor.

iv. Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.

2.4 Network Automation Engines (NAE)

A. Network Automation Engine (NAE 55XX)

1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
3. User Interface – Each NAE shall have the ability to deliver a web-based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web-based UI.
   a. The web-based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
   b. The NAE shall support up a minimum of four (4) concurrent users.
   c. The web-based user shall have the capability to access all system data through one NAE.
   d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
   e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
   f. The NAE shall have the capability of generating web-based UI graphics. The graphics capability shall be imbedded in the NAE.
   g. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
   h. The web-based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
      - ◊ Configuration
      - ◊ Commissioning
      - ◊ Data Archiving
      - ◊ Monitoring
      - ◊ Commanding

◊ System Diagnostics

i. Systems that require workstation software or modified web browsers are not acceptable.

j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.
7. The NAE shall include troubleshooting LED indicators to identify the following conditions:
   a. Power - On/Off
   b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
   c. Ethernet Connection Speed – 10 Mbps/100 Mbps/1000 Mbps
   d. FC Bus A – Normal Communications/No Field Communications
   e. FC Bus B – Normal Communications/No Field Communications
   f. Peer Communication – Data Traffic between NAE Devices
   g. Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running
   h. Bat Fault – Battery Defective, Data Protection Battery Not Installed
   i. 24 VAC – 24 VAC Present/Loss Of 24VAC
   j. Fault – General Fault
8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
   a. Two (2) USB port
   b. Two (2) URS-232 serial data communication port
   c. Two (2) RS-485 port
   d. One (1) Ethernet port
9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
    a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).
12. Controller network – The NAE shall support the following communication protocols on the controller network:
    a. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
        ◊ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
        ◊ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
        ◊ A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.
        ◊ The Conformance Statements shall be submitted 10 days prior to bidding.
        ◊ The NAE shall support a minimum of 100 control devices.
    b. The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.
        i. All LonWorks controls devices shall be LonMark certified.
        ii. The NAE shall support a minimum of 255 LonWorks enabled control devices.
    c. The NAE shall support the Johnson Controls N2 Field Bus.
        ◊ The NAE shall support a minimum of 100 N2 control devices.
        ◊ The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
        ◊ The Bus shall employ a master/slave protocol where the NAE is the master.
        ◊ The Bus shall employ a four (4) level priority system for polling frequency.
        ◊ The Bus shall be optically isolated from the NAE.
        ◊ The Bus shall support the Metasys Integrator System.

2.5 Network Control Engine (NCE 25XX)

a. The Network Control Engine (NCE) shall be a fully user-programmable, supervisory controller. The NCE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
b. The Network Control Engine (NCE) shall be a fully user-programmable, digital controller that includes a minimum of 33 I/O points.
c. Automation Network – The NCE shall reside on the automation network and shall support a subnet of 32 Field controllers.
d. User Interface – Each NCE shall have the ability to deliver a web-based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web-based UI.
    i. The web-based UI software shall be imbedded in the NCE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

ii. The NCE shall support a minimum of two (2) concurrent users.
iii. The NCE shall have the capability of generating web-based UI graphics. The graphics capability shall be imbedded in the NCE.
iv. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
v. The web-based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
◊ Configuration
◊ Commissioning
◊ Data Archiving
◊ Monitoring
◊ Commanding
◊ System Diagnostics
vi. Systems that require workstation software or modified web browsers are not acceptable.
vii. The NCE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

e. The NCE shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

f. The NCE shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only, shall not be acceptable.

g. The NCE shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

h. The NCE shall support the following number and types of inputs and outputs:
i. Ten Universal Inputs - shall be configured to monitor any of the following:
◊ Analog Input, Voltage Mode
◊ Analog Input, Current Mode
◊ Analog Input, Resistive Mode
◊ Binary Input, Dry Contact Maintained Mode
◊ Binary Input, Pulse Counter Mode
ii. Eight Binary Inputs - shall be configured to monitor either of the following:
◊ Dry Contact Maintained Mode
◊ Pulse Counter Mode
iii. Four Analog Outputs - shall be configured to output either of the following
◊ Analog Output, Voltage Mode
◊ Analog Output, Current Mode
iv. Seven Binary Outputs - shall output the following:
◊ 24 VAC Triac
v. Four Configurable Outputs - shall be configured to output either of the following:
◊ Analog Output, Voltage Mode
◊ Binary Output, 24 VAC Triac Mode

i. The NCE shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
   i. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
   ii. The SA Bus shall support a minimum of 10 devices.
   iii. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the NCE and the furthest connected device.

j. The NCE shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the Field Trunk or the SA Bus.

k. The NCE shall support, but not be limited to, the following applications:
   i. Central Equipment including chillers and boilers
   ii. Lighting and electrical distribution
   iii. Built-up air handling units for special applications
   iv. Power generation and energy monitoring equipment
   v. Interfaces to security and fire detection systems

l. The NCE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NCE size and capability shall be sufficient to fully meet the requirements of this Specification.

m. The NCE shall employ an industrial single board computer.

n. Each NCE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

o. The NCE shall include an integrated, hardware-based, real-time clock.

p. The NCE shall employ nonvolatile Flash memory to store all programs and data. The NCE shall employ a data protection battery to save data and power the real time clock when primary power is interrupted.

q. The NCE shall provide removable, color coded, screw terminal blocks for 24 VAC power, communication bus and I/O point field wiring.

r. The NCE shall include troubleshooting LED indicators to identify the following conditions:
   i. Power
   ii. Fault
   iii. SA Bus
   iv. FC Bus
   v. Battery Fault
   vi. Ethernet
   vii. 10 LNK
   viii. 100 LNK
   ix. Run
   x. Peer Com

s. Communications Ports – The NCE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
   i. USB port
   ii. RS-232 serial data communication port
   iii. RS-485 port
   iv. RJ-45 Ethernet port
   v. RJ-12 jack

t. Diagnostics – The NCE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Control Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

u. Power Failure – In the event of the loss of normal power, The NCE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
   i. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
   ii. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

v. Certification – The NCE shall be listed by Underwriters Laboratories (UL). File E107041, CCN PAZX, UL 916, Energy Management Equipment. FCC Compliant to CFR47, Part 15, Subpart B, Class A

w. Field Controller Bus – The NCE shall support the following communication protocols on the Field Controller Bus:
   i. The NCE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
      ◊ The NCE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
      ◊ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
      ◊ A BACnet Protocol Implementation Conformance Statement shall be provided for the NCE.
      ◊ The Conformance Statements shall be submitted 10 days prior to bidding.
      ◊ The NCE shall support a minimum of 32 control devices.
   ii. The NCE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10 on the Field Controller Bus (LonWorks Network).
      ◊ All LonWorks controls devices shall be LonMark certified.
      ◊ The NCE shall support a minimum of 32 LonWorks enabled control devices.
   iii. The NCE shall support the N2 devices on the Field Controller Bus (Johnson Controls N2 Bus).
      ◊ The NCE shall support a minimum of 32 N2 control devices.
      ◊ The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.

- ◊ The Bus shall employ a master/slave protocol where the NCE is the master.
- ◊ The Bus shall employ a four (4) level priority system for polling frequency.
- ◊ The Bus shall be optically isolated from the NCE.
- ◊ The Bus shall support the Metasys Integrator System.

2.6 DDC System Controllers

A. Field Equipment Controller (FEC X611)

1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
   a. The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
      - ◊ The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
      - ◊ The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
      - ◊ A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
      - ◊ The Conformance Statement shall be submitted 10 days prior to bidding.
2. The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
4. The FEC shall include troubleshooting LED indicators to identify the following conditions:
   a. Power On
   b. Power Off
   c. Download or Startup in progress, not ready for normal operation
   d. No Faults
   e. Device Fault
   f. Field Controller Bus - Normal Data Transmission
   g. Field Controller Bus - No Data Transmission
   h. Field Controller Bus - No Communication
   i. Sensor-Actuator Bus - Normal Data Transmission
   j. Sensor-Actuator Bus - No Data Transmission
   k. Sensor-Actuator Bus - No Communication
5. The FEC shall accommodate the direct wiring of analog and binary I/O field points.
6. The FEC shall support the following types of inputs and outputs:
   a. Universal Inputs - shall be configured to monitor any of the following:
      - ◊ Analog Input, Voltage Mode

- ◊ Analog Input, Current Mode
- ◊ Analog Input, Resistive Mode
- ◊ Binary Input, Dry Contact Maintained Mode
- ◊ Binary Input, Pulse Counter Mode

b. Binary Inputs - shall be configured to monitor either of the following:
- ◊ Dry Contact Maintained Mode
- ◊ Pulse Counter Mode

c. Analog Outputs - shall be configured to output either of the following
- ◊ Analog Output, Voltage Mode
- ◊ Analog Output, current Mode

d. Binary Outputs - shall output the following:
- ◊ 24 VAC Triac

e. Configurable Outputs - shall be capable of the following:
- ◊ Analog Output, Voltage Mode
- ◊ Binary Output Mode

7. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
   a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
   b. The FC Bus shall support communications between the FECs and the NAE.
   c. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
   d. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
   e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
8. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
   a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
   b. The SA Bus shall support a minimum of 10 devices per trunk.
   c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
9. The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
10. The FEC shall be equipped with a local controller display. Integral display is preferred.

B. Field Application Controller (FAC 3611)
   1. Furnish and install latest controllers, where applicable, to coincide with similar installations at other areas of MSCAA.

2.7 Field Devices

A. Input/Output Module (IOM X711)

1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
2. The IOM shall communicate with the FEC over the FC Bus or the SA Bus.
3. The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
   a. The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   b. The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   c. A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
   d. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The IOM shall have a minimum of 4 points to a maximum of 17 points.
6. The IOM shall support the following types of inputs and outputs:
   a. Universal Inputs - shall be configured to monitor any of the following:
      ◊ Analog Input, Voltage Mode
      ◊ Analog Input, Current Mode
      ◊ Analog Input, Resistive Mode
      ◊ Binary Input, Dry Contact Maintained Mode
      ◊ Binary Input, Pulse Counter Mode
   b. Binary Inputs - shall be configured to monitor either of the following:
      ◊ Dry Contact Maintained Mode
      ◊ Pulse Counter Mode
   c. Analog Outputs - shall be configured to output either of the following
      ◊ Analog Output, Voltage Mode
      ◊ Analog Output, current Mode
   d. Binary Outputs - shall output the following:
      ◊ 24 VAC Triac
   e. Configurable Outputs - shall be capable of the following:
      ◊ Analog Output, Voltage Mode
      ◊ Binary Output Mode
7. The IOM shall include troubleshooting LED indicators to identify the following conditions:
   a. Power On
   b. Power Off
   c. Download or Startup in progress, not ready for normal operation
   d. No Faults
   e. Device Fault
   f. Normal Data Transmission
   g. No Data Transmission
   h. No Communication

B. VAV Modular Assembly (VMA 16XX)

1. The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.
2. The VMA shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   a. The VMA shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   b. A BACnet Protocol Implementation Conformance Statement shall be provided for the VMA.
   c. The Conformance Statement shall be submitted 10 days prior to bidding.
3. The VAV Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
4. The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
5. The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.
6. The VAV Modular Assembly shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB or the controller is designed and suitable for use in other environmental air space (plenums) in accordance with Section 300.252(C) of the National Electrical Code.
7. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 60 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
8. The controller shall determine airflow by a state-of-the-art digital non-flow pressure sensor to provide 14-bit resolution with bidirectional flow operation that supports automatic correction for polarity on high- and low-pressure DP tube connections; this pressure sensor eliminates high- and low-pressure connection mistakes.
9. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
10. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
11. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
12. The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
13. Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.

14. The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
15. The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
16. The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
17. Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
    a. Absolute temperature loop error
    b. Signed temperature loop error
    c. Absolute airflow loop error
    d. Signed airflow loop error
    e. Average damper actuator duty cycle
18. The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
    a. Unreliable space temperature sensor
    b. Unreliable differential pressure sensor
    c. Starved box
    d. Actuator stall
    e. Insufficient cooling
    f. Insufficient heating
19. The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
20. The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.
21. The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
22. Inputs:
    a. Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
        ◊ 0-10 VDC Sensors
        ◊ 1000ohm RTDs
        ◊ NTC Thermistors
    b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."

c. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
d. Provide side loop application for humidity control.

23. Outputs
    a. Analog outputs shall provide the following control outputs:
       1. 0-10 VDC
    b. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.
    c. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
24. Application Configuration
    a. The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.
25. Sensor Support
    a. The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
    b. The VMA shall support an LCD display room sensor.
    c. The VMA shall also support standard room sensors as defined by analog input requirements.
    d. The VMA shall support humidity sensors defined by the AI side loop.

C. Network Sensors (NS-XXX-700X)
1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
   a. Zone Temperature
   b. Zone Humidity
   c. Zone Setpoint
   d. Discharge Air Temperature
   e. Zone CO2
2. The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
3. The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   a. The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).
   b. A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.
   c. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The Network Zone Temperature Sensors shall include the following items:
   a. A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint
   b. An LED to indicate the status of the Override feature
   c. A button to toggle the temperature display between Fahrenheit and Celsius
   d. A button to program the display for temperature or humidity
   e. A button to initiate a timed override command
   f. Available in either surface mount, wall mount, or flush mount
   g. Available with either screw terminals or phone jack
5. The Network Discharge Air Sensors shall include the following:

a. 4 inch or 8 inch duct insertion probe
b. 10 foot pigtail lead
c. Dip Switches for programmable address selection
d. Ability to provide an averaging temperature from multiple locations
e. Ability to provide a selectable temperature from multiple locations

6. The Network CO2 Zone Sensors shall include the following:
   a. Available in either surface mount or wall mount
   b. Available with screw terminals or phone jack

D. Mobile Access Portal (MAP) Gateway, Local Controller Display (DIS1710), and M4 Devices (ALL applicable next generation Metasys controllers)
   a. Furnish and install latest components, where applicable, to coincide with similar installations at other areas of MSCAA.

2.8 System Tools

A. System Configuration Tool (SCT)
   1. The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a Network Automation Engine (NAE) or a Network Integration Engine (NIE).
   2. The configuration tool shall provide an archive database for the configuration and application data.
   3. The configuration tool shall have the same look-and-feel at the User Interface (UI) regardless of whether the configuration is being done online or offline.
   4. The configuration tool shall include the following features:
      a. Basic system navigation tree for connected networks
      b. Integration of Metasys N1, LonWorks, and BACnet enabled devices
      c. Customized user navigation trees
      d. Point naming operating parameter setting
      e. Graphic diagram configuration
      f. Alarm and event message routing
      g. Graphical logic connector tool for custom programming
      h. Downloading, uploading, and archiving databases
   5. The configuration tool shall have the capability to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:
      a. BACnet Devices
      b. LonWorks devices
      c. N2 Bus devices
      d. Metasys N1 networks
   6. The configuration tool shall be capable of programming the Field Equipment Controllers.
      a. The configuration tool shall provide the capability to configure, simulate, and commission the Field Equipment Controllers.
      b. The configuration tool shall allow the FECs to be run in Simulation Mode to verify the applications.

c. The configuration tool shall contain a library of standard applications to be used for configuration.

7. The configuration tool shall be capable of programming the field devices.
   a. The configuration tool shall provide the capability to configure, simulate, and commission the field devices.
   b. The configuration tool shall allow the field devices to be run in Simulation Mode to verify the applications.
   c. The configuration tool shall contain a library of standard applications to be used for configuration

B. Handheld VAV Balancing Sensor (ATV7003)
1. The sensor shall be a light weight portable device of dimensions not more than 3.2 x 3.2 x 1.0 inches.
2. The sensor shall be capable of displaying data and setting balancing parameters for VAV control applications.
3. The sensor shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.
4. The sensor shall be a menu driven device that shall modify itself automatically depending upon what type of application resides in the controller.
5. The sensor shall contain a dial and two buttons to navigate through the menu and to set balancing parameters.
6. The sensor shall provide an adjustable time-out parameter that will return the controller to normal operation if the balancing operation is aborted or abandoned.
7. The sensor shall include the following
   a. 5 foot retractable cable
   b. Laminated user guide
   c. Nylon caring case
8. The sensor shall be Underwriters Laboratory UL 916 listed and CSA certified C22.2 N. 205, CFR47.

PART 3 – EXECUTION

3.1. BMS Specific Requirements

A. Graphic Displays
1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

B. Custom Reports:
1. Provide custom reports as required for this project

C. Actuation / Control Type
1. Primary Equipment
   a. Controls shall be provided by equipment manufacturer as specified herein.
   b. All damper and valve actuation shall be electric.

2. Terminal Equipment:
   a. Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.
   b. All Terminal Units shall be controlled with HVAC-DDC Controller)

3.2. Installation Practices

A. BMS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.
2. All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.
3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
4. Class 2 Wiring
   a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
   b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5’ from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.
7. Splicing of BAS network communication cable is NOT allowed. Communication (data transmission) network trunk cables and equipment grounding procedures shall meet the latest FCC guidelines (FCC rules, part 15, subpart J) for electromagnetic field generation. Communication cable trunks shall be installed in a daisy chain (must run from node to node) with no joints in between. Trunk end-of-line terminations must be installed or set where appropriate. Terminal blocks may be used for connections only inside field controller enclosures. All cable and wire installation must follow industry standard best practices.
8. Splicing of analog sensor, transmitter, or signal cable is NOT allowed. Splicing of binary command or status cable shall be limited to a field controller panel or motor starter cabinet (MCC) only. ANY splices or joints made in control cable must be

secured to prevent strain on the connection, they must be easily accessible, and they must be labeled at the end of both cables.

B. BMS Raceway
   1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit trade size is ¾" (three-quarters of an inch), except for conduits connecting individual devices which can be 1/2". Any conduit installed for building network cabling (Ethernet cable) shall be a minimum of ¾" (three-quarters of an inch). All conduit shall be sized so that at least 20% of the total capacity is available for future expansion.
   2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
   3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
   4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

C. Penetrations
   1. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.
   2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
   3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
   4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

D. BMS Identification Standards
   1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
   2. Provide proper marking and identification of all devices, wiring, and controls. Cable types specified in Item A shall be color coded for easy identification and troubleshooting. Wire markers and/or labels shall be printed heat-shrink tubing or the self-laminating type. Wire and cable shall be color coded according to the following chart:

Type	**Cable Jacket Color**	**Termination**	**Single Wire Color(s)**
24 VAC	N/A	**Hot**	**Orange**
		Common	**Brown**
Earth Ground	N/A	**Ground**	**Green**
MS/TP Field Bus (Controller Bus) 22/3	**Blue**	+	**Black**
		-	**White**
		Com	**Blue**

MS/TP Accessory Bus (Expansion Bus) 22/4	**Brown**	+	**Black**
		-	**White**
		Com	**Blue**
		Power	**Red**
DC Power (i.e.+15)	**Natural, White, or Grey**	+	**Red**
DC Common	**Natural, White, or Grey**	**Com**	**Black**
Standard I/O	**Natural, White, or Grey**	Various	Various

E. BMS Panel Installation
   1. The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
   2. The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.
   3. Every controller panel shall include at least one standard 120 VAC receptacle (5-15R) available for service tools. Dedicated circuits shall be installed in breaker panels to serve controller panels. Breakers shall be clearly labeled at their panels, and breaker locations properly identified at the BAS control panels. For panels with building automation supervisors, or other network communication devices, power shall be provided from a building UPS circuit (if available) or a local UPS shall be provided. The supervisor panel must be large enough to hold the local UPS, or it must be installed in an adjacent dedicated enclosure with an additional duplex receptacle.
   4. Control panels in clean and dry rooms (i.e. data rooms) may be type NEMA 1. Control panels exposed to the elements, or located in wet, dirty, or dusty environments shall be NEMA 4 or 12 rating (as applicable), and shall have continuously welded seams, continuous hinged doors, external mounting brackets, oil resistant gaskets, and data pockets on the inside of the doors. All control panel enclosures shall have perforated subpanels and use wire ducts for cable management. All control panels shall be sized so that at least 20% of the total capacity is available for future expansion.

F. Input Devices
   1. All Input devices shall be installed per the manufacturer recommendation
   2. Locate components of the BMS in accessible local control panels wherever possible.

G. HVAC Input Devices – General
   1. All Input devices shall be installed per the manufacturer recommendation
   2. Locate components of the BMS in accessible local control panels wherever possible.
   3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
   4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.

5. Outside Air Sensors
   a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
   b. Sensors shall be installed with a rain proof, perforated cover.
6. Water Differential Pressure Sensors
   a. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
   b. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
   c. The transmitters shall be installed in an accessible location wherever possible.
7. Medium to High Differential Water Pressure Applications (Over 21" w.c.):
   i. Air bleed units, bypass valves and compression fittings shall be provided.
8. Building Differential Air Pressure Applications (-1" to +1" w.c.):
   a. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
   b. The interior tip shall be inconspicuous and located as shown on the drawings.
9. Duct Temperature Sensors:
   a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
   b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
   c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
   d. The sensor shall be mounted to suitable supports using factory approved element holders.
10. Space Sensors:
    a. Shall be mounted per ADA requirements.
    b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
11. Low Temperature Limit Switches:
    a. Install on the discharge side of the first water or steam coil in the air stream.
    b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
    c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
12. Air Differential Pressure Status Switches:
    a. Install with static pressure tips, tubing, fittings, and air filter.
13. Water Differential Pressure Status Switches:
    a. Install with shut off valves for isolation.

H. HVAC Output Devices
   1. All output devices shall be installed per the manufacturer's recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
   2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. Modulating valve and damper actuators must be controlled

by a proportional signal; no floating or tri-state actuators allowed (integral VAV actuators are the only exception). Valve bodies must be controlled by a single actuator; tandem or stacked actuator assemblies shall not be permitted. Actuators exposed to weather, or otherwise at risk of damage by water, must be of NEMA 4 industrial construction; no weather hoods, covers, or blankets shall be permitted. Pneumatic actuators are NOT permitted.

3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.3. Training

A. The BMS contractor shall provide the following training services:

1. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

END OF SECTION

SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for pathways and cables.
2. Grout.
3. Common installation requirements.

1.2 SUBMITTALS

A. Product Data:

1. Raceways
   a. Electrical Metallic Tubing, boxes and fittings.
   b. Surface Metal Raceways
   c. Flexible Metal Conduit
2. Pathways
   a. J-Hooks
   b. Clips for Cable to Acoustical Ceiling Tile Grid Wire
3. Through Penetration Firestop Assemblies

PART 2 - PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.

b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials.

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly.

PART 4 METHOD OF MEASUREMENT

4.01 No separate measurement will be made for items required by this section.

PART 5 BASIS OF PAYMENT

5.01 No separate payment will be made for items required by this section.

Payment will be made under:

CDF Control Facility – per lump sum

END OF SECTION

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SECTION 27 05 26:

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

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. Provide work specified but not shown on Drawings, and work shown on Drawings but not specified, as though expressly required by both.

1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding labeling.

1.3 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TBB: Telecommunications bonding backbone

D. TGB: Telecommunications grounding busbar.

E. TMGB: Telecommunications main grounding busbar.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. BCT, TMGB, TGBs, TBBs and routing of their bonding conductors.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as a registered communications distribution designer to perform the on-site inspection.

PART 2: PRODUCTS

2.1 SYSTEM COMPONENTS

A. Comply with J-STD-607-A.

2.2 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Harger Lightning & Grounding.
2. Panduit Corp.
3. Engineer Approved Equal

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.
3. Harger Lightning & Grounding.
4. Panduit Corp.
5. Engineer Approved Equal

B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8 inch centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Chatsworth Products, Inc.
2. Harger Lightning & Grounding.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access

the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19 in. equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack. See drawings for detailed information concerning rack-mounted horizontal busbars.
3. Rack-Mounted Vertical Busbar: Designed for mounting inside the vertical wire manager. Vertical busbar shall run the height of the vertical wire manager unless shown otherwise on the drawings. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack. See drawings for detailed information concerning rack-mounted vertical busbars.

2.5 LABELING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brother International Corporation.
2. HellermannTyton.
3. Engineer Approved Equal

B. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3: EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with J-STD-607-A.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
3. The bonding backbone between the TMGB and the TGB in each communications room shall be as detailed on the drawings, but no smaller than No. 3/0 AWG.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Install in telecom cable tray or support at not more than 36-inch intervals where cable tray is not available.
4. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pre-twist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs to the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB with a No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where electrical panelboards for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of each panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted- pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.6 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus

2.0 percent.

a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Design Consultant promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

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SECTION 27 05 28:

PATHWAYS FOR COMMUNICATIONS SYSTEMS

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. Provide work specified but not shown on Drawings, and work shown on Drawings but not specified, as though expressly required by both.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Fire Rated Cable Pathways
5. J-Hooks.
6. Boxes, enclosures, and cabinets.
7. Buried communication line marking tape

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Source quality-control reports.

PART 2: PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AFC Cable Systems; a part of Atkore International.
2. Allied Tube & Conduit; a part of Atkore International.
3. Alpha Wire.
4. Anamet Electrical, Inc.
5. Electri-Flex Company.
6. O-Z/Gedney; a brand of Emerson Industrial Automation.
7. Picoma Industries, Inc.
8. Plasti-Bond.
9. Republic Conduit.
10. Southwire Company.
11. Thomas & Betts Corporation; A Member of the ABB Group.
12. Western Tube and Conduit Corporation.
13. Engineer Approved Equal.

C. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

D. GRC: Comply with ANSI C80.1 and UL 6.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. EMT: Comply with ANSI C80.3 and UL 797.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:

a. Material: Steel.
b. Type: compression.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external

bonding jumper.

H. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AFC Cable Systems; a part of Atkore International.
2. Allied Tube & Conduit; a part of Atkore International.
3. Anamet Electrical, Inc.
4. Arnco Corporation.
5. CANTEX INC.
6. Carlon; a brand of Thomas & Betts Corporation.
7. CertainTeed Corporation.
8. Condux International, Inc.
9. Dura-Line.
10. Electri-Flex Company.
11. Kraloy.
12. Lamson & Sessions.
13. Niedax Inc.
14. RACO; Hubbell.
15. Engineer Approved Equal.

C. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

F. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum installation unless otherwise indicated.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering

products that may be incorporated into the Work include, but are not limited to the following:

1. Alpha Wire.
2. Carlon; a brand of Thomas & Betts Corporation.
3. Dura-Line.
4. Endot Industries Inc.
5. Engineer Approved Equal.

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.4 FIRE RATED CABLE PATHWAYS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Hilti North America - Firestop Speed Sleeve
2. Wiremold/Legrand Flamestopper
3. Specified Technologies Inc. (STI) - EZ Path
4. Engineer Approved Equal

B. General Requirements for fire rated cable pathways:

1. Fire rated cable pathway devices shall be used in fire-rated construction for low-voltage, video, data and voice cabling and optical fiber cabling at locations shown on the drawings.
2. Fire rated cable pathways shall contain a built-in fire sealing system sufficient to maintain the hourly fire-rating of fire rated wall and or floor penetrated.
3. The self-contained sealing system shall adjust to the installed cable loading and shall permit cables to be installed or removed without the need to remove or reinstall firestop materials.
4. Fire rated cable pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
5. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.
6. Fire rated cable pathway shall replace conduit sleeves with firestop sealant/putty in walls and floors, and;
   a. When installed individually in walls/floors, devices shall pass through core- drilled opening utilizing tested wall/floor plates.
   b. When multiple units are ganged in walls/floors, devices shall be anchored by means of a tested grid.
7. Cable tray/cabled runway shall terminate at each wall/floor and resume on the other side such that cables pass independently through fire rated pathway devices. Cable tray/cable runway shall be properly supported on each side of the wall/floor.
8. Fire rated cable pathways shall be UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).

2.5 J-HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Erico, Inc.
2. Panduit Corp.
3. Engineer Approved Equal.

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

E. Rated for use with specified cable.

F. Galvanized steel.

G. J shape.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Adalet.
2. Carlon; a brand of Thomas & Betts Corporation.
3. Crouse-Hinds, an Eaton business.
4. EGS/Appleton Electric.
5. Erickson Electrical Equipment Company.
6. FSR Inc.
7. Hoffman; a brand of Pentair Equipment Protection.
8. Milbank Manufacturing Co.
9. Molex Industrial Products Group; Woodhead Brand.
10. MonoSystems, Inc.
11. Oldcastle Enclosure Solutions.
12. O-Z/Gedney; a brand of Emerson Industrial Automation.
13. Plasti-Bond.
14. Quazite: Hubbell Power Systems, Inc.
15. Engineer Approved Equal.

C. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and

labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.

3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4 11/16 inches square by 3 inches deep.

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

H. Hinged-Cover Enclosures and Cabinets: Comply with UL 50 and NEMA 250, with continuous- hinge cover, screw down clamps, padlock hasp and mounting panel unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:

   a. Material: Fiberglass.
   b. Finished inside with radio-frequency-resistant paint.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
4. Accessory feet where required for freestanding equipment.

5. Refer to drawings for required NEMA ratings.

2.7 BURIED COMMUNICATION LINE MARKING TAPE

A. Underground Communication Line Marking Tape: Permanent, bright-colored, continuous-printed, plastic, tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend shall be indicative of general type of underground line below, such as "CAUTION - BURIED COMMUNICATION LINE BELOW". Tape shall have integral metallic facing or metallic core to allow locating buried tape with electronic detection equipment.

PART 3: EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: GRC.

3. Underground Conduit: RNC, Type EPC-40-PVC.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

   a. Corridors used for traffic of baggage tugs and carts.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: IMC.
6. Pathways for Non-Armored-Optical-Fiber Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
7. Pathways for Non-Armored-Optical-Fiber Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway.
8. Pathways for Concealed General-Purpose Distribution of Non-Armored-Optical-Fiber Cable: Plenum-type, optical-fiber-cable pathway.
9. Pathways for MPO fiber optic trunk cable inside Communication Rooms: Split wall, plenum-type, optical-fiber-cable pathway.
10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and NEMA 250, Type 4 painted steel units in damp or wet locations.
11. Optical-fiber-cable pathway not required for armored optical fiber.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size for copper cables, and 1 1/2 inch (25 mm) for optical-fiber cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105.

7. NECA 111.

B. Cabling shall be concealed where possible and shall be installed as follows
1. Cables concealed inside hollow wall construction shall be installed in conduits stubbed into accessible ceiling cavities.
2. Cables installed in accessible ceiling cavities shall be supported with cable tray or J-Hook supports.
3. Cables located in rooms with an exposed ceiling structure shall be installed in conduit.
4. Cables installed above inaccessible ceilings shall be installed in conduit.
5. It is acceptable to fish flexible metal conduit inside existing hollow walls and above existing inaccessible ceilings.
6. Cables installed outdoors shall be installed in conduit.
7. Cables installed in casework shall be installed in conduit.
8. Route conduit and cables to suit field conditions.

C. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

D. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

E. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.

F. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

H. Arrange stub-ups so curved portions of bends are not visible above finished slab.

I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12
inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.

J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches (300 mm) of enclosures to which attached.

L. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits of 2-inch (50-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 1-Inch (25-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

T. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway- sealing fittings according to NFPA 70.

U. Install suitable pliable compound to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where an above grade pathway enters or exits a building structure.
4. Where otherwise required by NFPA 70, Article 300.7 (A).

V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

W. Expansion-Joint Fittings:

1. Install in each run of aboveground PVC that is located where environmental

temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground metal that is located where environmental temperature change may exceed 100 deg F (55 deg C), and that has straight-run length that exceeds 100 feet (30 m).

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
    d. Attics: 135 deg F (75 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion and seismic joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Fire Rated Pathways

1. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer’s installation instructions and technical information.
2. Install systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
3. Comply with manufacturer’s instructions for installation of products.
4. Place system stickers on each side of wall penetrations.

Y. J-Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 4 feet o.c.
5. Provide a hook at each change in direction.

6. Category 6A and fiber optic cable shall not be hung on the same J-Hook, use multiple J- Hooks to separate Category 6A cable from fiber optic cable.

Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

BB. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe of less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete around conduit for a minimum of 12 inches (300 mm) on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Buried Communication Line Warning Tape: Bury warning tape approximately

12 inches above all underground communication conduits.

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

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SECTION 27 05 29
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

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. Provide work specified but not shown on Drawings, and work shown on Drawings but not specified, as though expressly required by both.

1.2 SUMMARY

A. Section Includes:

1. Steel slotted support systems for communication raceways.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.
7. Design of Seismic restraint systems

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: Fabrication and installation details for communications hangers and support systems signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.

1. Trapeze hangers. Include product data for components.
2. Equipment supports.

C. Delegated-Design Submittal: For hangers and supports for communications systems signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.

1. Include design calculations for seismic requirements and code required restraints.
2. Include seismic restraint details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Projectors.

B. Seismic Qualification Certificates: For hangers and supports for communications equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

PART 2: PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- (10- mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface. Provide fittings and accessories that mate and match with steel slotted support systems and are of the same manufacturer.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. B-line, an Eaton business.
   b. Unistrut; Part of Atkore International.
   c. Engineer Approved Equal.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Material for Channel, Fittings, and Accessories: Galvanized steel.
4. Channel Width: Selected for applicable load criteria.
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA- 4.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
7. Channel Dimensions: Selected for applicable load criteria.
8. Provide steel channels with hot-dip galvanized finish for all outdoor locations.

B. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

        1) Hilti, Inc.
        2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.

2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

        1) B-line, an Eaton business.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti, Inc.
        4) ITW Ramset/Red Head; Illinois Tool Works, Inc.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3: EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are

stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

B. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Use expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP- 69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount

cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

C. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC- PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing- repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 27 05 36:

CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

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. Provide work specified but not shown on Drawings, and work shown on Drawings but not specified, as though expressly required by both.

1.2 SUMMARY

A. Section Includes:

1. Wire-mesh cable tray.
2. Cable tray accessories.
3. Warning signs.

B. Related Requirements:

1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to sides of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Delegated-Design Submittal: For cable tray support and seismic restraints.

1. Cable tray support and seismic-restraint details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting cable tray support and seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

PART 2: PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Component Importance Factor: 1.5.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended

location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-MESH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. B-line, an Eaton business.
2. Chalfant Manufacturing Company.
3. Cooper Industries; Cooper B-Line; GS Metals Corp.
4. Hubbell Incorporated; Wiring Device-Kellems.
5. Legrand US.
6. MP Husky USA Cable Tray & Cable Bus.
7. Chatsworth Products.
8. Engineer Approved Equal.

B. Description:

1. Configuration: steel wire mesh, complying with NEMA VE 1.
2. Width: As indicated on Drawings.
3. Minimum Usable Load Depth: As indicated on Drawings.
4. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
6. Class Designation: Comply with NEMA VE 1, Class 12A.
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of

ASTM A 510/A 510M, Grade 1008.

d. Finish: Electro-galvanized.

1) Hardware: Chromium-zinc plated, ASTM F 1136.

2.4 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, cable drop out fittings and other fittings as indicated, of same materials and finishes as cable tray.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3: EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Fasten cable tray supports to building structure and install seismic restraints (where applicable).

F. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

G. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

H. Support bus assembly to prevent twisting from eccentric loading.

I. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

J. Support wire-basket cable trays with trapeze hangers or wall brackets. Center hung trapeze hangers shall not be allowed.

K. Install protective cover over all threaded rod supports to prevent cable damage.

L. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

M. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

N. Make changes in direction and elevation using manufacturer's recommended fittings.

O. Make cable tray connections using manufacturer's recommended fittings.

P. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

Q. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

R. Install cable trays with enough workspace to permit access for installing cables.

S. Install barriers to separate cables of different systems, such as communications and security.

T. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with velcro tie wraps every 18 inches (450mm).

C. Fasten cables on vertical runs to cable trays with velcro tie wraps every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 36 inches (900 mm).

E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.

F. In existing construction, remove inactive or obsolete cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications and other low voltage cabling are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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. Provide work specified but not shown on Drawings, and work shown on Drawings but not specified, as though expressly required by both.

1.2 SUMMARY

A. Section Includes:

1. Backboards.
2. Telecommunications equipment racks and cabinets.
3. Power distribution units (PDU).
4. Cable runway

B. Related Requirements:

1. Section 270526 "Grounding and Bonding for Communications Systems" for grounding associated with system panels and devices.
2. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
3. Section 271313 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
4. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical fiber data cabling associated with system panels and devices.
5. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
6. Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical fiber data cabling associated with system panels and devices.
7. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For equipment racks and cabinets from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.

2. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2: PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints. Seismic Performance: Equipment racks and cabinets shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Section 061053 "Miscellaneous Rough Carpentry."

B. Install backboards starting at 12” AFF with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joint, unless noted otherwise on drawings.

C. Backboards shall be painted with white, fire retardant paint (leaving the certification label exposed and unpainted) on all sides. Backboards shall be painted prior to installation.

2.3 TELECOMMUNICATIONS EQUIPMENT RACKS AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. APC by Schneider Electric
2. Chatsworth Products, Inc.
3. Hubbell Premise Wiring.
4. Leviton Manufacturing Co., Inc.
5. Middle Atlantic Products, Inc.
6. Ortronics, Inc.
7. Panduit Corp.
8. Great Lakes Case & Cabinet Co., Inc.
9. Engineer Approved Equal

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with

dimensions of units to be supported.

2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch (480-mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. 2-Post Open Frame Relay Racks

1. Size: Fully adjustable 19-inch mounting verticals. Overall height shall be 84" with a minimum of 45 RU.
2. Construction:
   a. Racks shall be manufactured from aluminum extrusion. Each rack shall have two L-shaped top angles, two L-shaped base angles and two C-shaped equipment- mounting channels. The base angles shall be pre-punched for attachment to the floor. Baked-polyester powder coat finish.
   b. Equipment mounting channels shall be 3” deep and punched on the front and rear flange with the EIA-310-D Universal hole pattern, 1-3/4” rack-mount units (RU), to provide 45RU for equipment. Each mounting space (RU) shall be marked and numbered on the mounting channel.
   c. Equipment attachment points shall be drilled and tapped on both sides with 12-24 mounting holes at universal EIA spacing.
3. Mounting: All racks shall be floor mounted and permanently fixed to the floor with bolt- down kits. Multiple racks shall be connected together.
   Grounding: Provide grounding busbar as shown on drawings. Busbar shall consist of a 19” horizontal ground bar and/or a vertical ground bar installed inside the vertical wire managers. The busbar shall be connected to the perimeter grounding conductor with an irreversible compression fitting. All non-conductive coatings such as paint, lacquer, etc. shall be removed prior to making a ground connection at any point on the rack or cabinet.

D. Data Cabinets:

1. Size: Fully adjustable, front and rear 19-inch mounting verticals. Overall minimum dimensions shall be 30” wide, 42” deep with an overall height of 84”, with at least 45 RU.
2. Panels: Front, side, bottom and top panels shall be fully and easily removable by a latching mechanism. Front and rear panels shall be vented to allow airflow with a keyed locking mechanism, all cabinets shall be keyed alike. Coordinate keying requirements with owner.
3. Construction: The frame shall be made of extruded aluminum. Adjustable front and rear vertical mounting rails shall be drilled and tapped with 12-24 mounting holes at universal EIA spacing.
4. Cable Management: Cabinets shall contain integral vertical cable managers on both sides of the cabinet. Cable management shall run the entire height of the cabinet. If managers are not integral provide vertical cable managers as specified elsewhere in this specification.
5. Mounting: All cabinets shall be floor mounted with adjustable leveling feet and permanently fixed to the floor with bolt-down kits. Multiple cabinets shall be connected together with side panels removed for routing of cables between cabinets, provide ganging kits as required.
6. Grounding: Provide a 19” grounding busbar that accepts 2-hole grounding lugs in the top of each cabinet on the back side of the cabinet. The busbar shall be

connected to the perimeter grounding conductor with an irreversible compression fitting. All non- conductive coatings such as paint, lacquer, etc. shall be removed prior to making a ground connection at any point on the cabinet.

E. Server Cabinets:

1. Size: Fully adjustable, front and rear 19-inch mounting verticals. Overall minimum dimensions shall be 30” wide, 48” deep with an overall height of 84”, with at least 45 RU.
2. Panels: Front, side, bottom and top panels shall be fully and easily removable by a latching mechanism. Front and rear panels shall be vented to allow airflow with a keyed locking mechanism, all cabinets shall be keyed alike. Coordinate keying requirements with owner.
3. Construction: The frame shall be made of extruded aluminum. Adjustable front and rear vertical mounting rails shall be drilled and tapped with 12-24 mounting holes at universal EIA spacing.
4. Mounting: All cabinets shall be floor mounted with adjustable leveling feet and permanently fixed to the floor with bolt-down kits. Multiple cabinets shall be connected together with side panels removed for routing of cables between cabinets, provide ganging kits as required.
   Grounding: Provide grounding busbar as shown on drawings. Busbar shall consist of a 19” horizontal ground bar and/or a vertical ground bar installed inside the vertical wire managers. The busbar shall be connected to the perimeter grounding conductor with an irreversible compression fitting. All non-conductive coatings such as paint, lacquer, etc. shall be removed prior to making a ground connection at any point on the rack or cabinet.

F. Co-Location Cabinets:

1. Section Quantity: Co-location cabinets shall be provided with the quantity of sections as shown on the drawings.
2. Size: Fully adjustable front and rear 19-inch mounting verticals. Overall minimum dimensions shall be 30” wide, 42” deep with an overall height of 84”. 2-section cabinets shall provide 21 RU per section; 3-section cabinets shall provide 14 RU per section.
3. Panels: Front, side, bottom and top panels shall be fully and easily removable by a latching mechanism. Front and rear section doors shall be vented to allow airflow with a keyed locking mechanism. Each section shall be keyed differently, front and rear doors of the same section shall be keyed alike.
4. Keys: Individual keys shall be provided for each section. A grand master key shall be provided for all sections in all co-location cabinets provided under this project. Coordinate keying requirements with the owner.
5. Construction: The frame shall be made of extruded aluminum. Adjustable front and rear vertical mounting rails shall be drilled and tapped with 12-24 mounting holes at universal EIA spacing. Each compartment in the cabinet shall include two pairs of equipment mounting rails. Mounting rails shall bolt to the supports located near the top and bottom of the compartment and shall be fully adjustable in depth to provide front and rear support for equipment.
6. Cable Management: Cabinets shall include integral vertical cable management pathways that segregate and secure cables from each section.
7. Mounting: All cabinets shall be floor mounted with adjustable leveling feet and

permanently fixed to the floor with bolt-down kits. Multiple cabinets shall be connected together with side panels removed for routing of cables between cabinets, provide ganging kits as required.

8. Grounding: Provide a 19" grounding busbar that accepts 2-hole grounding lugs in the top of each section on the back side of the cabinet. Daisy-chain multiple busbars with the top- most busbar being connected to the perimeter grounding conductor with an irreversible compression fitting. All non-conductive coatings such as paint, lacquer, etc. shall be removed prior to making a ground connection at any point on the cabinet.

G. Cable Management Accessories

1. Open Frame Relay Racks
   a. Vertical: Provide double-sided vertical cable managers with extended fingers on both sides of the rack. Vertical cable managers shall contain cable guides (extended fingers) spaced 1 RU apart allowing front to rear cabling within the manager. Width of cable manager shall be as shown on drawings. Cable manager shall contain a snap-on or hinged cover and extend the full height of the rack.
   b. Horizontal: Provide horizontal managers at locations shown on drawings. Horizontal managers shall be 3.50" high (2RU) x 19" wide x 6" deep. Horizontal managers shall contain cable guide fingers spaced 1.75" apart with a snap-on or hinged cover.
2. Equipment Cabinets:
   a. Vertical: Vertical cable management shall be provided on both sides of the mounting rails and located at the front and rear of the cabinet. Vertical cable managers shall contain cable guides (fingers) spaced 1 RU apart.
   b. Horizontal: Provide horizontal managers at locations shown on drawings. Horizontal managers shall be 3.50" high (2RU) x 19" wide x 6" deep. Horizontal managers shall contain cable guide fingers spaced 1.75" apart with a snap-on or hinged cover.

2.4 POWER DISTRIBUTION UNITS (PDU)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. APC
2. Raritan (A brand of Legrand)
3. Tripp-Lite
4. Panduit
5. Engineer Approved Equal

B. Horizontal PDU Type 1:

1. Provide horizontal PDU's as shown on the drawings.
2. Mounting: Horizontal PDU shall mount on 19" rack rails. PDU shall require no more than 1RU for mounting.
3. Quantity: See the drawings for the number and type of PDU to provide in each

rack and cabinet.
4. Input: 30A, 120VAC, 1-phase. NEMA L5-30P plug type with 15-foot cord.
5. Output: 3KW, 120VAC, 1-phase with (12) 5-15/20R outlets, 120VAC.
6. Overload Protection: (2) 20A circuit breakers protect (6) outlets each
7. Metering: Integral meter displaying input current.
8. UL Listed
9. Basis of Design: Tripp-Lite Model No. PDUMH30

C. Vertical PDU Type 2:

1. Provide vertical PDU's as shown on the drawings.
2. Mounting: Vertical PDU's shall be mounted on the interior side wall of the cabinet or cabinet so as not to interfere with cable routing or prohibit the use of mounting equipment to the rear mounting rails. PDU shall utilize 0 RU when installed.
3. Quantity: See the drawings for the number and type of PDU to provide in each rack and cabinet.
4. Input: 30A, 208VAC, 3-phase. NEMA L21-30P plug type with 15-foot cord.
5. Output: 8.6KW, 120/208VAC, 3-phase. Provide the following outlets:
   a. (36) C13 Outlets, 208VAC
   b. (6) C19 Outlets, 208VAC
   c. (6) NEMA 5-15/20R Outlets, 120VAC
6. Overload Protection: (3) 20A double-pole circuit breakers (1 per output phase)
7. Metering: Integral meter displaying input current per-phase.
8. UL Listed
9. Basis of Design: Tripp-Lite Model No. PDU3MV6L2130

D. Horizontal PDU Type 3:
1. Provide horizontal PDU's as shown on the drawings.
2. Mounting: Horizontal PDU shall mount on 19" rack rails. PDU shall require no more than 2RU for mounting.
3. Quantity: See the drawings for the number and type of PDU to provide in each rack and cabinet.
4. Input: 30A, 208VAC, 3-phase. NEMA L21-30P plug type with 9.84-foot cord.
5. Output: 8.6KW, 120/208VAC, 3-phase. Provide the following outlets:
   a. (12) C13 Outlets, 208VAC
   b. (6) C19 Outlets, 208VAC
6. Overload Protection: (3) 20A double-pole circuit breakers (1 per output phase)
7. Metering: Integral meter displaying input current per-phase.
8. UL Listed
9. Basis of Design: Raritan Model No. PX3-1902R

2.5 CABLE RUNWAY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Chatsworth Products, Inc. – Universal Cable Runway
2. Cooper B-Line – Cable Runway
3. Engineer Approved Equal

B. Construction: Cable runway shall be manufactured from 3/8" (9.5 mm) wide by 1-1/2" (38 mm) high tubular steel with .065" (1.65 mm) wall thickness. Cable runway (side stringers) will be 9'- 11½ "(3.0 m) long. Cross members will be welded in between stringers on 12" (300 mm) intervals/centers beginning 5-3/4" (146 mm) from one end so that there are 10 cross members per cable runway section. There will be 10-1/2" (267 mm) of open space in between each cross member.

C. UL Listed: Cable runway will be UL Classified for suitability as an equipment grounding conductor only (Contractor shall remove paint or use ground straps at splices and intersections).

D. Sizes: Provide cable runway sizes as defined on drawings.

E. Finish shall be epoxy-polyester hybrid powder coat (paint) in black, unless noted otherwise.

F. Connector Assemblies: Turns, transitions, corners and brackets shall meet the same specification as the cable runway section.

G. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable runway.

H. Hardware and Fasteners: Steel, zinc plated matching same color as cable runway section.

I. Support: Provide a combination of wall mount, data cabinet to cable runway mount, relay rack to cable runway mount and ceiling trapeze cable runway support. The use of a single center hung support rod shall not be allowed.

J. Grounding: Grounding kits are required to provide a method of bonding cable runway sections and turns together that is independent of the pathway splices. The grounding kit shall be constructed of UL Listed components. The preferred solution is a #6 AWG green insulated stranded copper conductor connected on both ends to ladder rack using two-hole compression lugs and stainless steel hardware.

K. Accessories: All accessories shall be manufactured from same material as cable runway section. Provide following accessories:

1. Cable straps used for attaching cable bundles to the cable runway cross members must be reusable with a hook and loop-style closure.
2. End caps used to cover the ends of cable runway shall be manufactured from a black fire- retardant rubberized material.
3. End closing kits used to cover the end of cable runway. Kits shall consist of a bar cut to match the width of the cable runway and the hardware required to attach the bar to the end of a length of cable runway.
4. Radius drops used to create a radius to form cables over as the cables exit or enter the cable runway. The extrusion will be formed in a 90° arc with a minimum bend radius of 3" (75 mm). Radius drops will attach to either the side stringer or the cross member of the cable runway using a clevis pin. Provide radius drops at all sections where cable exits runway

2.6 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3: EXECUTION

3.1 ENTRANCE FACILITIES

A. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.3 FIRESTOPPING

A. Comply with requirements in Section 270528 "Pathways for Communications Systems" for fire rated pathways.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements noted elsewhere in Division 27 for specific labeling requirements.

B. Labels shall be preprinted or computer-printed type. Provide self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designators.

END OF SECTION

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SECTION 27 13 23:
COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

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. Provide work specified but not shown on Drawings, and work shown on Drawings but not specified, as though expressly required by both.

1.2 SUMMARY

A. Section Includes:

1. 9/125 micrometer single-mode, armored, indoor optical fiber cable (OS2).
2. Optical fiber cable connecting hardware, patch panels, and patch cords.
3. Cabling identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. LAN: Local area network.

D. RCDD: Registered Communications Distribution Designer.

E. APC: Angled Physical Contact

1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

A. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, patch panels, connectors, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Floor Plans: that identify device locations, cable routes and quantities, cable types, riser locations, and references to installation details and diagrams.
3. Diagrams/Elevations: showing room layouts, rack layouts (including elevations), riser layouts, etc.

C. Fiber optic cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD.

B. Source quality-control reports.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.8 WARRANTY

A. Period: The Contractor shall warranty all labor, workmanship, and materials for a period of one (1) year from the date of final Owner acceptance. Should a failure occur within this warranty period, the Contractor shall provide all labor and materials necessary to restore the system to the condition required for the final test and acceptance for this contract, at no cost to the Owner.

B. Extended Warranty: The manufacturer shall guarantee in writing that the optical fiber backbone cable channels as installed by this contract are free from defects in materials and workmanship and will meet the applicable ANSI/TIA/EIA and ISO/IEC channel transmission requirements in effect at the time of installation and will support any current or future application ratified by IEEE, ANSI, or ISO designed to operate over the applicable ANSI/TIA/EIA-568-B and ISO/IEC 11801 standards in effect at the time of installation. The duration of this warranty shall be for a period of 25 years from date of final Owner acceptance. Defective products shall be repaired or replaced by the manufacturer, at no cost to the Owner.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must be a certified installer meeting all requirements for the cable manufacturer’s 25 year warranty program and must have

personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with all other trades and service providers, if applicable.

PART 2: PRODUCTS

2.1 GENERAL REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA- 568-C.1, when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: Flame spread shall not exceed 5 ft (1.5 m) when tested in accordance with NFPA 262.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-B.

2.2 9/125 MICROMETER SINGLE-MODE, ARMORED, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, tight-buffered, armored optical fiber cable. Refer to drawings for strand count.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering

products that may be incorporated into the Work include, but are not limited to the following:

1. Belden CDT Networking Division/NORDX.
2. Corning Cable Systems.
3. General Cable; General Cable Corporation.
4. Mohawk; a division of Belden Networking, Inc.
5. Superior Essex Inc.
6. Engineer Approved Equal

C. General: Fiber optic cable construction shall consist of 8.3 µm single mode optical fibers typically formed in groups of six (6) or twelve (12) fibers each. Size, strand count and routing of fiber optic cables shall be as indicated on the drawings. These groups and individual fibers shall exceed all requirements for ANSI/TIA/EIA-568-B.3 and support high speed communication network applications. These groups assembled to form a single compact core, which is covered by a protective sheath.

D. Optical Fiber Requirements and Performance:
1. Core Diameter: 8.3µm
2. Cladding Diameter: 125µm ± 1µm
3. Cladding Non-Circularity: ≤ 1%
4. Core/Cladding Concentricity Error: 0.5µm
5. Colored Fiber Diameter: 254µm ±7µm
6. Minimum Bandwidth: 20GHz
7. Maximum Attenuation:
   a. 1310nm ≤ 0.65 dB/km
   b. 1550nm ≤ 0.50 dB/km

E. Design Specifications: Provide cable suitable for installation in indoor (plenum) environments with tight-buffered cables surrounded by an interlocking armor. Cable jacket shall meet the following specification:

1. Jacket Color: Yellow.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).
4. Plenum Applications: Cables shall be UL 910 listed OFNP.
5. Armor Material: The armor material shall be constructed of aluminum interlocking armor. The armor of each optical cable shall be bonded to the ground busbar located in the rack. An additional outer jacket shall be placed over the armor. The color of the armor jacket shall match the jacket color of the optical fiber cable located inside of the armor.

F. Single-mode (Dispersion Un-shifted): All single-mode fiber shall support 10 Gigabit Ethernet (10 Gbps) to distances of up to 10,000 meters @ 1310 nm and 40,000 meters @ 1550 nm per IEEE
802.3 performance. The single-mode fiber utilized in the optical fiber cable shall meet TIA- 492CAAB, "Detail Specification for Class Iva Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak," and ITU recommendation G.652 "Characteristics of a single-mode optical fiber cable."

G. Identification: The individual fibers shall be color coded for identification. The optical

fiber color coding shall be in accordance with EIA/TIA-598, "Optical Fiber Cable Color Coding." When buffered fibers are grouped into individual subunits, each subunit jacket shall be numbered for identification, with the exception of filler subunits where used. The outer jacket shall be marked with the manufacturer's name or ETL file number, date of manufacture, fiber count, fiber type, flame rating, listing symbol, and sequential length markings every two feet.

2.3 OPTICAL FIBER CABLE HARDWARE AND PATCH CORDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Belden CDT Networking Division/NORDX.
2. Corning Cable Systems.
3. Hubbell Premise Wiring.
4. Optical Cable Corporation.
5. Engineer Approved Equal

B. Patch Panel Housings

1. Fiber Optic housings shall provide a means for securing, strain-relieving, protecting, and labeling of fiber optic cable terminations.
2. Rack-Mount Housing Specifications
   a. Housings shall be designed for rack-mounted or frame-mounted applications that support conventional cross-connection and interconnection schemes as well as splicing applications.
   b. Housings shall be available in 1U, 2U, 3U and 4U. See drawings for exact size of housings.
3. The housings shall meet the design requirements of ANSI/TIA/EIA-598 and the plastics flammability requirements of UL 94 V-0.
4. The connector housings shall have a labeling scheme that complies with ANSI/TIA/EIA- 606.
5. The housings shall support cross-connection, inter-connection and/or splicing applications and routing schemes in the same housing.
6. The housing shall contain a front compartment whose function is to protect and manage jumpers that interface with the main housing behind it. The front jumper assembly compartment shall be removable and be accessible via a translucent door.
7. The front compartment shall contain jumper egress openings on both sides that are edged with protective pass-through grommets that provide bend radius support for optical fiber jumpers.
8. The rear assembly housing shall be accessible via a hinged door. The door shall contain a routing and cable sub-unit slack storage bracket for interior management of cable sub-units and buffer tubes.
9. The housing shall contain a brushed entry on both sides of the rear of the housing.
10. The housing shall provide means for strain-relieving fiber optic cables both interior to and exterior on the rear assembly housing.
11. The rear of the housing shall contain provisions for routing and maintaining fiber optic cable components, including cable sub-units and buffer tuber, 900 um optical fiber, and buffer tube transition kits.

12. The floor/base of the rear of the housing shall provide holes or slots for the installation (and removal) of fiber retention or slack management clips.
13. The floor/base of the rear assembly housing shall provide holes or slots for the installation (and removal) of transitional strain-relief clips.

C. Wall Mount Single-Panel Housing

1. The single-panel housing shall provide a base enclosure with a front (main) door, and back- plate, as well as top and bottom cable entries.
2. The housing shall provide necessary protection from incidental contact, dust and debris.
3. The housing shall be fully accessible from the front and sides (either left or right depending on mounting orientation of the housing).
4. The housing shall provide all necessary provisions for proper management and administration of optical fiber, fiber optic connectors, splices, cable-subunits, transition kits and other related components.
5. The single-panel housing shall support cross-connection, inter-connection and/or splicing applications and routing schemes in the same housing.
6. The housing shall accommodate direct connector installations or terminations via connector panels. Connector panels shall be held in place via push-pull plungers that are affixed to the housing itself.
7. The housing shall be capable of holding up to one (1) connector panel that loads directly into the side of the housing.
8. The housing shall accommodate pigtail splicing via an internal splice organizer with pigtailed connector panels.
9. The front or main entry of the housing and interior shall be accessible via a solid metal door. The rear or base of the housing shall be accessible via a solid metal back-plate.
10. The housing shall contain openings on both the top and bottom sides of it that allow fiber optic cables to enter the housing in either a through or mid-span configuration. The housing shall provide means for strain-relieving fiber optic cables inside the housing.
11. The housing's interior shall contain provisions for routing and maintaining fiber optic cable components, including cable sub-units and buffer tubes, 900 µm optical fiber, and buffer tube transition kits.
12. The housing's base shall incorporate pre-stamped metal lances for affixing a splice organizer capable of holding 12 to 24 fiber optic splice protectors.
13. Installation of the adapter or connector panel (including loaded connector pigtails) shall not interfere with the internal cable sub-unit routing.
14. The base of the housing, following removal of the back-plate, shall contain corner openings that allow cable sub-units to route between housings in a stacked configuration.
15. Wall-mountable connector housings shall accept an interchangeable connector panel. The connector panel shall have the following characteristics:
    a. The connector panel shall utilize a single mounting footprint and shall be available with various connector adapters and different adapter counts in each panel.
    b. The connector panel shall be interchangeable between the rack and wall-mountable hardware being proposed.
    c. The panel shall be attached to the housing or splice or slack storage cassette with latches to allow quick installation and removal.

D. Fiber Optic Adapter Panels
1. Rack and wall mountable connector housings shall accept an interchangeable connector panel.
2. The adapter panel shall utilize a single mounting footprint and shall be interchangeable between the rack and wall mountable hardware used.
3. The panel shall be attached with two push-pull latches to allow quick installation and removal.
4. The adapter panel shall be available with industry standard single fiber and small form factor multi-fiber adapters, including the SC duplex, LC duplex and MPO.
5. The adapter panel shall accommodate OS2 optical fiber.
6. Pigtailed panel shall consist of an adapter panel as described above, factory-loaded with factory-terminated pigtails, 3 m in length.
7. Blank adapter panels shall be available to fill unused space within housings. Housings shall be supplied with blank adapter panels for all available positions unless the housing is ordered with optical fiber adapters panels pre-installed. The blank panel shall be attached with at least two spring clips to allow quick installation and removal.

E. Fiber Optic Splice Cassettes
1. Rack mountable housings shall accept an interchangeable splice cassette.
2. The splice cassette shall consist of a base constructed from injection-molded black plastic and a removable hinged lid or cover constructed from injection-molded translucent plastic.
3. The splice cassette shall be available with pre-installed connector pigtails and panels.
4. The splice cassette shall allow one connector panel to be installed into the base.
5. The splice cassette shall be able to hold and contain at least one meter of pigtail fiber slack on the interior floor of the base.
6. The splice cassette shall be able to hold and contain up to one meter of 2.0-3.0 mm buffer tube slack or jacketed pigtail slack (up to 24 fiber) on the exterior bottom of the base.
7. The splice cassette shall contain a pivoting (and removable) splice tray above the base in a horizontal position that rotates up into a vertical position at least 90 degrees relative to the base allowing access to the base.
8. The splice tray shall contain one interchangeable splice organizer capable of holding up to
(24) splice heat-shrinks, routing tabs and provisions for holding a total of two meters of 250 or 900 micron fiber slack and contain slots and provisions for installing cable ties for securing incoming and outgoing buffer tubes and/or jacketed optical fibers.
9. The splice cassette shall contain relief slots for holding up to two buffer tube transition ("fan-out") kits on either side of the base.
10. The splice cassette shall contain two fiber retention tabs behind the connector panel location to maintain fiber below the connections and adapters in an installed connector panel.
11. Refer to rack elevation drawings for required Fiber Optic Splice Cassette types.

F. Multi-fiber Push On (MPO) Trunk Connectors
1. The optical fiber backbone cabling system shall utilize a modular solution consisting of factory-terminated trunk assemblies utilizing 12-fiber MPO array connectors, MPO to LC Duplex modules and jumpers, and MPO adapter panels

and harnesses.

2. MPO to MPO High-Density Trunk Assemblies:
   a. Trunks shall be all-dielectric construction.
   b. Trunks shall be terminated with MPO connectors at both ends, having 12 fibers per ferrule.
   c. Jacket color and break-out leg jacket color shall be yellow for single-mode fiber assemblies.
   d. MPO -terminated primary trunks shall have non-pinned MPO connectors on both ends.
   e. MPO -terminated extender trunks shall have pinned MPO connectors on the end to be interconnected with a primary trunk and non-pinned MPO connectors on the other end.
   f. The trunk assemblies shall be available in 12, 24, 36, 48, 72, 96, and 144-fiber counts; specific fiber counts to be used shall be specified on the drawings.
   g. Trunks shall be furcated into 12-fiber legs (subunits). Standard leg length shall be 33 in +3/-0 in.
   h. Trunk length shall be the distance between furcation points at each end of the cable and shall not be inclusive of the length of the legs at each end.
   i. Trunk furcation plugs shall incorporate mechanically designed features that allow securing the trunks inside or outside a connector housing.
   j. The trunk shall incorporate a flexible boot at the back of the epoxy plug, in order to provide a uniformly smooth transition between the plug and the trunk cable.
   k. The trunk cable shall have a minimum bend radius of five times the cable outside diameter.
   l. Trunks shall meet the connector performance specifications of TIA/EIA-568-C.3, Optical Fiber Cabling Components Standard, (normative) Annex A.
   m. Manufacturer shall have a field installable MPO connector offering (to support capabilities to field repair). The field installable MPO connector shall be a no epoxy/no polish style connector.
   n. Contractor shall field verify the type and lengths of MPO trunk cables, prior to placing order.

3. MPO to LC High-Density Modules (Cassettes)
   a. Modules shall contain 12 fiber terminations with one 12-fiber cable assembly within a protective housing. Cable assemblies within the modules shall be terminated with an MPO pinned connector at the back and LC connectors at the front.
   b. Modules shall have shuttered LC adapters at the front, with a shutter door that opens inward. Module shall have self-retracting shutter adapter mechanism that allows a single hand operation. The shutter shall be translucent and shall be VFL compatible.
   c. Modules shall permit front and rear installation into the patch panel housings.
   d. Modules shall contain discrete fiber and port identification. This fiber and port identification shall be pad printed on top and bottom of the modules.

G. Fiber Optic Patch Cords:

1. Single-mode, duplex fiber patch cable shall be LC-LC, yellow.
2. The single-mode, duplex fiber patch cable shall consist of 9 micron core and a 125 micron cladding. The fiber cladding shall be covered by aramid yarn and OFNR rated, unless otherwise indicated on the drawings.
3. Contractor shall field verify the type and lengths of patch cables, prior to placing order.
4. Contractor shall provide all patch cords required to perform the patching as designated on the contract drawings and specifications. Provide one (1) patch cord for each terminated fiber port at both ends. All slack in the patch cords shall be appropriately dressed using vertical and horizontal patch cord organizers to maintain a neat appearance.
5. Fiber optic patch cords shall be manufactured and certified by the same manufacturer of the permanent link cabling.

H. UPC Fiber Optic Connector:

1. LC, Single-mode (OS2), UPC, ceramic ferrule, field installable, blue housing, blue boot, pre-polished connector.
2. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B for Type LC connectors and TIA-604-5-D for Type MPO connectors. Comply with TIA-568-C.3.
3. Quick-connect, duplex, Type LC connectors. Insertion loss not more than 0.25 dB.

I. APC Fiber Optic Connector:

1. SC, Single-mode (OS2), APC, ceramic ferrule, field installable, blue housing, blue boot, pre-polished connector.
2. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B for Type SC connectors. Comply with TIA-568-C.3.
3. Quick-connect, simplex, Type SC connectors. Insertion loss not more than 0.25 dB.
4. Angled polished connectors shall be used for Boingo Distributed Antenna Systems (DAS) connectivity.

2.4 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 SOURCE QUALITY CONTROL

A. Factory test optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

B. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568- C.3.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3: EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to termination points without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 301.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate and test all cables; no cable shall contain unterminated elements. Make terminations only at indicated patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 36 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to termination points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination points. Remove and discard cable if damaged during installation and replace it with new cable.

8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, install a 10-foot (3-m) long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in communications equipment rooms with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

3.3 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Shields/armors shall be grounded according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

A. Cable Management Software: This contractor shall be responsible for updating the existing airport cable management software program with all communication optical fiber backbone cables installed as part of this project.

B. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and

destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Label each unit and field within distribution racks and frames.
3. Identification within patch panels in communication equipment rooms: Label each connector and each discrete unit of cable-terminating and connecting hardware.

E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL AND TESTING

A. General:

1. This Section includes the minimum requirements for the test certification, identification and administration of backbone and horizontal optical fiber cabling.
2. This Section includes minimum requirements for:
   a. Fiber optic test instruments
   b. Fiber optic testing
   c. Administration
   d. Test results documentation
3. Testing shall be carried out in accordance with this document. This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS). In addition to OLTS testing the optical fiber cabling may require testing with an optical time domain reflectometer (OTDR), this is defined elsewhere in this section.
4. All tests shall be documented including OLTS dual wavelength attenuation measurements and OTDR traces with event tables as well as OTDR maps where OTDR testing is required.

B. Requirements:

1. All testing procedures and field-test instruments shall comply with the latest version and applicable requirements of ANSI/TIA/EIA standards addressing the testing and administration of optical fiber cabling.
2. Trained technicians who have successfully attended an appropriate training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof shall execute the tests.
3. The Owner or the Owner's representative shall be invited to witness field-testing.
   a. The Owner or the Owner's representative shall be notified of the start

date of the testing phase five (5) business days before testing commences.

4. Manufacturers catalog sheets and specifications for fiber optic field-test instruments including optical loss test sets (OLTS; power meter and source) and optical time domain reflectometer (OTDR), if required.

5. A schedule (list) of all optical fibers to be tested.

6. Sample test reports.

C. Test Limits and Parameters

1. Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in compliance with the following test limits:

a. Optical Loss Testing

1) Multimode and Singlemode links: The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA-568-C.0.

a) Link Attenuation (dB) = Cable_Attn (dB) + Connector_Attn (dB) + Splice_Attn (dB)

b) Cable_Attn (dB) = Attenuation_Coefficient (dB/km) * Length (Km)

c) Connector_Attn (dB) = number_of_connector_pairs * connector_loss (dB)

d) Maximum allowable connector_loss = 0.75 dB

e) Splice_Attn (dB) = number_of_splices * splice_loss (dB)

f) Maximum allowable splice_loss = 0.3 dB

g) The values for the Attenuation_Coefficient (dB/km) are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Multimode 62.5/125 µm	850	3.5	1300	1.5
Multimode 50/125 µm	850	3.5	1300	1.5
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

2. OTDR Testing

a. In addition to OLTS testing, OTDR testing shall be required for optical fiber cabling containing a splice within the link length of the cable run. Splices made to connect break-out kits and pig tails are not required to be

tested by an OTDR.

b. Reflective events (connections) shall not exceed:

1) 0.75 dB in optical loss when bi-directionally averaged

2) -35 dB Reflectance for multimode connections

3) -40 dB reflectance for UPC singlemode connections

4) -55 dB reflectance for APC singlemode connections

c. Non-reflective events (splices) shall not exceed 0.3 dB.

3. All installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described under Optical Fiber Cable Testing section of this specification. Any link or channel that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation in accordance with the Optical Fiber Cable Testing section of this specification.

4. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

D. Testing Equipment:

1. The field-test instrument shall be within the calibration period recommended by the manufacturer and a copy of the calibration certificate made available.

2. Acceptable manufacturers

a. Fluke Networks

b. Tektronix

c. Engineer Approved Equal

E. Test Records:

1. Administration of the documentation shall include test results of each fiber link and channel.

2. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.

3. The test result records saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records.

F. Optical Fiber Testing

1. Field-test instruments shall have the latest software and firmware installed.

2. Testing shall be performed on each cabling link (connector to connector).

3. Testing shall be performed on each cabling channel (equipment to equipment) as identified in the contract documents.

a. Testing shall not include any active devices or passive devices within the

link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

4. Testing of the cabling shall be performed using high-quality test reference cords of the same core size as the cabling under test, terminated with reference grade connectors. Reference grade connectors are defined as having a loss not exceeding 0.1 dB for multimode and 0.2 dB for singlemode.

5. OLTS Testing

   a. Horizontal/Backbone link

      1) Multimode links shall be tested in one direction at 850 nm and 1300 nm in accordance with ANSI/TIA-526-14-B, one-cord reference method, with an Encircled Flux compliant launch.

      2) Singlemode backbone links shall be tested in one direction at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1 (One-cord reference method).

      3) Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

6. OTDR Testing

   a. Fiber links shall be tested at these wavelengths for anomalies and to ensure uniformity of cable attenuation, connector insertion loss and reflectance.

      1) Multimode: 850 nm and 1300 nm.

      2) Singlemode: 1310 nm and 1550 nm.

   b. Each fiber link and channel shall be tested in both directions.

      1) The launch and tail fibers shall remain in place for the measurement in the opposite direction – failing to do so will result in an increase in measurement uncertainty.

      2) The use of a loop back fiber at the far end with a tail fiber at the near end on the adjacent fiber is permitted for bi-directional testing, so long as the OTDR is able to split the trace automatically into two traces for the two fibers under test.

   c. A launch cable shall be installed between the OTDR and the first link connection.

   d. A tail cable shall be installed after the last link connection.

7. Length Measurement

   a. The optical length of each fiber shall be recorded using an OLTS or OTDR.

8. Polarity Testing

   a. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA 568 C.0. The polarity of

the paired duplex fibers shall be verified using an OLTS.

G. Administration

1. Test results documentation

a. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests.

b. The database for the complete project shall be stored and delivered on CD/DVD prior to Owner acceptance of the building in the original format used by the cabling vendors' software.

c. Circuit IDs reported by the test instrument should match the cable label ID.

d. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information

1) The identification of the customer site as specified by the end-user.

2) The name of the test limit selected to execute the stored test results.

3) The name of the personnel performing the test.

4) The date and time the test results were saved in the memory of the tester.

5) The manufacturer, model and serial number of the field-test instrument.

6) The version of the test software and the version of the test limit database held within the test instrument.

7) The fiber identification number.

8) The length for each optical fiber.

9) The index of refraction used for length calculation when using length capable OLTS.

10) The backscatter coefficient of the fiber under test when using an OTDR.

11) Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).

12) Test results to include OTDR link and channel traces, event tables at the appropriate wavelength(s) and a map of the link tested.

13) The length for each optical fiber as calculated by the OTDR.

14) The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements

END OF SECTION

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SECTION 27 15 00
COMMUNICATIONS - HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pathways.
2. Fire Alarm Cabling.
3. UTP cabling.
4. Cabling identification products.
5. Cabling administration system

1.2 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the Fire Alarm Control Unit and the fire alarm devices located through the system.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
2. Cabling administration drawings and printouts.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance data.

1.5 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. Flame-Spread Index: 25 or less.

2. Smoke-Developed Index: 50 or less.

B. 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.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-A.

E. Fire Alarm Cable: UL 1424

F. Comply with NFPA 70, The National Fire Alarm Code

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Cable Support: NRTL labeled for support of Category 6a cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.

2. J-hooks and bridle rings with accessories to fasten to walls and ceiling grid wires.

3. Straps and other devices.

B. Conduit and Boxes: Comply with requirements in Section "Raceway and Boxes for Electrical Systems."

1. Wall outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2. Junction boxes shall be no smaller than 4 inches wide and tall and 2-1/2 inches deep. Boxes and covers shall be factory finish red.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

2.3 FIRE ALARM CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden CDT Inc.; Electronics Division.

2. Southwire

3. Berk-Tek; a Nexans company.

4. Genesis Cable Products; Honeywell International, Inc.

B. These requirements cover 60 - 250°C (140 - 482°F) single- and multiple-conductor cables for use as fixed wiring within buildings (some are also marked for direct burial) principally for power-limited fire-alarm circuits as described in Article 760 and other applicable parts of the National Electrical Code (NEC). Cables covered by these requirements are:

1. Type FPLP (plenum cable),

2. Type FPLR (riser cable), and

3. Type FPL (cable for other than plenum and riser uses in general and in trays), and "Power-limited fire-alarm circuit cable" (cable for limited use).

C. Cables shall be red finish.

D. A cable that contains one or more electromagnetic shields may be surface marked or have a marker tape to indicate that it is "shielded". A cable that contains one or more optical-fiber members has "-OF" supplementing the type letters and is marked in accordance with 45.1(d). A cable may consist of or contain one or more coaxial members.

E. The overall jacket on a cable that has "sun res" or "sunlight resistant" in a surface marking or on a marker tape complies with a 720-h sunlight-resistance test.

F. A cable that has "dir bur", "direct burial", or "for direct burial" in a surface marking or on a marker tape complies with a 1000-lbf crushing test. Direct-burial cable with wire armor, a metal braid, interlocked metal armor, or a smooth or corrugated metal sheath has a jacket over the metal covering.

G. TYPE FPLP CABLE - Cable that is intended for installation in accordance with section 760-154(A) of the National Electrical Code (ANSI/NFPA 70) in a duct, plenum, or other space used to transport environmental air without the cable being enclosed in a raceway in that space is to be tested for smoke and flame characteristics in accordance with the National Fire Protection Association Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces, ANSI/NFPA 262. A cable that complies exhibits a maximum flame-propagation distance that is not greater than 5 ft, 0 inch, a peak optical density of smoke produced of 0.50 or less (32 percent light transmission), and an average optical density of smoke produced of 0.15 or less.

H. TYPE FPLR CABLE - Cable that is intended for use in vertical runs in a shaft, or for installations in which the cable penetrates more than one floor, as specified in section 760-154(B) of the National Electrical Code ANSI/NFPA 70. This cable is to be tested for flame-propagation characteristics in accordance with the Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts, UL 1666. A cable that complies has a flame-propagation height less than 12 ft, 0 inch or 366 cm and temperatures are 850.0°F (454.4°C) or less at a height of 12 ft, 0 inch or 366 cm.

I. TYPE FPL CABLE - Type FPL cable complies with a 70,000 Btu/h (20.5 kW) vertical-tray flame test. The cable manufacturer chooses one of the following tests:

1. THE UL TEST REFERENCED IN 23.2.1 - This paragraph applies the test method described as the UL Flame Exposure (smoke measurements are not applicable) in the

Standard Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685, to cable that is surface marked or designated by a marker tape as "FPL". A cable of a given construction shall not exhibit char that reaches the upper end of any specimen (a maximum of 8 ft, 0 inch).

2. THE FT4/IEEE 1202 TEST REFERENCED IN 23.3.1 - This paragraph applies the test method described as the FT4/IEEE 1202 Type of Flame Exposure (smoke measurements are not applicable) in the Standard Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables, UL 1685. This test differs from the UL tests in loading (more cables are used, with small cables bundled, and the spacing between cables or bundles is limited), burner angle, and failure criterion. For compliance, this test damages less than 150 cm (59 inches) of cable. A cable that complies either is not marked or it bears the designation "FT4/IEEE 1202" or "FT4" legible on or through the outer surface or on a marker tape.

J. POWER-LIMITED FIRE-ALARM CIRCUIT CABLE - Cable that is surface marked or designated by a marker tape as "power-limited fire-alarm circuit cable" or as "power ltd fire alarm cable" complies with the VW-1 vertical-specimen flame test. The cable is not marked "VW-1".

K. “Power-limited fire-alarm circuit cable" is used with protection such as raceway. All other cables covered in these requirements are not required by the NEC to be used in raceway and are capable of use without the physical protection of raceway but may be pulled into conduit or installed in other raceway.

L. "Power-limited fire-alarm circuit cable" is used:

1. In concealed spaces.

2. In raceway.

M. These requirements do not cover cables that contain conductors for electric-light, power, or Class 1 circuits. These requirements do not cover cables for Class 3 or Class 2 power-limited circuits (see the Standard for Power-Limited Circuit Cables, UL 13), communications cables (see the Standard for Communications Cables, UL 444), or cables for non-power-limited fire-alarm circuits (NPLF types).

N. These requirements do not cover the optical or other performance of any optical-fiber member or group of such members.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Thomas and Betts

2. Hubbell Premise Wiring.

3. Panduit Corp.

4. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 5e and Category 6.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 SOURCE QUALITY CONTROL

A. Factory test UTP cables according to TIA/EIA-568-B.2.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Methods:

1. Install cables in EMT raceways in open spaces including:

    a. Outdoors

    b. Mechanical Rooms

    c. Mechanical Chases

    d. Any room that does not have a ceiling.

    e. Any room that has a gypsum board ceiling.

2. Install cables in open pathway wiring methods where there is an acoustical ceiling.

3. Install plenum cable in environmental air spaces, including plenum ceilings.

4. Comply with requirements for raceways and boxes specified in Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.

2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 24 inches apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

A. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.

B. Cable Schedule: Post in prominent location in each Fire Alarm Control Unit. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for SLC , NAC and low voltage power circuits. Follow convention of NICET and TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

D. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 10 feet.

3. Label each terminal strip and screw terminal in each panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.

4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.8 FIELD QUALITY CONTROL

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel in fire alarm cable-plant management operations, including changing signal pathways for different devices, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new device outlets.

PART 4 METHOD OF MEASUREMENT

4.01 No separate measurement will be made for items required by this section.

PART 5 BASIS OF PAYMENT

5.01 No separate payment will be made for items required by this section.

Payment will be made under:

CDF Control Facility – per lump sum

END OF SECTION

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SECTION 28 13 00

ACCESS CONTROL SYSTEM

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. This section includes an extension of the existing Schneider Electric Andover Control Continuum Airport ACS system. Communication from Access Control System (ACS) head- end servers to access control intelligent field panels shall be IP over an existing local area network. This section will specify the access control panels, card readers, door devices, cabling and system testing procedures.

2. The Contractor shall subcontract the services of Schneider Electric to provide the noted equipment and services listed in this specification section. Contact Kenneth Kendra of Schneider Electric at 919-463-3317 to coordinate the access control system work specified herein. The Contractor shall include Schneider Electric associated costs to complete all the work in the bid. Schneider Electric shall provide all shop drawings, bill of material and all other related items to describe the operation of the system or equipment provided as required.

1.3 DEFINITIONS

A. I/O: Input/Output.

B. IFP: Intelligent Field Panel

C. IP: Internet Protocol

D. LAN: Local area network.

E. ROM: Read-only memory. ROM data are maintained through losses of power.

F. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

G. UPS: Uninterruptible power supply.

H. USB: Universal serial bus.

I. WAN: Wide area network.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
      a. Workstation outlets, jacks, and jack assemblies.
      b. Patch cords.
      c. Patch panels.
   2. Battery and charger calculations for controllers.

C. Product Schedules.

D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Record Drawings

   1. Record Documentation shall consist of “As-Built” Drawings produced from the hand marked field documents and Operation and Maintenance Manuals. The Record Documentation shall be submitted to the Engineer within forty-five (45) days after final acceptance.
   2. Produce all Record Drawings using the latest version of AutoCAD. Record Drawings shall, at a minimum, include the following:
      a. Floor plan drawings indicating device locations, with device legends indicating manufacturers and model numbers for each device.

b. Floor plan drawings indicating wire routing. Wire routing shall be delineated in straight line runs and be tagged with cable identification and terminal strip numbers to coincide with the installation.
c. Mounting details for all equipment and hardware.
d. Functional block diagrams for each subsystem.
e. Wiring details showing rack elevations, equipment wiring and terminations, and inter-rack wiring.
f. Wiring diagrams for all custom circuitry including interfaces to various control output controlled devices, i.e. overhead doors, automatic sliding doors, parking gate operators, fire alarm system interface, etc.
g. Wiring diagrams for each field panel (IFP). Wiring diagrams shall be identical to those laminated and located with each IFP.
h. Typical point-to-point wiring diagrams for each piece of equipment and groups of equipment within the system.
i. Layout details for each riser location, including security panels, power supplies, junction boxes, conduit, and any other security related equipment.

B. Operation and Maintenance Manuals:
1. Intent: The intent of this Section is to require complete documentation of the System for the purpose of system operation and maintenance during and after the Warranty period. It is intended that the operation and maintenance manuals be exhaustive in the coverage of the system to the extent that they may be used as the sole guide to the troubleshooting, identification, and repair of defective parts.
2. Scope: The Contractor shall provide the Owner with three (3) complete drawing books and maintenance and operation manuals on the completed system hardcopy and three (3) copies of the drawing books and maintenance and operations manuals in PDF format on CD-ROM media. These manuals shall include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual. It is required that everything in the system be neatly labeled and easily identifiable. Every terminal, wire, component, or piece of equipment, relay, and other such items shall have a number or letter designation. All of these identification characteristics shall be included in the maintenance and operation manuals. Provide a table of contents and tabulated sheets for each manual. Place tab sheets at the beginning of each chapter or section and at the beginning of each appendix if applicable
3. The maintenance manual requirement of this Section is in addition to Shop Drawing requirements. Maintenance manuals and drawing sets shall be compiled after system fabrication and testing, and shall incorporate any changes made after Shop Drawing submittal. The maintenance manuals and drawing books shall be permanently bound in hard plastic covers.
4. Maintenance Manuals, Manufacturer's Literature: Provide manufacturer's standard literature, covering all equipment included in the system. The maintenance manuals shall contain Specifications, adjustment procedures, circuit schematics, component location

diagrams, and replacement parts identification. All references to equipment not supplied on this Project shall be crossed out.
5. Drawing Books: All Drawings developed specifically for this Project shall be reduced to 11" X 17", folded and bound with hard plastic covers. The 11” X 17” Drawings provided

shall be easily readable after printing. The Drawing book documents shall be produced with AutoCAD and the electronic files shall be provided to the Owner at the completion of the project on CD-ROM in DWG format. Provide component identification and cross reference on the Drawings to allow the maintenance department to understand the function of each item (the block diagram), find the room where the device is mounted (Contract document plans), find its location in a rack (arrangement drawings), find how it is wired (wiring diagrams), and its detailed Specifications (vendor data sheets), and how to repair it (spare parts). Include the following drawings as a minimum:

6. Functional Block Diagram: Provide overall block diagrams showing the major interconnections between subsystems.
7. Arrangement Drawings: Provide drawings showing the physical arrangement of all major system components. This shall include:
8. Elevation drawings of all equipment racks showing the location of each component in the racks. Components in the racks shall be identified as in the functional blockdiagrams.
9. Wiring Diagrams: Provide wiring diagrams showing all field installed interconnecting wiring. Wire identification on the diagrams shall agree with the wire markers installed on the equipment.
10. Operation and Maintenance Manuals shall apply to all security related devices, equipment and software modules.
11. Explanations of subsystem interrelationships. Explanations shall include operations of each subsystem and operations unique to the interfaces between each of the subsystems and possible conflicts that may occur with the interfaces. Each explanation shall be identified, tagged, bound and indexed into a single binder.
12. Power-up and power-down procedures for each subsystem.
13. Description of all diagnostic procedures.
14. A list of manufacturers, their local representatives and subcontractors that have performed Work on the Project. The list shall include contact names, phone numbers and addresses for each.
15. Installation and service manuals for each piece of equipment.
16. Maintenance schedules for all installed components. Schedules shall include inspections and preventative maintenance schedules, and documentation of all repaired or replaced equipment.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Card readers (5%, minimum of two per type)
2. Card reader modules (5%, minimum of two per type)
3. Input / output modules (5%, minimum of two per type)

4. Power supplies (5%, minimum of two per type)

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

B. Source Limitations: Obtain ACS panels, modules, controllers, and all software through one source from single manufacturer.

C. 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.

D. Comply with NFPA 70, "National Electrical Code."

E. Comply with SIA DC-01 and SIA DC-03 and SIA DC-07.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Equipment

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F (10 and 30 deg C), and not more than 80 percent relative humidity, noncondensing.
2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
3. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg. F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Indoor, Uncontrolled Environment: NEMA 250, Type 3R enclosures. System components installed in non-temperature-controlled indoor environments shall be rated for continuous

operation in ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg. C) dry bulb and 20 to 90 percent relative humidity, noncondensing.

3. Outdoor Environment: NEMA 250, Type 4X enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.
4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
5. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X enclosures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Access Control System (controllers, and modules):
    a. Schneider Electric Andover Control Continuum to match the existing Airport's ACS system.
2. Card Readers with keypad:
    a. HID
3. Identification Credential Smart Cards
    a. Existing to remain
4. Servers and Computer Workstations
    a. Dell
    b. HP
5. Electric Locks:
    a. See architectural door hardware specifications.
6. Door Hold Open Units:
    a. See architectural door hardware specifications.

7. Electric Door Hardware crash bar w/ RTE switch and transfer hinges:

    a. See architectural door hardware specifications.

8. Flush Mounted Man door balance magnetic switches:

    a. UTX Security – Sentrol

9. Surface and special application security switches:

    a. UTX Security – Sentrol

10. Power Supplies (for controller, module, and door hardware):

    a. Alarm Safe
    b. Altronix
    c. SDC
    d. Securitron
    e. Schlage

11. Duress alarm buttons:

    a. Dortronics Systems, Inc.
    b. Locknetics
    c. Securitron
    d. Security Door Controls.

12. Visual and/or Audible Devices:

    a. System Sentry
    b. Wheelock
    c. Approved Equivalent

13. Passive Infrared Motion Sensor (for Request to Exit Applications)

    a. Bosch
    b. Securitron
    c. Approved Equivalent

2.2 SYSTEM DESCRIPTION

A. General: The ACS components are specified here to be compatible with the existing Airport ACS system. Operating features of hardware and software specified in this section are intended to limit the ACS components to compatible Schneider Electric Andover Control equipment.

B. Testing of installed components is included: This contract includes the provision, programming, installation and testing of new access control intelligent field panels (IFP) and their IP connection to the Airport Security VLAN. The IFP shall be capable of stand-alone operation, and its proper stand-alone operation and control of all devices included under this contract shall be required for final acceptance. This project shall provide all hardware, software, cable and other components necessary for a full functioning system capable of stand-alone operation.

C. Database Modifications: This Contractor shall be responsible for updating and integrating all existing ACS databases affected by the installation of the system. A certified manufacturer representative shall perform all database modifications, uploading and integration between the existing main ACS head-end and all components, new or existing, affected by the extension.

D. Alarm Programming: This Contractor shall coordinate with the Airport Security on specific alarm programming requirements. Contractor shall be responsible for programming alarm and trouble text for each door and respective door device. Coordinate with Airport on descriptors and tag numbers for each device and door.

E. The ACS and card readers shall be capable of reading and processing existing airport proximity smart cards. Coordinate with Airport Security on exact type of card in use.

F. This project also consists of the extension of an existing ACS to secure, monitor and control additional secured doors and portals. The extension of this system shall be seamless in that access points installed under this project will operate, alarm and report in the same manner as existing access points. It is the Contractor's responsibility to meet with Airport Security and coordinate the exact operation and integration of access points.

G. The security integrator shall provide all required programming, software and graphic map updates required for the installation of the ACS. All programming, software updates, database modifications, graphic user maps, etc. shall be provided and installed/programmed by an authorized and certified manufacturer representative.

H. This project shall provide for the integration of the ACS to the following systems:

1. Fire Alarm System: for automatic release of electrified locking devices on emergency egress doors.
2. Duress Alarms: monitoring and alarm of duress pushbuttons.
3. Automatic Defibrillators: monitoring and alarm of door tamper switch.
4. VSS System: for automatic call-up of VSS cameras located throughout the project limits. The existing VSS system is a Milestone Video Management system.

I. Access Control Functions

1. Card reader and remote control of doors, overhead doors and vehicle gates as indicated in the drawings.
2. Control point outputs for lock power control activated by card reader, file server/system workstation keyboard or time schedule.
3. Control of access through card reader controlled devices based on the card user's access levels. An access level shall define a door or group of doors accessible by a card holder during a certain time period. Time periods shall include both authorized days and hours, and shall include independent holiday schedules. The ACS allows each card holder to have multiple access levels.
4. Alarm indication at the file server / alarm monitoring system workstation for unauthorized reader use attempts. Unauthorized reader use alarms shall be user selectable on an individual card reader basis.
5. Access requests, both authorized and denied, shall be sent to the host for storage and annunciation, as required, with the cardholder number, name, and access point/area where access was attempted or gained.
6. System workstation display and event printing of card use (all transactions or violations only; by card and / or by card reader).
7. Momentary, programmable time, or maintained release of card reader controlled door locks via the system workstation keyboard.
8. Monitoring of the status of card reader controlled doors against intrusion or doorpropping.
9. Selective card reader tracking by individual card reader or groups of card readers.
10. The ACS shall offer an individually selectable door shunt time to allow persons with disabilities additional time to access a portal and an extended shunt time to allow additional time to pass through the door before alarm. This shall be selectable by cardholder and shall meet all of the requirements as set forth in the Americans with Disabilities Act.
11. The ACS shall offer an adjustable door shunt time to allow airport to dynamically extend door shunt time, permitting airport operations without “door held open” alarms. The operator via special PIN code entry on the card reader/keypad shall extend the normal portal shunt time. Door shall operate normally when no special PIN code isused.
12. Alarms shall be prioritized. The alarm-monitoring screen shall provide information about the time and location of the alarm, along with its priority. The alarm monitoring screen shall be able to sort pending and/or insert new alarms based on any of the following attributes: priority, date/time, IFP, card reader, or card holder. Date/time sorts must be user selectable to be either ascending or descending and must have the option of displaying the seconds of the minute in which the alarm arrived into the system. The system shall provide for alarm monitoring and/or transaction reporting for specific events, such as, but not limited to the following:

    a. Duress condition at a card reader / keypad device (duress PIN).
    b. Anti-pass back violation.
    c. Rejected access request.
    d. Invalid biometric (if biometric in use and activated)

e. Card reader tamper.
f. Card reader off-line.
g. Controller cabinet tampers.
h. SNMP network alarms.
i. Commercial AC power failure.
j. Controller communications failure.
k. Low battery at UPS power supply.
l. Monitoring of door devices (door position, magnetic lock bond sensor, tamper switches, etc.)
m. Monitoring of miscellaneous devices (duress alarm buttons, key switch position, and other contact closure devices, etc.)

2.3 HARDWARE EQUIPMENT

A. Proximity Card Reader and proximity card readers with integral keypad: Provide card readers at locations shown on drawings. The card readers shall be capable of reading existing Airport ID cards. The card reader shall have the following characteristics:

1. Keypad: 12 button, weatherized keypad built-in to the card reader.
2. Construction: Weatherized, polycarbonate, vandal resistant enclosure with conformal coating. Provide built-in heater on all exterior units.
3. Mounting: Reader shall mount to a standard single gang mounting plate attached to a double-gang outlet box.
4. Interface Technology: iClass, FIPS 201 compliant, 13.5MHz contactless smart card technology
5. Audio/Visual Indicators: Reader shall be equipped with multicolor LEDS and beeper for audio/visual feedback to user. LEDS shall change state upon presentation of valid card (green) and invalid card or pin number (red and audio beep).
6. Certifications: UL294/1076, CE, CSA
7. Warranty: Two years minimum.
8. Provide exterior rated steel black powder coat paint pedestal and stainless steel weather proof hood for card readers mounted at gates. Pedestal shall have 8” diameter concrete footing, minimum 36” deep, with steel rebar reinforcement. Provide dual height car/ truck pedestals where indicated.

B. COMPUTER WORKSTATIONS

1. Small Form Factor
2. Operating System: Microsoft Windows latest version compatible with the ACS client software
3. Processor: 3.0 GHz 64-bit Quad-core
4. Memory: 8GB 1333MHz DDR3 SDRAM
5. Disk: 7200 RPM SATA 3.0 1TB Hard drive
6. 1333 MHz Front Side Bus
7. PCI Express x16 Slot
8. DVD-RW Optical Drive

9. Minimum 4 USB ports
10. 10/100/1000 Ethernet Port
11. Ergonomic 103 keys multi-media keyboard
12. Stereo speaker sound bar attachable to display screen listed herein
13. 110-120 VAC, 60Hz Power Supply.
14. Video Card (s):

    a. 2 monitor support
    b. PCI Express x16 compatible
    c. Minimum 784MB DDR3 graphics memory
    d. HDMI connectors supporting 1920 x 1080 resolution per display
    e. RoHs and WEE compliant, support 4:3 and 16:9 aspect ratio
    f. Supports configuration of four screen arranged horizontally, vertically or combination of both orientations.
15. Display Screen:

    a. LCD IPS active matrix
    b. 24-inch viewable size
    c. 178-degree viewing angle
    d. 16:9 aspect ratio
    e. Black colored enclosure
    f. Minimum of two USB 2.0 Ports
    g. 1920 x 1080 Native resolution
    h. 64-bit color support
    i. Minimum 160 MHz video bandwidth
    j. HDMI connector
    k. 800:1 minimum contrast ratio
    l. 110-120 VAC, 60Hz power supply.

C. Audible/Visual Alarm Units: Provide combination audio/visual alarm indicator units at the door locations indicated on the drawings with the following characteristics:

1. Wall mounted, white in color w/ no labeling so that it will not be confused with fire alarm units.
2. Audible: Selectable tones and dB levels. Tone selection shall be coordinated with fire alarm provider so that the ACS audible is different from the fire alarm.
3. Visual: >= 15 candela output.
4. Voltage: 24vdc coordinated with active ACS components and power supplies.
5. Certifications: UL294, CE, CSA

D. Balanced Magnetic Switch (Security doors): Provide high security balanced magnetic switches at door locations as indicated on the drawings. Switches shall have the following features and characteristics:

1. Construction: Rugged construction designed for flush mounting for new doors or surface mounting for steel doorframes.

2. High security: Balanced, triple-biased type switch.
3. Contacts: Independent Form-C contacts wired in a SPDT configuration.
4. Life expectancy: 10,000,000 cycles.
5. Gap distance: ½", maximum.
6. Classification: UL listed 634 level 1 for use with security systems.
7. Tamper proof: Integral magnetic and pry tamper contacts.

E. Wide Gap Balanced Magnetic Switch: Provide high security balanced magnetic switches at overhead door and gate locations as indicated on the drawings. Switches shall have the following features and characteristics:

1. Construction: Rugged construction designed for surface mounting to door and to the floor.
2. High security: Balanced, triple-biased type switch.
3. Contacts: Independent form-C contacts wired in a SPDT configuration.
4. Life expectancy: 10,000,000 cycles.
5. Gap distance: 1", minimum; 2", maximum.
6. Classification: UL listed 634 level 1 for use with security systems.
7. Rating: Indoor and Outdoor use, encapsulated

F. Duress Alarms: Provide duress buttons at locations shown on drawings. Duress Button shall be provided for initiation of silent alarm to ACS. Provide duress button with followingfeatures:

1. Construction: ABS plastic
2. SPDT contacts
3. Surface Mount
4. Mount under desk unless otherwise noted.

G. Passive Infrared Detector: Passive Infrared (PIR) Motion Detectors shall be furnished and installed as indicated on the plans. PIR shall be used as a REX device where indicated on the plans. Provide devices with the following characteristics:

1. 12 or 24 VAC or VDC operation (typical 26 mA @ 12 VDC).
2. Two form "C" contacts.
3. Relay latch time adjustable up to 60 seconds.
4. Operating temperatures of -20 degrees to + 120 degrees F.
5. Externally visible activation LED.
6. Adjustable "look down" coverage pattern to minimize nuisance activations.

H. Request-to-Exit (REX) Pushbutton. Provide REX pushbutton as shown on drawings. The REX button will act as a lock device override in the case that the ACS and/or card reader does not unlock the door when accessed from the secure side. Provide pushbutton with the following characteristics:

1. Stainless steel, heavy duty type pushbutton and cover plate. Minimum pushbutton diameter shall be 2.5 inches or as required by code
2. DPDT contacts, rated 4A.
3. Rated for outdoor locations. Provide proper backbox and cover plates for outdoor

applications.

4. Pushbutton color: GREEN
5. Time-delay: Adjustable from 1 to 30 seconds
6. Continuously illuminated with positive visual feedback of successful activation.

I. Door Hardware: Door hardware (electrified and non-electrified) shall be furnished and installed by the Division 8 Contractor. The security integrator shall meet and coordinate with the door hardware supplier and contractor on the proper interface and wiring of all electrified door hardware to the ACS. The security integrator shall wire and test all electrified door hardware including but not limited to:

1. Electrified strikes and lever sets
2. Electrified panic bars and latch retraction sets
3. Request-to-Exit switches integral to the door hardware

J. ACS INTELLIGENT FIELD PANEL (IFP)

1. Manufacturer: Schneider Electric Andover Controls Model ACX 5740 to match existing airport ACS
2. Certifications: UL/ULC 294/1076, CSA, CE
3. Communication Availability: LAN/WAN, 10 Base-T, TCP/IP, Ethernet Compliant, Echelon LON, EIA RS-232, Dial-up Modem, EIA RS-485. This project shall utilize dual Ethernet network interface cards for communication to the local area network in a redundant mode.
4. Capacity: Provide IFP with two (2) Access Control Modules (ACM) to support the following devices and I/O:
5. Card Reader Inputs: 8
6. Supervised Inputs: 12
7. Form C Relay Outputs (Suitable for Door Control): 4
8. Memory: 128MB, suitable for use with current firmware version.
9. Expansion capability
10. Enclosure: 16 ga steel with tamper switch, hinged, lockable cover with tamper switch. Tamper switch shall be monitored.
11. Power Requirements: Input: 90-240VAC, 0.5A Max. Output: 12VDC @3.3A maximum.

K. READER AND ADD-ON MODULES

1. General: All required reader modules and expansion modules shall be compatible with the IFP and an approved equivalent. Provide all required reader and expansion I/O modules as needed to support, monitor and control all points and devices on the project.

L. IFP POWER SUPPLY

1. Certifications: UL Class II power limited, ULC 294/1076, CSA, CE
2. Input Power: 120VAC, 60Hz.
3. Output Power: Regulated and filtered 13.8VDC, 3.75A.

4. Battery backup: Provide sufficient sealed gel type re-chargeable battery backup to power the IFP and all door security devices connected to that IFP for a period of not less than four (4) hours.
5. Provide the following alarm outputs and connect to input of assigned IFP for transmission of trouble signal to system head-end:

    a. AC Fault on blown fuse
    b. Low Battery (below 10.3 VDC)

M. MULTI-OUTPUT DOOR HARDWARE LOCK POWER SUPPLY

1. The security integrator shall be responsible for interfacing the lock power supply to the power transfer hinge and locking mechanism. Provide all cabling and electrical connectors as required.

2. Provide power supplies for fail-safe operation of all electric and electromagnetic locking mechanisms as required by local codes. Fail-safe locking devices shall unlock automatically under the following conditions:

    a. Any building fire alarm
    b. Failure of the power supply

3. Provide power supplies with the following characteristics:

    a. Input power 120VAC.
    b. Battery backup: Provide sufficient battery backup to power the locks connected to that ACP for a period of not less than 4 hours.
    c. Output power eight (8) individually fused 12 or 24VDC outputs for lock power.
    d. Two (2) NO outputs, loss of AC and low battery.
    e. Diagnostic LEDs for power and blown fuse indication.
    f. Cabinets shall be lockable and provided with tamper switches. Provide signage warning that an alarm will sound if access is attempted and giving the telephone number of the security monitoring desk.

N. ACS INTERFACE VIA LOCAL AREA NETWORK (LAN)

1. Provide dual LAN connections via Cat 6A cable to local LAN network equipment required for the communication of IFP panels provided under this project to the ACS server. The security integrator shall coordinate with Airport IT and security department as required for network setup and configuration.

O. WIRE AND CABLE

1. Provide wire and cable as required to install the ACS as indicated on the drawings and specified herein.
2. Wire and cable shall be Underwriter's Laboratories (UL) listed, and shall meet all national, state and local code requirements for its application.

3. Wire and cable shall meet individual system or subsystem manufacturer specifications.
4. Insulated wire and cable shall conform to the minimum requirements of Insulated Cable Engineer Association (ICEA) Standards.
5. Wire and cable shall comply with the applicable requirements of the National Electrical Code (NEC), latest edition, in regards to cable construction and usage.
6. The conductors of wires shall be copper, and have conductivity in accordance with the standardization rules of the Institute of Electrical and Electronics Engineers, Inc. (IEEE). The conductor and each strand shall be round and free of kinks and defects.
7. Cable carrying data or voice transmissions shall be shielded. All other cable shall be shielded where necessary for interference-free signals.
8. Insulation shall be rated for a minimum of 300 V.
9. Color coding shall be accomplished by using solidly colored insulation. Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by the National Electric Code (NEC).

P. CONDUITS AND RACEWAYS

1. ACS cables shall be installed in conduit. Install conduit, supports, and accessories necessary for a complete installation. Conduit and boxes in finished areas shall be concealed in chases, furrings, below concrete slabs and/or above suspended ceilings. No exposed conduit shall be installed within public areas. Exposed exterior conduit shall be rigid steel (RGS) painted to match surrounding surfaces.

2.4 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 tocomponents.

1. All inputs shall be protected against surges induced on device wiring. Outputs shall be protected against surges induced on control and device wiring installed outdoors and as shown. All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors, except fiber optics, which serve as communications circuits from security console to field equipment, and between field equipment, shall have surge protection circuits installed at each end.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal 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 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. The Airport assumes no responsibility or liability for transportation from country of origin, storage fees, drayage, import taxes, duty taxes, or other costs associated with the delivery and storage of system components

C. Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the Airport.

D. Contractor shall store products in accordance with manufacturer's instructions, within Contractor's staging area and with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

E. Contractor shall provide coverings to protect products from damage from traffic and construction operations. Remove coverings when no longer needed.

3.3 CABLING

A. Install cables and wiring according to requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."

B. ACS wire and cable shall be installed in conduit.

C. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."

D. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

E. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. (1220 m).

F. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

3.4 GROUNDING

A. Comply with Section 270526 "Grounding and Bonding for Communication Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.5 INSTALLATION

A. Contractor shall provide all tools, applications and test equipment required to install, verify, and test the installation and to determine that it meets the specifications. The Contractor shall furnish all necessary materials required to implement and to achieve the required work performance.

B. Where undefined by codes and standards, Contractor shall apply a safety factor of at least two (2) times the rated load to all fastenings and supports of system components. Conform installation to local seismic codes.

C. Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and shall furnish all cables, connectors, terminations, interconnections, services, and adjustments required for a complete and operable system.

3.6 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Section 271300 "Communication Systems Identification" and with TIA/EIA 606-A.

B. Label cables, equipment, panels, enclosures, modules, and power supplies with permanent markings to indicate system zone, partition, and circuit, and coordinate labels with record documentation.

C. Label wires and cables as follows:

1. Mark all wire and cable in common at both ends.
2. Place wire identification numbers 12 inches from the ends of each cable by using sleeve type, heat shrinkable markers.
3. Install markers to be readable from left to right or top to bottom. Locate labels near termination points.
4. Install labels when wire and cables are installed.
5. Labeling shall agree with recorddocumentation.

D. Cable Labeling Scheme

1. General

a. The labeling scheme shall identify the type of cable (Access Control), the Communication room where the cable terminates, and a unique cable number.
b. The labeling scheme shall not utilize room names and/or numbers asdesignations.

3.7 TESTING AND QUALITY CONTROL

A. Cable tests and inspections:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 6A tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.

2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
4. Devices and circuits will be considered defective if they do not pass tests andinspections.
5. Prepare test and inspection reports.

B. Phased ACS System Testing

1. General: A phased testing approach shall be implemented to insure that the system is capable of operating as designed. The tests shall be structured to prove that higher level components are functional prior to connection to lower level components. Successfully complete each testing phase before proceeding to the next level of testing. Any problems discovered during these tests will be documented and brought to the attention of the Airport and corrected at Contractor's expense. The Contractor shall promptly correct all problems encountered, providing field service personnel appropriately trained for the types of problems encountered. Prior to connection of the first portal, the cardholder and door configuration databases must be completely populated and new badges must have been issued.

2. System Communications Test: Upon completion of a controller installation and wiring, communications testing may begin. The Host shall be limited to communication with one
(1) controller at a time for this test. The database shall be populated with portal configurations and test cards, which shall be downloaded to each portal. The test shall include reading each of the test cards at the controller under test (through a temporarily connected portal devices) and observing the controller operation and workstation display. Test cards shall be read under two (2) different conditions, with the Host making access decisions and with the controller making access decisions. The results of the test shall be compared to a printed copy of the transaction log for accuracy. This test should prove basic “no load” communications, upload and download integrity.

3. Local Test: Upon completion of each portal, download the cardholder and door configuration databases and test each portal device for specified functionality with the test cards. Access requests are to be based on controller decisions and valid site codes with communications to the portal disabled. One (1) of the test cards shall be disabled during the test. This test should prove the basic integrity of the controller and the wiring and terminations between the portal interface and the portal devices. Upon successful completion of the test, the portal shall be in service and controlled by the ACS system.

4. Final Test and Acceptance: Upon completion of Local Tests, the system will be operating at normal traffic capacity with the Host in communication with all controllers for this test. The test shall include reading each of the test cards at the controller under test and observing the workstation display, portal operation and related I/O to connected components. This test should prove “under load” communications, upload and download integrity, I/O functionality and system logic. After a successful test, the test card data shall be removed from the database. All ACS functions shall be demonstrated to ensure the entire system is operational as required by these Specifications and Drawings. The Contractor shall provide a test schedule including the time and dates. The Owner's representative will observe the testing. This test shall be conducted by the final test and acceptance plan as outlined below.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.9 DEMONSTRATION AND TRAINING

A. Train Owner's maintenance personnel for a minimum of one week to adjust, operate, and maintain the access control system.

B. Course materials shall be delivered to airport. Final delivery of the course materials shall include a master hard copy of all materials and an electronic copy in a format reviewed in advance by the airport. The Contractor shall supply a DVD of each training course.

C. All training shall be completed a minimum of two weeks prior to the system becoming operational and utilized by airport. Training schedule is subject to the airport’s review.

END OF SECTION

SECTION 28 31 11

DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Addressable interface device.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

A. Non-coded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

B. Non-coded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

1.5 SUBMITTALS

A. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified fire-alarm technician, Level IV minimum.
c. Licensed or certified by authorities having jurisdiction.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Delegated-Design Submittal: For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

E. Qualification Data: For qualified Installer.

F. Field quality-control reports.

G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

    a. Frequency of testing of installed components.
    b. Frequency of inspection of installed components.
    c. Requirements and recommendations related to results of maintenance.
    d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.
7. Copy of NFPA 25.

H. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 **QUALITY ASSURANCE**

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

D. 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.

E. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.

F. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

G. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FMG-approved alarm company.

1.7 **PROJECT CONDITIONS**

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

1.8 **SEQUENCING AND SCHEDULING**

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.9 **SOFTWARE SERVICE AGREEMENT**

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 60 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
3. Smoke Detectors, Fire Detectors, : Quantity equal to 10 percent of amount of each type installed, but no less than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamper-proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: As part of this project contractor will be required to furnish and install a complete addressable type fire alarm system in compliance with ADA requirements as manufactured by Simplex True Alarm Series 4100ES. (No other manufacturer's will be considered).

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.
7. Heat detectors in elevator shaft and pit.
8. Fire-extinguishing system operation.
9. Fire standpipe system.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
9. Activate stairwell and elevator-shaft pressurization systems.
10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
11. Recall elevators to primary or alternate recall floors.
12. Activate emergency lighting control.
13. Activate emergency shutoffs for gas and fuel supplies.
14. Record events in the system memory.
15. Record events by the system printer.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Elevator shunt-trip supervision.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

    a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.

    a. Smoke sensors shall additionally communicate sensitivity setting [and allow for adjustment of sensitivity at fire-alarm control unit].
    b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

C. Circuits:

    a. Initiating Device Circuits: Class A.
    b. Notification Appliance Circuits: Class A.
    c. Signaling Line Circuits: Class A.
    d. Install no more than 50 addressable devices on each signaling line circuit.

D. Elevator Recall:

1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.

    a. Elevator lobby detectors except the lobby detector on the designated floor.
    b. Smoke detector in elevator machine room.
    c. Smoke detectors in elevator hoistway.

2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

    a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

E. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

F. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

G. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever] type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
3. Station Reset: Key- or wrench-operated switch.
4. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.

b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.

c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.

1. Mounting: Adapter plate for outlet box mounting.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.

1. Mounting: Adapter plate for outlet box mounting.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Continuous Linear Heat-Detector System:

1. Detector Cable: Rated detection temperature 155 deg F. NRTL listed for "regular" service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short- circuit wires at the location of elevated temperature.
2. Control Unit: Two-zone or multi-zone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control unit.
3. Signals to Fire-Alarm Control Unit: Any type of local system trouble shall be reported to fire-alarm control unit as a composite "trouble" signal. Alarms on each detection zone shall be individually reported to central fire-alarm control unit as separately identified zones.
4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.

B. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

D. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output:
   a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.

3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.

E. Voice/Tone Notification Appliances:

1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
2. High-Range Units: Rated 2 to 15 W.
3. Low-Range Units: Rated 1 to 2 W.
4. Mounting: Flush semi-recessed or surface mounted and bidirectional.
5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

2.8 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Install fire-alarm control unit on concrete base with tops of cabinets not more than 72 inches above the finished floor. Comply with requirements for concrete base specified in Division 03 Section " Miscellaneous Cast-in-Place Concrete."

1. Install seismic bracing. Comply with requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing control/monitoring equipment as necessary to extend existing control/monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

D. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

F. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

G. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

H. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

I. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

L. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

3.2 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated air-conditioning duct systems.
4. Alarm-initiating connection to elevator recall system and components.

5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
9. Supervisory connections at elevator shunt trip breaker.
10. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
11. Supervisory connections at fire-pump engine control panel.

3.3 WIRING

A. All fire alarm wiring shall be in conduit.

B. Conduit shall be a completely separate and independent raceway system.

C. Comply with wiring requirements specified in Division 26 Section “Low-Voltage Electric Power Conductors and Cables.”

D. Comply with conduit requirements specified in Division 26 Section “Raceway and Boxes for Electrical Systems.”

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.6 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by AHJ.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

END OF SECTION

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