

PROJECT MANUAL



VOLUME II PREQUALIFICATION SET

**Ider High School Gymnasium
1064 Crabapple Lane, Ider, AL**

**DCM No. 2021135, PSCA No. 9228
WSA Project No. 20-036
DATE: June 10, 2022**

OWNER: DeKalb County Board of Education
P.O. Box 1668
Rainsville, Alabama 35986
(256) 638-6921

ARCHITECT: Ward Scott Architecture, Inc.
2715 Seventh Street
Tuscaloosa, Alabama 35401
(205) 345-6110

**CONSTRUCTION
MANAGER: Scout Program Management**
850 Corporate Pkwy #114
Birmingham, AL 35242
(205) 616-5124

**CIVIL
ENGINEER: Schoel Engineering Co., Inc.**
7500 S Memorial Pkwy, Ste 209
Huntsville, Alabama 35802
(256) 539-1221

**MECHANICAL/
PLUMBING/
FIRE PROTECTION
ENGINEER: Pinnacle Engineering, Inc.**
2111 Pkwy Office Cir 125
Birmingham, Alabama 35244
(205) 733-6912

**ELECTRICAL
ENGINEER: Garner & Associates Engineering**
901 South Perry Street
Montgomery, Alabama 36104
(334) 647-1596

**STRUCTURAL
ENGINEER: LBYD, Inc.**
1525 Perimeter Pkwy NW 510
Huntsville, Alabama 35806
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TABLE OF CONTENTS

VOLUME I

BIDDING DOCUMENTS

Invitation to Bidders
 Instructions to Bidders, DCM Form C-2, Aug 21
 Proposal Form, DCM Form C-3, Aug 21
 Accounting of Sales Tax Attachment to DCM Form C-3 Proposal Form, DCM Form C-3A, Aug 21
 Form of Bid Bond, DCM Form C-4, Aug 21

CONTRACTUAL DOCUMENTS

Preparation and Approval of Construction Contracts and Bonds Checklist, DCM Form B-7, July 22
 Construction Contract, DCM Form 9-A, PSCA Version of C-5, Dec 21
 Disclosure Statement of Relationships between Contractors/Grantees
 And Public Officials/Employees Pursuant to Executive Order #55
 Performance Bond, DCM Form 9-B, PSCA Version of C-6, July 22
 Payment Bond, DCM Form 9-C, PSCA Version of C-7, July 22
 General Conditions of the Contract, DCM Form C-8, July 22
 Article 37 Contractor's and Subcontractors' Insurance Requirements
 Supplementary General Conditions
 Permit Fee & Permit Re-Inspection Calculation Worksheet
 Pre-Construction Conference Checklist, DCM Form B-8, Nov 21
 Asbestos Affidavit
 Detail of PSCA Plaque, DCM Form 9-M, July 22
 Detail of Project Sign, DCM Form C-15, Oct 21
 Application and Certification for Payment, DCM Form C-10, July 22
 Schedule of Values, DCM Form C-10SV, Oct 21
 Inventory of Stored Materials, DCM Form C-10S, Aug 21
 Final Payment Checklist, DCM Form B-13, July 22
 Progress Schedule and Report, DCM Form C-11, Aug 21
 Change Order Checklist, DCM Form B-12, July 22
 Contract Change Order, DCM Form 9-J, PSCA Version of C-12, Aug 21
 Change Order Justification, DCM Form B-11, Aug 21
 Certificate of Substantial Completion, DCM Form C-13, Aug 21
 Form of Advertisement for Completion, DCM Form C-14, Aug 21
 Contractor's Affidavit of Payment of Debts and Claims, DCM Form C-18, Aug 21
 Contractor's Affidavit for Release of Liens, DCM Form C-19, Aug 21
 Consent of Surety for Final Payment, DCM Form C-20, Aug 21
 Contractor Guarantee
 General Contractor's Roofing Guarantee, DCM Form C-9, Aug 21
 Final Payment General Release and Indemnity Agreement

DIVISION 01 - GENERAL REQUIREMENTS

011000 ----SUMMARY
 012100 ----ALLOWANCES
 012200 ----UNIT PRICES
 012500 ----SUBSTITUTION PROCEDURES
 012600 ----CONTRACT MODIFICATION PROCEDURES
 012900 ----PAYMENT PROCEDURES
 012910 ----SALES AND USE TAX SAVINGS
 013100 ----PROJECT MANAGEMENT AND COORDINATION
 013200 ----CONSTRUCTION PROGRESS DOCUMENTATION
 013300 ----SUBMITTAL PROCEDURES
 014000 ----QUALITY REQUIREMENTS
 014210 ----REFERENCES
 015000 ----TEMPORARY FACILITIES AND CONTROLS
 016000 ----PRODUCT REQUIREMENTS
 017300 ----EXECUTION
 017700 ----CLOSEOUT PROCEDURES
 017823 ----OPERATION AND MAINTENANCE DATA
 017839 ----PROJECT RECORD DOCUMENTS
 017900 ----DEMONSTRATION AND TRAINING

DIVISION 02 – SITE CONDITIONS

020000---- GEOTECHNICAL REPORT

DIVISION 03 - CONCRETE

032000---- CONCRETE REINFORCING
033000---- CAST-IN-PLACE CONCRETE
033543---- POLISHED CONCRETE FINISHING

DIVISION 04 - MASONRY

042000---- UNIT MASONRY

DIVISION 05 - METALS

051200---- STRUCTURAL STEEL FRAMING
053100---- STEEL DECKING
054000---- COLD-FORMED METAL FRAMING
055000---- METAL FABRICATIONS

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES

061000---- ROUGH CARPENTRY
061600---- SHEATHING
064116---- PLASTIC LAMINATE FACED ARCHITECTURAL CABINETS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

072100---- THERMAL INSULATION
072414---- DIRECT APPLIED EXTERIOR FINISH SYSTEM (DEFS)
072500---- GYPSUM BOARD WEATHER-RESISTANT BARRIER AND AIR BARRIER SYSTEM
072726---- FLUID APPLIED MEMBRANE AIR BARRIER
076200---- SHEET METAL FLASHING AND TRIM
079200---- JOINT SEALANTS

DIVISION 08 - OPENINGS

081113---- HOLLOW METAL DOORS AND FRAMES
081416---- FLUSH WOOD DOORS
083313---- COILING COUNTER DOORS
083323---- OVERHEAD COILING DOORS
084113---- ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS
087100---- DOOR HARDWARE
088000---- GLAZING

DIVISION 09 - FINISHES

092216---- NON-STRUCTURAL METAL FRAMING
092900---- GYPSUM BOARD
093013---- CERAMIC TILING
095113---- ACOUSTICAL PANEL CEILINGS
096466---- WOOD ATHLETIC FLOORING
096513---- RESILIENT BASE AND ACCESSORIES
096519---- RESILIENT TILE FLOORING
096723---- RESINOUS FLOORING
096813---- TILE CARPETING
099123---- INTERIOR PAINTING

DIVISION 10 - SPECIALTIES

101100---- VISUAL DISPLAY UNITS
101416---- PLAQUES
101419---- DIMENSIONAL LETTER SIGNAGE
101423---- ROOM-IDENTIFICATION PANEL SIGNAGE
102113---- PLASTIC TOILET COMPARTMENTS
102800---- TOILET, BATH, AND LAUNDRY ACCESSORIES
104413---- FIRE PROTECTION CABINETS
104416---- FIRE EXTINGUISHERS
105113---- METAL LOCKERS
105126---- PLASTIC LOCKERS
105300---- ALUMINUM WALKWAY COVERS
105613---- METAL STORAGE SHELVING

DIVISION 11 - EQUIPMENT

113100---- RESIDENTIAL APPLIANCES
114000---- FOOD SERVICE EQUIPMENT
116623---- GYMNASIUM EQUIPMENT
116653---- GYMNASIUM DIVIDER CURTAIN

DIVISION 12 – FURNISHINGS

- 122113 ----HORIZONTAL LOUVER BLINDS
- 123623 ----PLASTIC-LAMINATE-CLAD COUNTERTOPS
- 123661 ----SIMULATED STONE COUNTERTOPS
- 126600 ----TELESCOPING STANDS

DIVISION 13 - SPECIAL CONSTRUCTION

- 133419 ----METAL BUILDING SYSTEMS

VOLUME II

DIVISION 21 – FIRE SUPPRESSION

- 211201 ----STANDPIPE FIRE PROTECTION SYSTEM
- 211301 ----FIRE-SUPPRESSION SYSTEMS (INTERIOR)

DIVISION 22 – PLUMBING & FIRE PROTECTION

- 220500 ----PLUMBING GENERAL
- 220505 ----PLUMBING SUBMITTALS
- 220510 ----BASIC MATERIALS AND METHODS
- 220700 ----PLUMBING INSULATION
- 221001 ----PLUMBING PIPING
- 221005 ----PLUMBING SPECIALTIES
- 222010 ----GAS PIPING SYSTEMS
- 223005 ----PLUMBING EQUIPMENT
- 224005 ----PLUMBING FIXTURES

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING

- 230500 ----MECHANICAL GENERAL
- 230505 ----MECHANICAL SUBMITTALS
- 230510 ----BASIC MATERIALS AND METHODS
- 230514 ----MOTOR STARTERS (MANUAL AND MAGNETIC)
- 230593 ----TESTING, ADJUSTING, AND BALANCING
- 230700 ----HVAC INSULATION
- 230923 ----DIRECT DIGITAL CONTROLS
- 233113 ----LOW PRESSURE DUCTWORK
- 233115 ----DUCTWORK AND ACCESSORIES
- 233423 ----POWER VENTILATORS
- 233713 ----REGISTERS, GRILLES AND DIFFUSERS
- 235533 ----UNIT HEATERS – GAS FIRED
- 237413 ----PACKAGED AIR CONDITIONING UNITS
- 238153 ----DUCTLESS SPLIT SYSTEMS

DIVISION 26 – ELECTRICAL

- 260000 ----DIVISION 26 SEAL PAGE
- 260100 ----GENERAL ITEMS W/ATTACHMENT "A"
- 260519 ----LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
- 260526 ----GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
- 260529 ----HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
- 260533 ----RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
- 260543 ----UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
- 260544 ----SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAY AND CABLING
- 260553 ----IDENTIFICATION FOR ELECTRICAL SYSTEMS
- 260923 ----LIGHTING CONTROL SYSTEM
- 262413 ----SWITCHBOARDS
- 262416 ----PANELBOARDS
- 262418 ----LOW-VOLTAGE TRANSFORMERS
- 262726 ----WIRING DEVICES
- 262813 ----FUSES
- 262816 ----ENCLOSED SWITCHES AND CIRCUIT BREAKERS
- 263000 ----SHORT CIRCUIT COORDINATION STUDY AND ARC FLASH HAZ ANALYSIS
- 265119 ----LED INTERIOR LIGHTING
- 265619 ----LED EXTERIOR LIGHTING
- 266000 ----ELECTRIC HAND DRYERS

DIVISION 27 - COMMUNICATIONS

- 270000 ----DIVISION 27 SEAL PAGE
- 270510 ----IDENTIFICATION FOR COMMUNICATION SYSTEMS
- 270520 ----COMMUNICATION CABLE MANAGER AND LADDER RACK
- 270525 ----GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS
- 270528 ----PATHWAYS FOR COMMUNICATIONS SYSTEM S
- 270544 ----SLEEVES AND SLEEVE SEALS COMMUNICATIONS PATHWAYS AND CABLING

- 271300---- COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING
- 271500---- COMMUNICATIONS COPPER HORIZONTAL CABLING
- 272005---- COMMUNICATIONS PATCH PANELS AND FIBER OPTIC ENCLOSURES
- 272010---- COMMUNICATIONS RACKS AND ENCLOSURES
- 272015---- COMMUNICATIONS FACEPLATES AND CONNECTORS
- 272020---- COMMUNICATION PATCH CORDS AND WORKSTATION CORDS

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

- 280000---- DIVISION 28 SEAL PAGE
- 282300---- VIDEO MANAGEMENT SYSTEM
- 282315---- VIDEO CONTENT ANALYTICS PLATFORM
- 282400---- GYMNASIUM AUDIO SYSTEM, LED MOTION VIDEO BOARDS, LED SCORER'S TABLE, LOCKER ROOM GAME CLOCKS
- 283111---- DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM
- 284111---- FIRE FIGHTER COMMUNICATION SYSTEM

DIVISION 31 - EARTHWORK

- 311000---- SITE CLEARING
- 312000---- EARTHMOVING
- 312500---- EROSION SEDIMENTATION
- 313116---- TERMITE CONTROL

DIVISION 32 - SITE CONSTRUCTION

- 321216---- ASPHALT PAVING
- 321313---- CONCRETE PAVING
- 321373---- CONCRETE PAVING JOINT SEALANTS
- 323113---- CHAIN-LINK FENCES AND GATES

DIVISION 33 - UTILITIES

- 330500---- COMMON WORK FOR UTILITIES
- 331415---- WATER DISTRIBUTION
- 334200---- STORMWATER DRAINAGE

Ider High School – New Gymnasium

Pinnacle Project #21025

Specification Index



21 1201 Standpipe Fire Protection System

21 1301 Automatic Sprinkler System

22 0500 Plumbing General

22 0505 Plumbing Submittals

22 0510 Basic Materials and Methods

22 0700 Plumbing Insulation

22 1001 Plumbing Piping

22 1005 Plumbing Specialties

22 2010 Gas Piping Systems

22 3005 Plumbing Equipment

22 4005 Plumbing Fixtures

23 0500 Mechanical General

23 0505 Mechanical Submittals

23 0514 Motor Starters (Manual and Magnetic)

23 0593 Testing, Adjusting, and Balancing

23 0700 HVAC Insulation

23 0923 Direct Digital Controls

23 3113 Low Pressure Ductwork

23 3115 Ductwork and Accessories

23 3423 Power Ventilators

23 3713 Registers, Grilles, and Diffusers

23 5533 Unit Heaters – Gas Fired

23 7413 Packaged Air Conditioning Units

23 8153 Ductless Split Systems

IDER HIGH SCHOOL GYMNASIUM

Ider, Dekalb County,
Alabama

June 15, 2022

Engineer Project No. 20-446

Architect Project No. 20-036



Civil Engineer

SCHHOEL

IDER HIGH SCHOOL GYMNASIUM
SPECIFICATIONS INDEX

DIVISION 31—EARTHWORK

31 10 00 – SITE CLEARING 3

31 20 00 – EARTH MOVING 9

31 25 00 – EROSION SEDIMENTATION 2

DIVISION 32—EXTERIOR IMPROVEMENTS

32 12 16 – ASPHALT PAVING 7

32 13 13 – CONCRETE PAVING 6

32 13 73 – CONCRETE PAVING JOINT SEALANTS 4

DIVISION 33—UTILITIES

33 05 00 – COMMON WORK 7

33 14 15 –WATER DISTRIBUTION 17

33 42 00 – STORMWATER DRAINAGE 10

SECTION 21 1201 - STANDPIPE FIRE PROTECTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. Install standpipes, connecting piping, valves, hoses and outlets, gauges, etc. as indicated by the contract drawings.

1.2 CODES AND STANDARDS:

- A. Comply with requirements of NFPA 14 - Standpipe and Hose Systems.

1.3 SUBMITTALS:

- A. Submit outlets, hoses, cabinets, valves, etc. for approval.
- B. Submit shop drawings indicating all phases of the installation including materials, pipe, valves, control devices, sections, elevations, details of special hangers and riser details for review and approval. Submittal shall be made to the Architect at the same time it is made to the Authority Having Jurisdiction (AHJ) and the insurance underwriter.
- C. Submittal to include a water flow test at the point of connection to existing City water main and complete system hydraulic calculations.
- D. Submit six (6) sets of shop drawings, to Architect for approval. The submittal shall include evidence that the shop drawings have been sent to the other review authorities. Approval from other authorities shall be provided to the Architect. Revisions shall be made for comments and resubmitted for approval. No work is to begin until approval has been given in writing.

1.4 COORDINATING:

- A. Coordinate design and installation with other trades for timely installation and to avoid delays and interference.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. All devices and equipment shall be UL listed and FM approved for fire service.

2.2 PIPING:

- A. Schedule 40 black steel pipe, ASTM A53, Grade B, seamless with welded, screwed and/or approved grooved pipe couplings. Provide UL 203 listed supports and hangers.
- B. Fittings:
 - 1. Malleable Iron, 150 lb. class conforming to ANSI B16.3. Dimensions conforming to Federal Spec WW-P-521. Carbon steel butt welding fittings shall conform to ASTM A-234. Elbows shall be long radius type. Welding tees shall be used on branch connections equal to or greater than 1/2 the diameter of the main run. Fittings shall be Ladish Tube-Turn or Weldbend.
 - 2. Carbon steel reinforced branch, welding fittings up to 3 inches, but not greater than 1/2 the diameter of the main run may be used. Fittings shall be Bonney Forge or Phoenix Forging.
- C. Flanges:
 - 1. Carbon steel flanges shall conform to ANSI B16.5, ASTM A105. Flanges shall be Class 150, weld neck type with 1/16 inch raised face. Flanges shall have the same bore as the pipe they are installed on.

2. Note: Flanges which must mate with cast or ductile iron flat face flanges shall have the raised face machined off. Use full face gaskets.
 3. All workmanship and materials for welding shall be in accordance with the latest AWS and ASME codes for these classes of work.
- D. Valves:
1. Provide valves, check valves, etc. with UL listings for fire service. All valves must be of domestic origin.
 2. Provide cast iron gate valves, flanged, OS and Y with bolted bonnets, 175 psi rated Powell, Crane, Hammond, Jenkins, Stockham or approved equal.
 3. Butterfly valves shall be lug type, Class 150 with iron body, stainless steel shaft, aluminum bronze disc and EPDM liner. Indicator must be integral with the valve. Control valves shall be equipped with tamper switches having SPDT contacts and tamper proof.

2.3 **FIRE PROTECTION EQUIPMENT:**

- A. Fire protection equipment shall be Potter Roemer, Elkhart Brass, Croker or approved equal.
- B. Hose Valve: Potter Roemer 4065 angle valve 2-1/2 inch.
- C. Cap and Chain: Potter Roemer 2810 reducer, 2-1/2 inch by 1-1/2 inch. Potter Roemer 4615 cap and chain, 1-1/2 inch.
- D. Hose Rack Assembly: Potter Roemer 2710 hose reel 1-1/2 inch by 100 feet with 2-1/2 inch angle valve, steel rack, rack nipple, lug coupling, lined hose, stream nozzle and escutcheon.
- E. Hose Cabinet: Potter Roemer 1156-A surface mounted wall cabinet with full glass door for above hose rack assembly and hose valve.
- F. Fire Department Connection: Potter Roemer 5023-D chrome plated wall connection. Provide with a check valve, ball drip and hose threads to match those of the local Fire Department. Identify for standpipe and/or automatic sprinkler as applicable.

PART 3 - EXECUTION

3.1 **INSTALLATION:**

- A. Joints subject to blowing off of line under pressure shall be braced or have bridle rods as required.
- B. All valves in the standpipe system shall be provided with tamper proof switches, furnished and installed under this specification.
- C. Install a UL listed cutoff valve at the base of each standpipe riser.
- D. Install a 3-1/2 inch dial spring gauge with control valve at the top of each standpipe.
- E. Fire Department connections for the standpipes must not be further than 100 feet from the nearest fire hydrant.
- F. Provide access panels for valves, switches and other items requiring maintenance in enclosed spaces. See Section 15050 for specification.
- G. Installation shall not be deemed as complete until certificates of acceptance from the Authority Having Jurisdiction are presented to and accepted by the Owner.

3.2 **TESTING:**

- A. Piping in the standpipe system shall be tested at a water pressure of 200 psi for a period of not less than two hours. Bracing shall be in place, and air shall be removed from the system before the test pressure is applied. No apparent leaks will be permitted on interior or underground piping.

3.3 FLUSHING OF PIPING:

- A. Mains and lead-in connections to system risers shall be flushed thoroughly before connection is made to system piping in order to remove foreign materials that may have entered the main during the course of the installation or that may have been present in existing piping. The minimum rate of flow shall be not less than the water demand rate of the system, which is determined by the system design, or not less than that necessary to provide a velocity of 10 feet per second, whichever is greater. For all systems, the flushing operations shall be continued for a sufficient time to ensure thorough cleaning. When planning the flushing operations, considerations shall be given to disposal of the water issuing from the test outlets.
- B. Exception: When the flow rate as listed in the table below cannot be verified or met, supply piping shall be flushed at the maximum flow rate available to the system under fire conditions.

Flow Required to Product a Velocity of 10 Ft per Second in Pipes

PIPE SIZE (in.)	FLOW RATE (gpm)
4	390
6	880
8	1560

3.4 CERTIFICATION:

- A. Fire protection systems shall be installed only by contractors licensed by the state for fire protection work.

END OF SECTION 21 1201

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SECTION 21 1301 - FIRE-SUPPRESSION SYSTEMS (INTERIOR)

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes fire-suppression piping and equipment for the following building systems:
 - 1. Automatic wet-type, Class I, fire-suppression standpipes and branches for sprinklers.
 - 2. Automatic wet-type, Class II, fire-suppression standpipes and branches for sprinklers.
 - 3. Automatic wet-type, Class III, fire-suppression standpipes and branches for sprinklers.
 - 4. Wet-pipe, fire-suppression sprinklers, including piping, valves, specialties, and automatic sprinklers.
 - 5. Dry-pipe, fire-suppression sprinklers, including piping, valves, specialties, automatic sprinklers, air compressor, and accessories.
- B. Work specified in this Section includes, but is not limited to providing the following:
 - 1. Design and installation of a complete hydraulically calculated automatic wet or dry sprinkler system.
 - 2. Provide sprinkler heads in all areas to insure required coverage per NFPA 13.
 - 3. Piping layouts as required to meet NFPA 13 Standards.
 - 4. Testing of system.

1.2 SYSTEM PERFORMANCE REQUIREMENTS:

- A. Design automatic sprinkler system and obtain approval from authorities having jurisdiction (AHJ).
- B. Design sprinkler piping according to the following and obtain approval from AHJ.
 - 1. Include 10 percent margin of safety for available water flow and pressure.
 - 2. Include losses through water-service piping, valves, and backflow preventers.
 - 3. Sprinkler Occupancy Hazard Classifications: As follows:
 - a. Building Service Areas: Ordinary Hazard, Group 1.
 - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - c. General Storage Areas (Stockpiles 10 ft or less): Ordinary Hazard, Group 2.
 - d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - e. Office and Public Areas: Light Hazard.
 - f. Repair Garages: Ordinary Hazard, Group 2.
 - 4. System density and design areas shall be per NFPA 13 and based on occupancy designations listed above.
 - 5. Sprinkler spacing shall be per NFPA 13 unless directed otherwise within the sprinkler listing or manufacturer's requirements.
- C. Components and Installation: Capable of producing piping systems with 175-psig minimum working-pressure rating, unless otherwise indicated.

1.3 SUBMITTAL:

- A. Submittal shall be made to the Architect at the same time it is made to the authority having jurisdiction.

- B. Submit six (6) sets of shop drawings, indicating all phases of the installation, pipe routing, equipment layouts, elevations, sections and details to Architect for approval. The submittal shall include evidence that the shop drawings have been sent to other review authorities. Approvals from other authorities shall be provided to the Architect. Revisions shall be made for comments and resubmitted for approval. No work is to begin until approvals have been given in writing.
- C. Submit product data for the following:
1. Pipe and fitting materials and methods of joining piping.
 2. Pipe hangers and supports.
 3. Piping seismic restraints (as applicable).
 4. Valves, including specialty valves, backflow preventers, accessories, and devices.
 5. Alarm devices.
 6. Air compressors and air maintenance devices.
 7. Fire department connections. Include type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
 8. Hose connections. Include size, type, and finish.
 9. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
- D. Fire-Hydrant Flow Test Report:
1. A fire-hydrant flow test shall be performed by contractor as a basis for hydraulically calculated systems. Testing shall be conducted at a location representative of the actual future system supply and be no more than one year old at the date of submission. The flow test report shall have, as a minimum, the following information:
 - a. Contractor's name, company, telephone number and address.
 - b. Project name.
 - c. Date, time and location of flow test.
 - d. Static pressure (in pounds per square inch).
 - e. Residual pressure (in pounds per square inch).
 - f. Flowing (in gallons per minute).
 - g. Elevation of hydrant(s) tested.
- E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by AHJ. Include hydraulic calculations.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- G. Maintenance Data: For each type of standpipe and sprinkler specialty to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE:

- A. Installer Qualifications: An experienced installer, licensed by the state in which the Project is located to install fire protection systems, who has designed and installed fire-suppression systems similar to that indicated for this Project and obtained design approval and inspection approval from AHJ.
- B. Contractor's Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer. Base calculations on results of fire-hydrant flow test.
- C. Contractor's Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of fire-suppression piping that are similar to those indicated for this Project in material, design, and extent.
- D. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.

- E. Standpipe and Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to AHJ.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to AHJ.

1.5 EXTRA MATERIALS:

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounting steel cabinet and hinged cover, with space for a minimum of six spare sprinklers plus sprinkler wrench. Include the number of sprinklers required by NFPA 13 and wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 PIPES AND TUBES:

- A. Ductile-Iron Pipe: AWWA C151, push-on-joint type; with cement-mortar lining and seal coat according to AWWA C104. Include rubber gasket according to AWWA C111.
- B. Ductile-Iron Pipe: AWWA C151, mechanical-joint type; with cement-mortar lining and seal coat according to AWWA C104. Include gland, rubber gasket, and bolts and nuts according to AWWA C111.
- C. Ductile-Iron Pipe: AWWA C115 or AWWA C151, with cement-mortar lining and seal coat according to AWWA C104 and ends factory or field, radius-cut grooved according to AWWA C606.
- D. Standard-Weight Steel Pipe: ASTM A 53, ASTM A 135, or ASTM A 795; Schedule 40 in NPS 8 and smaller, and Schedule 30 in NPS 10 and larger.
- E. Schedule 30 Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and equal to or greater than Schedule 30 or ASTM A 795 and ASME B36.10M, Schedule 30 wrought-steel pipe.
- F. Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller and NFPA 13 specified wall thickness in NPS 6 to NPS 10.

2.2 PIPE AND TUBE FITTINGS:

- A. Ductile-Iron Fittings: AWWA C110, ductile-iron or cast-iron push-on-joint type; or AWWA C153, ductile-iron, compact push-on-joint type. Include cement-mortar lining and seal coat according to AWWA C104 and rubber gaskets according to AWWA C111.
- B. Ductile-Iron Fittings: AWWA C110, ductile-iron or cast-iron type; or AWWA C153, ductile-iron, compact mechanical-joint type. Include cement-mortar lining and seal coat according to AWWA C104 and glands, rubber gaskets, and bolts and nuts according to AWWA C111.
- C. Ductile-Iron Fittings: ASTM A 47, malleable-iron or ASTM A 536, ductile-iron casting complying with AWWA pipe size; with ends factory grooved according to AWWA C606. Include cement-mortar lining and seal coat according to AWWA C104 or epoxy, interior coating according to AWWA C550.
- D. Ductile-Iron Fittings: ASTM A 47, malleable-iron or ASTM A 536, ductile-iron casting complying with AWWA pipe size; with ends factory grooved according to AWWA C606.
- E. Cast-Iron Threaded Fittings: ASME B16.4.
- F. Malleable-Iron Threaded Fittings: ASME B16.3.
- G. Steel, Threaded Couplings: ASTM A 865.
- H. Steel Welding Fittings: ASTM A 234/A 234M, ASME B16.9, or ASME B16.11.

- I. Steel Flanges and Flanged Fittings: ASME B16.5.
- J. Steel, Grooved-End Fittings: UL-listed and FM-approved, ASTM A 47, malleable iron or ASTM A 536, ductile iron; with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

2.3 JOINING MATERIALS:

- A. Ductile-Iron, Keyed Couplings: UL 213 and AWWA C606, for ductile-iron pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts.
- B. Ductile-Iron, Flanged Joints: AWWA C115, ductile-iron or gray-iron pipe flanges, rubber gaskets, and steel bolts and nuts.
- C. Steel, Keyed Couplings: UL 213 and AWWA C606, for steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts. Include listing for dry-pipe service for couplings for dry piping.
- D. Transition Couplings: AWWA C219, sleeve type, or other manufactured fitting the same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

2.4 FIRE PROTECTION SERVICE VALVES:

- A. General: UL listed and FM approved, with minimum 175-psig nonshock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type of ends specified.
- B. Gate Valves, NPS 2 and Smaller: UL 262; cast-bronze, threaded ends; solid wedge; OS&Y; and rising stem.
- C. Indicating Valves, NPS 2-½ and Smaller: UL 1091; butterfly or ball-type, bronze body with threaded ends; and integral indicating device.
 - 1. Indicator: Visual.
 - 2. Indicator: Electrical 115-V ac, prewired, single-circuit, supervisory switch.
 - 3. Indicator: Electrical 115-V ac, prewired, two-circuit, supervisory switch.
- D. Gate Valves, NPS 2-½ and Larger: UL 262, iron body, bronze mounted, taper wedge, OS&Y, and rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.
- E. Indicator-Post, Gate Valves: UL 262, iron body, bronze mounted, solid-wedge disc, and nonrising stem with operating nut and flanged ends.
- F. Indicator Posts: UL 789, horizontal, wall type, cast-iron body, with windows for target plates that indicate valve position, extension rod and coupling, locking device, and red enamel finish.
 - 1. Operation: Operating wrench.
 - 2. Operation: Hand wheel.
- G. Swing Check Valves, NPS 2 and Smaller: UL 312 or MSS SP-80, Class 150; bronze body with bronze disc and threaded ends.
- H. Swing Check Valves, NPS 2-½ and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze-disc ring and flanged ends.
- I. Split-Clapper Check Valves, NPS 4 and Larger: UL 312, cast-iron body with rubber seal, bronze-alloy discs, and stainless-steel spring and hinge pin.

2.5 SPECIALTY VALVES:

- A. Alarm Check Valves: UL 193, 250-psig working pressure; designed for horizontal or vertical installation, with cast-iron flanged inlet and outlet, bronze grooved seat with O-ring seals, and single-hinge pin and latch design. Valve trim shall be externally galvanized and have a maximum working pressure of 250-psig. Include trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer. Valve shall be Viking Corp model J-1 or equal.

1. Option: Grooved-end connections for use with keyed couplings.
 2. Drip Cup Assembly: Pipe drain without valves, and separate from main drain piping.
 3. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
- B. Dry-Pipe Valves: UL 260; differential type; 250-psig working pressure; with cast-iron flanged inlet and outlet, bronze seat with gasketed seals, and single-hinge pin/positive latching design. Valve trim shall be galvanized. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment. Valve shall be Viking Corp model F-1 or equal.
1. Option: Grooved-end connections for use with keyed couplings.
 2. Compressed Air Supply: An air supply capable of restoring system pressure within 30 minutes shall be provided. Acceptable air supply arrangements are:
 - a. Owner supplied air system with an air maintenance device on the supply side inlet.
 - b. A tank mounted air compressor with an air maintenance device between the air compressor and the air supply inlet on the system riser.
 - c. A riser mounted air compressor feeding an air reservoir and the system riser.
 - d. Riser mounted air compressor listed as an air maintenance compressor. Such compressor shall be a Viking Model E-1 Air Maintenance Compressor.
 3. Air Maintenance Device: Air supplies provided for sprinkler systems shall be equipped with an automatic air pressure maintenance device. The device shall be equipped with a bypass and field adjustable air pressure regulator that is factory set at 40 PSI. The Viking Corporation, Model D-2.
 4. Quick Opening Device: If water cannot be delivered to the dry system inspectors test connection within one minute of opening, an accelerator shall be provided on the system riser. The accelerator shall be of the same manufacturer as the dry pipe valve. The Viking Corporation, Model E-1.
 5. Anti-Flooding Device: Accelerators installed on sprinkler systems shall be equipped with an external anti-flooding device. The device shall be of a brass body and UL Listed. The Viking Corporation, Model B-1.
- C. Ball Drip Valves: UL 1726, automatic drain valve, NPS 3/4, ball check device with threaded ends.

2.6 **SPRINKLERS:**

- A. General:
1. Store sprinkler system components in their original shipping container, in a clean, dry space protected from weather. Until completion of all finish-out, protective caps shall not be removed from concealed sprinklers or cover plates installed. Any painted sprinklers or cover plates shall be replaced.
 2. Fire sprinklers shall be of one manufacturer throughout the building. No mixing of sprinkler brands shall be permitted. Sprinklers shall be of all brass frame construction utilizing a metal Belleville spring seal, coated on both sides with Teflon film. Utilization of non-metal parts in the sealing portion of the sprinkler is strictly prohibited.
- B. Automatic Sprinklers: With heat-responsive element complying with the following:
1. UL 199
 2. UL 1767, for early suppression, fast-response applications.
- C. Sprinkler Types and Categories
1. Upright or Pendent: Viking Micromatic (Standard Response) or Viking Microfast (Quick Response).
 2. Recessed Pendent: Viking Micromatic (Standard Response) or Viking Microfast (Quick Response) with Model E-1 or E-2 recessed escutcheon.
 3. Concealed Pendent: Viking Horizon Mirage (Standard or Quick Response).
 4. Standard Coverage Sidewall: Viking Micromatic (Standard) or Viking Microfast (Quick Response).
 5. Extended Coverage Sidewall: Viking Micromatic (Standard) or Viking Microfast (Quick Response).
 6. Concealed Sidewall: Viking QR Concealed HSW, Model VK408.

- D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers. Concealed sprinklers shall have a cover plate that is a push-on, thread-off design that allows for up to ½" of adjustment and have a diameter no greater than 2-3/4".
1. Ceiling Mounting: Plastic, white finish, one piece, flat.
- E. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.7 SPECIALTY SPRINKLER FITTINGS:

- A. Specialty Fittings: UL listed and FM approved; made of steel, ductile iron, or other materials compatible with piping.
- B. Dry-Pipe-System Fittings: UL listed for dry-pipe service.
- C. Drop-Nipple Fittings: UL 1474, with threaded inlet, threaded outlet, and seals; adjustable.
- D. Sprinkler, Drain and Alarm Test Fittings: UL-listed, cast- or ductile-iron body; with threaded inlet and outlet, test valve, and orifice and sight glass.
- E. Sprinkler, Branch-Line Test Fittings: UL-listed, brass body; with threaded inlet and capped drain outlet and threaded outlet for sprinkler.
- F. Sprinkler, Inspector's Test Fittings: UL-listed, cast- or ductile-iron housing; with threaded inlet and drain outlet and sight glass.

2.8 HOSE CONNECTIONS:

- A. Description: UL 668, 300-psig minimum pressure rating, brass, hose valve for connecting fire hose. Include 90-degree angle pattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. Include NPS 1-½ or NPS 2-½ as indicated, and hose valve threads according to NFPA 1963 and matching local fire department threads.
1. Valve Operation: Nonadjustable type, unless pressure-regulating type is indicated.
 2. Valve Operation: Nonadjustable type.
 3. Valve Operation: Pressure-regulating type.
 4. Finish: Rough brass.
 5. Finish: Rough chrome-plated.

2.9 FIRE DEPARTMENT CONNECTIONS:

- A. Wall, Fire Department Connections: UL 405; cast-brass body with brass, wall, escutcheon plate; brass, lugged caps with gaskets and brass chains; and brass, lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with permanent descriptive marking appropriate to system served.
1. Mounting: flush or exposed projecting mounting as indicated on plans.
 2. Escutcheon Plate: round, square or rectangular.
 3. Finish: Polished brass.
- B. Exposed, Freestanding, Fire Department Connections: UL 405, cast-brass body, inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, and bottom outlet with pipe threads. Include brass, lugged caps, gaskets, and brass chains; brass, lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round, floor, brass, escutcheon plate with permanent descriptive marking appropriate to system served.
1. Finish Including Sleeve: Polished brass.

2.10 ALARM DEVICES:

- A. General: Types matching piping and equipment connections.
- B. Electronic Water Flow Alarm: Alarm shall be Potter Electric Horn Strobe Model SASH-120, 120 VAC or equal by system sensor.
- C. Water-Flow Indicators: UL 346; electrical-supervision, vane-type water-flow detector; with 250-psig pressure rating; and designed for horizontal or vertical installation. Include two single-pole, double-throw, circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
- D. Pressure Switches: UL 753; electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
- E. Valve Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
- F. Indicator-Post Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

2.11 PRESSURE GAGES:

- A. Pressure Gages: UL 393, 3-1/2- to 4-1/2-inch diameter dial with dial range of 0 to 250 psig.

PART 3 - EXECUTION**3.1 EXAMINATION:**

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING APPLICATIONS:

- A. Do not use welded joints with galvanized steel pipe.
- B. All steel piping used for dry pipe systems shall be hot-dipped galvanized.
- C. Flanges, unions, and transition and special fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- D. Piping between Fire Department Connections and Check Valves: Use galvanized, standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
- E. Underground Service-Entrance Piping:
 - 1. Ductile-iron, mechanical-joint pipe and fittings and restrained joints.
 - 2. Ductile-iron, grooved-end pipe and fittings; ductile-iron, keyed couplings; and grooved joints.
- F. Standpipes: Use the following: (See Section 211201 for details)
 - 1. NPS 4 - NPS 8:
 - a. Standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

- b. Standard-weight steel pipe with plain ends, steel welding fittings, and welded joints.
 - c. Galvanized, standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
 - d. Schedule 10 steel pipe with roll-grooved ends; steel, grooved-end fittings; and grooved joints.
- G. Wet-Pipe Sprinklers: Use the following:
- 1. Sprinkler-Piping Option: Specialty sprinkler fittings, NPS 2 and smaller, including mechanical-T fittings, may be used downstream from sprinkler zone valves.
 - 2. NPS 2 - NPS 6
 - a. Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
 - b. Standard-weight steel pipe with plain ends, steel welding fittings, and welded joints.
 - c. Galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints.
- H. Dry-Pipe Sprinklers: Use the following:
- 1. NPS 2 - NPS 6
 - a. Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
 - b. Standard-weight steel pipe with plain ends, steel welding fittings, and welded joints.
 - c. Galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints.

3.3 **VALVE APPLICATIONS:**

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
- 1. Fire-Protection-Service Valves: UL listed and FM approved for applications where required by NFPA 13.
 - a. Shutoff Duty: Use indicating OS & Y valves.
 - 2. General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13.
 - a. Shutoff Duty: Use ball or butterfly valves.
 - b. Throttling Duty: Use globe, ball, or butterfly valves.

3.4 **JOINT CONSTRUCTION:**

- A. Ductile-Iron-Piping, Grooved Joints: Use ductile-iron pipe with radius-cut-grooved ends; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
- B. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.
- C. Dissimilar-Piping-Material Joints: Construct joints using adapters or couplings compatible with both piping materials. Use dielectric fittings if both piping materials are metal. Refer to Division 15 Section "Basic Materials and Methods" for dielectric fittings.

3.5 SERVICE ENTRANCE PIPING:

- A. Connect standpipe and sprinkler piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 2 for exterior piping.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Refer to Division 2 for backflow preventers.
- C. Install shutoff valve, check valve, pressure gage, drain, and other accessories at connection to water service.

3.6 PIPING INSTALLATION:

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. They do not show all changes in direction, elevation or offsets necessary for complete installation. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from AHJ. File written approval with Architect before deviating from approved working plans.
- B. Install underground service-entrance piping according to NFPA 24 and with restrained joints.
- C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-½ and larger connections.
- F. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install drain valves on standpipes.
- J. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- K. Install alarm devices in piping systems.
- L. Hangers and Supports: Comply with NFPA 13 for hanger materials. Install according to NFPA 13 for sprinkler piping.
- M. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.
- N. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they will not be subject to freezing.

3.7 SPECIALTY SPRINKLER FITTING INSTALLATION:

- A. Install specialty sprinkler fittings according to manufacturer's written instructions.

3.8 VALVE INSTALLATION:

- A. O S & Y Valves: Install fire-protection-service valves supervised-open, located to control sources of

water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

- B. Valves for Wall Fire Hydrants: Install gate valve with nonrising stem in supply pipe.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
- D. Alarm Check Valves: Install valves in vertical position for proper direction of flow, including bypass check valve and retard chamber drain-line connection.
- E. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.9 SPRINKLER APPLICATIONS:

- A. General: Use sprinklers according to the following applications unless noted otherwise:
 - 1. Rooms without Ceilings: Upright and pendent sprinklers, as indicated.
 - 2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers, as indicated.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Upright; dry pendent and dry sidewall.
 - 5. Special Applications: Use extended-coverage and quick-response sprinklers where indicated.
 - 6. Sprinkler Finishes: Use sprinklers with the following finishes:
 - a. Upright, Pendent, and Sidewall Sprinklers: Chrome-plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
 - b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - c. Flush Sprinklers: Bright chrome, with painted white escutcheon.

3.10 SPRINKLER INSTALLATION:

- A. Install sprinklers in accordance with manufacturer's listing.
- B. Install sprinklers in suspended ceilings in center of acoustical panels and tiles.
- C. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical panels.
- D. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.11 HOSE-CONNECTION INSTALLATION:

- A. Install hose connections adjacent to standpipes, unless otherwise indicated.
- B. Install freestanding hose connections for access and minimum passage restriction.
- C. Install NPS 2-½ hose connections with quick-disconnect reducer adapter and flow-restricting device, unless otherwise indicated.
- D. Install wall-mounting-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Refer to Division 10 Section "Fire-Protection Specialties" for cabinets.

3.12 CONNECTIONS:

- A. Connect water supplies to standpipes and sprinklers. Include backflow preventers.
- B. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- C. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- D. Electrical Connections: Power wiring is specified in Division 26.
- E. Connect alarm devices to fire alarm.

3.13 LABELING AND IDENTIFICATION:

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.14 FIELD QUALITY CONTROL:

- A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.
- B. Flush, test, and inspect standpipes according to NFPA 14, "Tests and Inspection" Chapter.
- C. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- D. Report test results promptly and in writing to Architect and AHJ.

3.15 CLEANING:

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers having paint other than factory finish.

3.16 PROTECTION:

- A. Protect sprinklers from damage until all finish-out operations have been completed.

3.17 TESTING AND STARTUP:

- A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- B. Verify that specified tests of piping are complete.
- C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
- D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
- E. Verify that potable-water supplies have correct types of backflow preventers.
- F. Verify that hose connections and fire department connections have threads compatible with local fire department equipment.
- G. Fill wet-pipe sprinkler piping with water.
- H. Energize circuits to electrical equipment and devices.
- I. Adjust operating controls and pressure settings.
- J. Coordinate with fire alarm tests. Operate as required.

3.18 DEMONSTRATION:

- A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.
- B. Schedule demonstration with Owner with at least seven days' advance notice.

END OF SECTION 21 1301

SECTION 220500 - PLUMBING GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The "General Conditions", "Supplementary Conditions", Statutory Declarations, Special Conditions and Division 1 of the specifications as written and referred to are adopted and made part of Division 22.

1.2 SUBMITTALS:

- A. Submittals shall include the documents listed below:
 - 1. Certificates of Inspection and Approval.
 - 2. Qualifications of Superintendent.
 - 3. Warranties.
 - 4. List of proposed material manufacturers.
 - 5. Operating and Maintenance Manuals.
 - 6. Record electronic as-built drawings.

1.3 DESCRIPTION OF WORK:

- A. Provide equipment, labor, material, etc., required to make a complete working installation as shown or as specified.
- B. Equipment and materials used in the work shall be:
 - 1. In accordance with the contract documents.
 - 2. The best quality and grade for the use intended.
 - 3. New and unused.
 - 4. The manufacturer's latest standard or current model.
- C. All equipment and method shall be installed and connected in accordance with the best engineering practices and in accordance with the manufacturer's recommendations.
 - 1. Where the Engineer determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
 - 2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.
 - 3. Contractor is responsible for dimensions and sizes of equipment. Inform Architect in writing of equipment differing from that shown.
- D. Plumbing work includes, but is not limited to:
 - 1. Make arrangements with local utility company for services as shown or specified.
 - 2. Obtain all permits and inspections including: building permits, health department permits and sewer tap permits.
 - 3. Complete the domestic water distribution system.

4. Extend gas services from utility tap.
5. Provide cutting of pavement, sidewalks, driveways, etc., excavating, trenching, shoring and de-watering. Provide backfill material and perform backfilling.
6. Restore site to original condition or new final grades. Provide paving, concrete, seed, or sod.
7. Complete the domestic hot and cold water system. Provide sanitary rinse and flush.
8. Complete the interior sanitary sewer.
9. Complete the interior natural gas service. Install valves, devices and specialties furnished by others.
10. Complete insulation on piping and equipment.
11. Provide vibration isolation devices for all rotating or reciprocating equipment and piping connected to that equipment.
12. Provide roofing including flashing, and counter flashing for roof mounted equipment, roof penetrations and supports for work in this Division, unless noted otherwise.

1.4 UTILITY CONNECTIONS:

- A. Arrange with local utility companies for utility service connections, taps, meters and installation. Pay all fees and charges (if any) necessary for the utility services shown on the drawings or listed in the specifications.
- B. It is the responsibility of the Contractor to re-confirm with the Utility Companies, prior to bidding, that locations, arrangements, line sizes, pressures, interruptions, shut downs, etc. are in accordance with their regulations and requirements.
- C. If the utility company requirements are at variance with these drawings and specifications, this Contractor shall include the utility company requirements in his work without additional cost to the Owner.
- D. Obtain from Utility Company any additional charges for service of type, size and location called for. Include charges in bid to be paid by Contractor to appropriate party. Provide payment of these charges so as to allow logical progression of construction and avoid delay of completion.
- E. Should cost above not be available prior to bid, submit with bid a letter signed by responsible Utility Company personnel stating that cost is not available. Prime Contractor shall submit letter with his bid to Owner. Cost will then be omitted from contract and become responsibility of Owner.
- F. Furnish with shop drawings a signed document from each utility company describing location and type of service to be supplied and requirements for service. Document shall be signed by the appropriate responsible representative of the respective utility company.

1.5 WORK NOT INCLUDED:

- A. Finish painting of piping or equipment.
- B. Electrical wiring and conduits shown on the electrical drawings.

1.6 RELATED WORK SPECIFIED ELSEWHERE:

- A. Electrical: Division 26.

1.7 REQUIREMENTS OF REGULATORY AGENCIES:

- A. Obtain and pay for all permits required for the work. Comply with all ordinances pertaining to work described herein.
- B. Install the work under this Division in accordance with drawings and specifications and the standards and codes (latest edition) that apply to this work. In the event of a conflict, install work in accordance

with the most stringent code requirements determined by Architect.

- C. Arrange, pay for and complete work to pass required tests by agencies having authority over work. Deliver to Architect Certificates of Inspection and approval issued by authorities.

1.8 **QUALIFICATION OF CONTRACTOR:**

- A. Has completed minimum two projects same size and scope in past five (5) years.
- B. This qualification applies to Sub-Contractors.
- C. Use workmen experienced in their respective trade. Submit qualifications of Superintendent for review.
- D. Owner reserves right to reject bid of any Contractor failing to meet these qualifications.

1.9 **GENERAL JOB REQUIREMENTS:**

- A. Drawings and Specifications:
 - 1. Work for the plumbing trades are shown on the drawings series P (Plumbing).
 - 2. Drawings and specifications are complementary. Work called for by one is binding as if called for by both.
 - 3. Drawings are drawn to a small scale and are diagrammatic only. The drawings indicate size and general arrangement of equipment.
 - 4. Do not scale drawings for exact locations. Refer to architectural drawings. Field measurements take precedence.
- B. Provide necessary offsets, elbows and fittings as required to avoid conflict with equipment of other Divisions and to obtain proper headroom and clear passageways. This shall be done at no additional cost to the Owner.
- C. Visit to Site/Work in other Division:
 - 1. Examine not only the plans and specifications for this Division, but plans and specifications of the other Divisions of work and visit the site to become acquainted with existing conditions. Execution of Contract is evidence that Contractor has examined all drawings and specifications, and that all conditions which have a bearing in any way on the manner of installing the work in this Division are known. Later claims for labor and materials required due to difficulties encountered, which could have been foreseen had examination been made, will not be recognized.
- D. Underground Utilities/Concealed Utilities:
 - 1. All utilities and services, whether shown on the drawings or not, shall be suitably protected and maintained, and any damages thereto shall be promptly repaired. Owner shall be advised immediately of any damages sustained. If any extra expense is incurred due to the existence of buried utilities not shown on the drawings, or the location of which is not made known to the Contractor, the contract price shall be adjusted in accordance with the General Conditions. The Contractor shall advise the Owner three (3) days in advance of any operation which could possibly disrupt any underground utility. The Contractor shall utilize locator services to mark any underground utilities in the area he is working in, and shall make any other measure deemed necessary to avoid utility disruption.
- E. Definitions:
 - 1. Concealed: Materials or systems not visible. Work installed above a ceiling, furred behind a wall or enclosed in a chase.
 - 2. Exposed: Materials or systems that are visible. Work installed in a room without a ceiling. Work not enclosed by walls.

3. Provide: Furnish, install and make complete.
4. Install: Receive, unload, move into place, and make connections.
5. Work: Materials completely installed and connected.
6. AGA: American Gas Association.
7. ANSI: American National Standard Institute.
8. ARI: American Refrigeration Institute.
9. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
10. ASME: American Society of Mechanical Engineers.
11. ASTM: American Society of Testing Materials.
12. AWS : American Welding Society.
13. FM: Association of Factory Mutual Fire Insurance Company.
14. MSS: Manufacturer's Standard Society of the Valve and Fittings Industry, Inc.
15. NEC: National Electrical Code.
16. INT'L: Building Code, Gas Code, Mechanical Code, Plumbing Code.
17. NEMA: National Electrical Manufacturer's Association.
18. NFPA: National Fire Protection Association.
19. NRCA : National Roofing Contractors Association.
20. NSF: National Sanitation Foundation.
21. OSHA: Occupational Safety and Health Act.
22. PDI: Plumbing Drainage Institute.
23. UL: Underwriters Laboratories.

F. Workmanship, Warranty and Acceptance:

1. Work under this Division shall be first class with emphasis on neatness and workmanship.
2. Install work using competent mechanics, under supervision of foreman, all duly certified by local authorities. Installation subject to Architect's or Engineer's observation, final approval, and acceptance. Architect or Engineer may reject unsuitable work.
3. Furnish Architect written warranty, stating that if workmanship and/or materials executed under this Division is proven defective within one (1) year after final acceptance, such defects and other work damaged will be repaired and/or replaced.
4. In event that project is occupied or system placed in operation in several phases at Owner's request, warranty will begin on date each system or item of equipment is accepted by Owner.

G. Observations of Work and Demonstration of Operation:

1. When observations are scheduled, provide sufficient personnel to expedite removal of access doors, coverplates, manholes covers, etc.
2. Contractor to assist Architect or Engineer in demonstration of operation of new systems to satisfaction of Owner. Contractor to have manpower available for demonstration of systems

where requested by Owner.

H. Materials and Substitutions:

1. All materials shall be new. All materials and equipment for which a UL Standard, an AGA approval, an AWWA standard, FM listing or ASME requirements is established, shall be so approved and labeled or stamped.
2. Wherever in these specifications products are specified by manufacturer's name, bids shall be based on the named products. Where more than one manufacturer's name is mentioned, the one first listed establishes the standard for that product. If the bidder desires to submit a product of a manufacturer other than that listed first, it must be the equivalent of the one listed first.
3. The drawings are based on the use of products specified and listed first. If any revision in piping, conduit work, foundations, anchor bolts, connections, etc., is required by other named products or approved substitutions, it shall be the Contractor's responsibility to make such revisions at no additional expense to the Owner.
4. If any bidder desires to submit products of manufacturers not listed, he may submit a request for prior approval to the Engineer no later than 10 days prior to the bid date. If the Engineer decides to accept the manufacturers, they will be listed as "Approved" by written addendum.
5. If the manufacturers are not listed as approved either by addendum or in the specifications, they will not be accepted.
6. Submit to Architect a complete list of proposed material manufacturers. List does not preclude submission of shop drawings. Approval of manufacturer or list does not constitute approval of specific material or equipment.

I. Operating and Maintenance Manuals:

1. Provide maintenance and operating manuals bound in 8-1/2" x 11" hardback, three-post binders. Manuals shall contain written instructions for each system, shop drawings, schematic drawings, equipment catalog cuts, manufacturer's instructions, manufacturers warranties, and valve tag list.
2. Arrange information in the following sequence: title of job, Owner, address, date of submittal, name of Contractor, name of Engineer, index, shop drawings, operating instruction, Contractor's purchase order numbers, supplier's name and address, date of start-up of each piece of equipment and valve tag list.
3. Submit one (1) copy for review. Make required corrections, and submit two (2) record copies.

J. Record As-Built Prints:

1. Provide Record as-built prints at the completion of job. Keep set of prints on job and record day to day changes to Contract drawings with red pencil. Indicate actual location of piping, valves, and equipment. Turn over prints to Architect at final observation.
2. Provide the following items for Owner at time of substantial completion:
 - a. Certificates of inspection and approval from authorities having jurisdiction.
 - b. Warranties.
 - c. Record as-built electronic drawings - Autocad format.
 - d. Operating and Maintenance Manuals (3 copies) - Binders.
 - e. Operating and Manual - PDF or DOC format
 - f. Spare Parts (furnish receipt).
 - g. Affidavit of Owner Instruction (1 copy).

h. Release of Liens.

1.10 PROTECTION AND STORAGE:

- A. Provide warning lights, bracing, shoring, rails, guards and covers necessary to prevent damage or injury.
- B. Protect all equipment and materials, from damage by weather, entrance of water or dirt. Cap open piping, use plastic covers made for that purpose. Do not use rags or construction debris.
- C. Avoid damage to materials and equipment in place. Repair, or remove and replace damaged work and materials.
- D. Protect all surfaces from weld spatter, solder and cutting oil.
- E. Deliver equipment and materials to job site in original, unopened, labeled container. Store to prevent damage and injury. Store ferrous materials to prevent rusting. Store finished materials and equipment to prevent staining and discoloring. Store materials affected by condensation in warm dry areas. Provide heaters. Storage space on site and in building designated by Owner/Architect.

END OF SECTION 220500

SECTION 220505 - PLUMBING SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY:

- A. This Section includes procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

1.3 DEFINITIONS:

- A. Action Submittals: Written and graphic information that requires Engineer's through the Architect responsive action.

1.4 SUBMITTAL PROCEDURES:

- A. General: Electronic copies of CAD Drawings of the Contract Drawings will not be provided by Engineer for Contractor's use in preparing submittals.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Submittals Schedule: Comply with requirements in Division 1 for list of submittals and time requirements for scheduled performance of related construction activities.
- D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal.
 - 1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer through the Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Concurrent Review: Where concurrent review of submittals by other consultants, Owner, or other parties is required, allow 21 days for initial review of each submittal.
 - a. Division 22 equipment requiring electrical connection
 - 3. If intermediate submittal is necessary, process it in same manner as initial submittal.
 - 4. Allow 15 days for processing each resubmittal.
 - 5. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.
- E. Identification: Place a permanent label or title block on each submittal for identification.
 - 1. Indicate name of firm or entity that prepared each submittal on label or title block.

2. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name and address of Contractor.
 - e. Name and address of Sub-Contractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Unique identifier, including revision number.
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Other necessary identification.
- F. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.
- G. Number of Copies:
 1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.
 2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.
- H. Transmittal:
 1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
 2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
 3. Transmittal Form: Provide locations on form for the following information:
 - a. Project name.
 - b. Date.
 - c. Destination (To:).
 - d. Source (From:).
 - e. Names of subcontractor, manufacturer, and supplier.
 - f. Category and type of submittal.
 - g. Submittal purpose and description.
 - h. Submittal and transmittal distribution record.
 - i. Remarks.
 - j. Signature of transmitter.
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Use only final submittals with mark indicating action taken by Engineer in connection with construction.

PART 2 - PRODUCTS

2.1 SUBMITTALS:

- A. General: Prepare and submit Submittals required by individual Specification Sections.
 1. Number of Copies: Submit copies of each submittal, unless otherwise indicated. Engineer

through Architect will return copies. Mark up and retain one returned copy as a Project Record Document.

- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Manufacturer's catalog cuts.
 - f. Wiring diagrams showing factory-installed wiring.
 - g. Printed performance curves.
 - h. Operational range diagrams.
 - i. Mill reports.
 - j. Standard product operating and maintenance manuals.
 - k. Compliance with recognized trade association standards.
 - l. Compliance with recognized testing agency standards.
 - m. Application of testing agency labels and seals.
 - n. Notation of coordination requirements.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Shopwork manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Design calculations.
 - j. Compliance with specified standards.
 - k. Notation of coordination requirements.
 - l. Notation of dimensions established by field measurement.
 2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
 3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-½ by 11 inches, but no larger than 30 by 40 inches.
 4. Number of Copies: Submit one correctable, translucent, reproducible print and one black line print of each submittal. Engineer through Architect will return the reproducible print.
 5. Number of Copies: Submit 6 prints where prints are required for operation and maintenance manuals. Engineer and Architect will retain one print each; remainder will be returned.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Review of submittals by Engineer is to insure general quality conformance with the contract documents. The contractor assumes all responsibility for dimensions, quantities, conditions that pertain to the fabrication and installation, and for processes and techniques of construction.

- B. Review of submittals or shop drawings by Engineer does not relieve Contractor of responsibility for errors or omissions during the submittal process. Submittal review does not relieve the contractor of any obligation in the contract documents.
- C. Products of one manufacturer have been scheduled or specified as the basis of design. Any modifications to ductwork, piping, wiring, building structure, etc. that results from the use of any other products shall be coordinated by this contractor with all trades prior to delivery of approved product from the manufacturer. All modifications required shall be performed without incurring any additional cost to the Contract. Contractor shall document all modifications on the as-built record plans.

3.2 CONTRACTOR'S REVIEW:

- A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.3 ENGINEER'S ACTION:

- A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
 - 1. Approved - Fabrication/Installation may be undertaken.
 - 2. Approved as Noted - Fabrication/Installation may be undertaken.
 - 3. Revise and Resubmit - Fabrication/Installation MAY NOT be undertaken. In resubmitting, limit corrections to items marked.
 - 4. Rejected - Fabrication/Installation MAY NOT be undertaken. In resubmitting, limit corrections to items marked.
- C. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION 220505

SECTION 220510 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. Provide equipment, labor, materials, etc. required to make a complete working installation as shown or as specified.

1.2 SUBMITTALS:

- A. Provide submittals for:
1. Access panels
 2. Sound stopping
 3. Piping seals
 4. Pipe identification

PART 2 - PRODUCTS

2.1 ACCESS PANELS:

- A. Access panels shall have welded steel frame, one piece doors, and self latching door locks.
- B. Panels shall be Milcor, Cesco, Karp or prior approved equal. Milcor model numbers are cited as examples.

<u>Construction or Material Surface</u>	<u>Model No.</u>
Fire rated walls or ceiling 1-1/2 Hr, B-Label 16 ga frame, 20 ga door	Fire Rated-Primer Finish
Drywall walls and ceilings 16 ga frame, 14 ga door panel	DW primer finish
Plaster walls and ceilings 16 ga frame, 14 ga door	K - primer finish
Masonry and Tile	M - primer finish MS - stainless steel

- C. Locks: Standard locks shall be screw driver operated with case hardened steel cam.

2.2 FIRESTOPPING AND SOUNDSTOPPING:

- A. Sound stopping material shall be .75 lb per cu. ft. density fiberglass.
- B. Other acceptable manufacturer's include GE "Pensil", Dow Corning, Hilti.

2.3 PIPING SEALS:

- A. Thunderline Corp. "Link Seal" LS Series.

2.4 MISCELLANEOUS STEEL:

- A. ASTM A-36 Structural Steel

2.5 PIPE IDENTIFICATION:

- A. Identification shall be in accordance with ANSI-A13.1. Pipe markers shall be Brady B-946 or Seton's Weather-Code.

2.6 PIPE SLEEVES:

- A. Sleeves in concrete walls, floors or masonry - Sch 40 steel pipe, machine cut.
- B. Sleeves in gypsum board or plaster walls - 14 gauge, rolled galvanized sheet metal. Tack welded on the longitudinal seam.

2.7 WALL AND CEILING PLATES:

- A. Beaton and Cadwell, Keeney or Grinnell, nickel plated steel, split plates with set screw.

2.8 FLOORPLATE:

- A. Concrete floor plate, Grinnell figure 400.

PART 3 - EXECUTION

3.1 ACCESS PANELS:

- A. Provide access panels in walls and ceilings as needed to allow access to valves, equipment, shock absorbers, trap primers, etc. and where noted.
- B. Access doors shall be selected for the type of wall or ceiling where needed.

3.2 FIRE STOPPING AND SOUND STOPPING:

- A. Provide penetrations for piping through floors and walls for work under this contract.
- B. Penetrations through floors and fire resistant walls shall be sealed to the rated fire resistance equal to the wall. Installation shall be done by a qualified installer, approved by the manufacturer.
- C. Provide sound proofing through non-rated walls.

3.3 WATER STOP PIPE SEALS:

- A. Provide modular, resilient seals around pipes penetrating all exterior walls, and floors below grade.

3.4 EXCAVATION, SHORING AND BACKFILL:

- A. Provide any excavation required for work in this Division.
- B. Provide separate trench for each utility.
- C. Provide bracing, shoring, sheetpiling to protect sides of excavation, workers and adjacent structures. Provide site de-watering systems where water level is above bottom of trench.
- D. Provide barricades and lights to protect open excavations.
- E. Provide steel plates over excavations for automobile and truck traffic across excavations.
- F. Remove all timber and foreign material from excavation before backfilling. Backfill simultaneously on both sides of tanks, piping, etc. Backfill materials shall be approved clay or chert, free of debris, rock larger than 1-1/2 inch or other harmful material.
- G. Backfilling shall be done in 12 in. lifts or layers. All backfilling shall be compacted to the Modified Proctor Density (ASTM D-1557) listed below:

90 Percent	95 Percent
Under sidewalks	Paved areas
Grassed areas	Under structures
	Building slabs

- H. Restore existing pavement, curbs, sidewalks, sodding, etc. removed or damaged by work in this Division.
- I. Repair any settlement exceeding 1 inch that occurs within one year of acceptance of work.

3.5 ANCHORS:

- A. Mount all equipment, brackets, hangers, anchors, etc. to safely resist the vibration or thrust forces and support the unit's weight.
- B. Floor mounted static items, wall and ceiling mounted equipment bracket and hangers shall be installed using drilled anchors or cast in place inserts. Anchors shall be Phillips Drill Company "Red Head" or Multi-Set II. Size anchors and inserts for four times the applied load. Bolts used outdoors or in a wet environment shall be hot dip galvanized.

3.6 PIPE SLEEVES:

- A. Provide pipe sleeves where pipes pass through floors and walls above or below ceilings. Provide pipe sleeves in new walls and floors as the work progresses. Provide split pipe sleeves in new walls built up around existing pipes. Tack weld split sleeves together.
- B. Size pipe sleeves to allow continuous insulation, but not less than two pipe sizes larger than pipe.
- C. Sleeves in walls shall be flush with wall, sleeves in floors shall extend 3/4 inches above floor and be flush with structure below.

3.7 WALLS AND FLOOR PLATES:

- A. Provide plates around pipes extending into exposed areas where they pass through walls, floors and ceilings. Size plates to completely cover pipe sleeves.

3.8 FLASHING:

- A. Provide flashing at piping penetrations through roof and roof mounted structures furnished under this Division. Flash in accordance with roofing manufacturers details.
- B. Flashing materials shall be in accordance with the roofing manufacturers system.
- C. Provide flashing at pipes passing through floors with waterproof membrane. Flashing shall be in accordance with waterproofing manufacturer's details.

3.9 PIPE IDENTIFICATION:

- A. Provide pipe markers and directional arrows on pipes at both sides of partitions and floors slabs, at branch line take-offs, at valves, at intermediate intervals not in excess of 20 ft. and at connections to equipment.
- B. Tape color band identifying markers and arrows on each pipe, both insulated and bare pipes. Pipe markers and arrows shall be located where readily visible and on lower quadrants of overhead pipes.
- C. Submit schedule of pipe markers, with legend and background colors for approval by the Architect.

3.10 EQUIPMENT IDENTIFICATION:

- A. Identify each piece of equipment with a 1/8 inch thick engraved melamine plastic laminate nameplate. Letters shall be 1/2 inch high standard style. Names, abbreviations, and numbering shall agree with the corresponding equipment designations shown on the drawings. Use black letters cut in a white background for all equipment on standard electrical power.
- B. Fasten nameplates to equipment in a conspicuous location using self-tapping stainless steel screws, except use contact epoxy adhesive where screws cannot or should not penetrate substrate.

3.11 WORKMANSHIP:

- A. Pipe size changes shall be made at reducing fittings. Bushings shall not be used.
- B. Provide drain valves at points where water is trapped in piping.
- C. Install pipe to prevent noise or water hammer.
- D. Blowout or flushout all lines prior to final connection or start-up, to remove foreign matter.
- E. Make allowance in piping for expansion and contraction, for installation of insulation and to avoid air pockets.
- F. Do not tap small pipes into larger pipes. Provide fittings or reinforced branch connections.
- G. Cut pipes ends square, ream and de-burr. Cut threads clean and sharp. Pipe threads shall conform to ANSI B 2.1.
- H. Pull up threaded fittings to a tight fit with an approved good quality pipe joint compound applied to male threads.
- I. Inspect screwed joints for leakage and remake each joint that appears to be faulty. Do not wait for rust to form. Clean threads on both parts apply compound and remake joints.
- J. Clean piping strainers after start-up by removing strainer screen and wire brushing.
- K. Conceal pipes in pipe shafts, partitions and furred spaces except where otherwise distinctly indicated on the drawings. Each riser shall be separately valved.
- L. Every branch pipe shall be controlled by a valve where it connects to the supply main or riser.
- M. Valves shall be easily accessible, with proper clearance for maintenance. Valves inside furred spaces, behind access doors shall be grouped to keep the number of access doors and their sizes to a minimum.
- N. Provide drain valves and drain lines from pumps, heaters, water cooled equipment, relief valves, etc., and pipe to floor drains.
- O. Tighten flanges and packing glands after the system has been placed in operation. Replace gaskets in flanges that show any signs of leakage after tightening.
- P. Install NO piping in electrical switchgear room, transformer vaults, telephone rooms or electrical closets. Provide drip pans under drain piping above electrical switchgear in mechanical rooms.
- Q. Install piping in alignment with and parallel to the walls of the building. All risers shall be plumb.
- R. No cross connections shall be installed between potable water systems and polluted supply or waste systems.
- S. Provide valves and unions or flanges at equipment such as pumps, coils, tanks, automatic valves, heat exchangers, etc. Provide valves on capped branches for extension by other contractors.
- T. Support piping at the proper intervals. Adjust pipe hangers and supports for correct pitch and alignment. Brace piping systems which sway.
- U. Remove rust, scale, and foreign materials from equipment and renew any defaced surfaces. If equipment is marred, provide new materials.
- V. Protect insulation. Repair insulation that is damaged. Keep it dry and free of tears. Allow no punctures in vapor barrier. Insure good tape adhesion. Provide smooth surfaces in finished areas.
- W. Pitch sanitary and storm lines: pipes 3 in. and larger not less than 1/8 inch per foot, pipes 2 inch and smaller not less than 1/4 inch per foot. Make changes in grade or direction by "Y" branches.
- X. Pitch vent piping to free themselves of water and condensation. Install vent branches not less than 42 inches above floor. Clean fixtures of labels and stains with whiting and alcohol. Clean copper tubing and fittings with steel wool to remove traces of oxidation.

- Y. All copper tubing shall be hard drawn unless noted otherwise. Annealed tubing where used shall be stretched, and installed with tool formed bends.

END OF SECTION 220510

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SECTION 22 0700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. All work covered in this section consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to piping and equipment.

1.2 DEFINITIONS:

- A. Exposed piping is that which can be seen when the building is complete without opening or removing access door panels, or ceilings tiles. This also includes all mechanical equipment rooms and pipe tunnels.
- B. Concealed piping are those elements above ceilings, in chases, interstitial space and pipe spaces. Other piping is considered to be exposed.
- C. Exterior piping is that which is exposed to the weather and/or outside the building envelope. Piping protected by overhangs, areaways, etc., exterior to the building envelope are considered exterior.
- D. ASJ: All service jacket, white finish facing or jacket.
- E. Air conditioned space: Space directly supplied with heated or cooled air.
- F. Cold: Equipment or piping handling media at design temperature of 60 degrees F or below.
- G. FRK: Foil reinforced kraft facing.
- H. FSK: Foil-scrim-kraft facing.
- I. Hot: Equipment or piping handling media above 105 degrees F.
- J. Pcf: Density, pounds per cubic foot.
- K. Runout: Branch pipe connection up to one inch nominal size to a one terminal piece of equipment (fan coil, terminal box).
- L. Thermal conductance: Heat flow rate through materials.
 - 1. Flat surface: BTU per hour per square foot.
 - 2. Pipe or cylinder: BTU per hour per linear foot.
 - 3. Thermal conductivity (k): BTU per inch thickness, per hour, per square foot, per degree Fahrenheit temperature difference.

1.3 QUALITY ASSURANCE:

- A. Products of the manufacturers, herein, will be acceptable for use for the specific functions noted. All materials shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such materials in either the wet or dry state.
- B. Materials shall be applied subject to their temperature limits. Any methods of application of insulation materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.
- C. Insulation shall be applied by experienced workers regularly employed for this type work.

1.4 RATING:

- A. All insulation shall have composite surface burning characteristic rating as tested by ASTM E 84, UL 723, or NFPA 255 not exceeding:

Flame Spread	25
Smoke Developed	50

- B. Composite shall include insulation, jacketing and adhesive used to secure jacketing or facing. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement, tape and cloth shall have the same component rating as specified above.

1.5 **STANDARDS:**

- A. International Energy Conservation Code
- B. ANSI/ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-rise Residential Buildings.
- C. Midwest Insulation Contractors Association “Commercial and Industrial Insulation Standards” - Third Edition.

1.6 **SUBMITTALS:**

- A. Submittals shall include all materials used, including:
1. Insulation
 2. Jacketing
 3. Tapes
 4. Hardware
 5. Mastics
 6. Adhesives
- B. Submittals shall be formatted to include a list of materials for each service:
- C. Submittals shall use pages from Midwest Insulation Contractors Association - “Commercial and Industrial Insulation Standards” for defining how insulation materials will be applied.

PART 2 - PRODUCTS

2.1 **GLASS FIBER INSULATION:**

- A. Nominal minimum thicknesses are listed in the table at the end of this section. These thicknesses are based on insulation having a thermal resistivity between 4.0 to 4.6 sq. ft.-hr.-F/BTU-in. on a flat surface resistivity to maintain equivalent insulation value.
- B. Insulation shall be 850 deg. F rated as manufactured by Owens Corning, Manville or Knauf.
- C. Insulation shall have factory-applied, reinforced, flame retardant, vapor barrier jacket equal to Owens-Corning ASJ with selfsealing lap. Butt joints shall be taped with field-applied ASJ tape 3 in. wide.
- D. Refer to the table at the end of this section for required pipe insulation thicknesses.
- E. Routed or molded fitting insulation shall be Hamfab.

2.2 **ELASTOMERIC CLOSED CELL INSULATION:**

- A. Tubing and Sheet shall be flexible fire retardant closed cell, conforming to ASTM C 534, and ASTM 1056. Thermal resistivity shall be 3.70 sq.ft.-hr-F/BTU-in. Insulation shall be Rubatex or Armaflex.

2.3 **FINISHES:**

- A. Metal jacketing, smooth .016 in. thick, type T 3003 aluminum with laminated moisture barrier. Jacketing shall be Childers, aluminum roll jacketing with Polykraft moisture barrier. Jacketing shall be embossed "No Asbestos" on a 6 inch spacing.
- B. Metal fitting covers shall be two piece aluminum. Covers shall be EII-Jac.
- C. Foil scrim kraft (FSK) jacket, flame retardant vapor barrier. Jacket shall be Alpha Temp 10651, all

service jacket.

- D. Fitting covers shall be one piece 20 mil PVC, covers shall be Ceel-Tite 550 PVC-UVR by Ceel-Co. Zeston and Proto are approved equals.
- E. Water based latex enamel equal to Armstrong WB Armaflex Finish.

2.4 **MISCELLANEOUS:**

- A. Adhesives:
 - 1. Glass & Mineral Fiber - Foster 85-20 / Vimasco 795.
 - 2. Cellular Glass - Pittcote 300 / Childers CP-30.
- B. Mastic (Weather Barrier):
 - 1. Foster 35-00 Mastic / Vimasco.
 - 2. Childers Vi-Cryl CP10/11.
 - 3. Vimasco WC-5.
- C. Coatings:
 - 1. Foster - Monolar Coating / Vimasco
 - 2. Foster Sealfas 30-36 / Vimasco
 - 3. Foster Tite-Fit 30-56 / Vimasco
 - 4. Pittcote 300
- D. Vapor Barrier Sealant: Foster Flextra 95-50
- E. FSK tape 3 in. wide, equal to Nashua FSK.
- F. Roll on Corner bead (2 in. x 2 in., 26 ga. galvanized steel).
- G. Fiber reinforced tape - Nashua 357, or 398.
- H. Insulation protection shields - Grinnell fig 167.
- I. Rigid insulation inserts - Hamfab.
- J. Reinforcing Cloth - Vimasco, Elastafab 894, conforming to ASTM D1668.
- K. Bands - .020 in., aluminum, ½ in. wide, embossed continuously with the legend "No Asbestos".
- L. Hexagonal Wire Netting - One inch mesh, 22 ga. galvanized steel.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Insulation shall be applied to clean and dry surfaces after tests and approvals required by this specification have been completed.
- B. On cold surfaces where a vapor barrier must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.
- D. All pipe insulation shall be continuous through walls, ceiling or floor openings, or sleeves; except where firestop or firesafing materials are required.
- E. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed as required between the pipe and the insulation shields. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required.

- F. Size insulation to cover electric heat tracing on piping where it is specified.
- G. All clevis type pipe supports shall be sized to fit the outside diameter of the insulation.
- H. Insulate valves, fittings, flanges etc. with the same thickness of insulation as specified for piping.
- I. Repair insulation damaged by work under this contract to match existing work or replace damaged portion with insulation specified for new work.
- J. Piping covered with metal or P.V.C. jacketing systems shall have the joints made to shed water. Laps shall be positioned in the bottom quadrant on horizontal pipe.

3.2 **PLUMBING SYSTEMS:**

- A. Domestic Water Piping:
 - 1. See schedule at the end of the section for thickness.
 - 2. Each section of insulation shall be firmly butted and secured with ASJ or SSL butt strips a minimum 3 inches wide. ASJ jacket laps and butt strips shall be secured with outward clinch staples at 4 inch spacing (hot piping only).
 - 3. All fittings and valves shall be insulated with preformed fiber glass fittings or mitered sections of pipe insulation. Insulation shall be of equal thickness to the adjacent pipe insulation.
 - 4. Insulate flanges and unions with insulation of same thickness as specified for pipe connected to flanges.
 - 5. Provide rigid insulation inserts per manufacturer's recommendations at each support.
 - 6. Provide insulation shield at each support.
- B. Elastomeric:
 - 1. Apply closed cell elastomeric insulation to all pipes, equipment and surfaces listed below.
 - 2. Secure insulation with contact adhesive in accordance with manufacturers instructions.
 - 3. Insulate fittings and valves with miter cut pieces of insulation same thickness as piping.
 - 4. Insulated surfaces:
 - a. Waste piping from electric cooler - 1 in. thick.
 - b. Waste piping from ice maker - 1 in. thick.
 - c. Cooling coil condensate piping - 1 in. thick.
 - d. Waste piping and p-traps from floor drains above ground receiving cooling coil condensate - 1 in. thick.
 - e. Covers and caps for all valve stems and operators, gauge cocks, thermometer wells and other appurtenances subject to sweating.
- C. Finishes:
 - 1. All Service Jacket/fitting Covers:
 - a. Exposed insulated piping indoors not scheduled for painting shall be covered with an All Service Jacket. Fittings shall be covered with molded fitting covers.
 - b. Concealed Piping finish covering shall be the All Service Jacket. Fittings shall be covered by wrapping the fitting with fiber reinforced tape, with a 5 percent overlap.
 - c. Pipe fittings larger than cataloged aluminum two piece or PVC covers shall be covered with vapor barrier mastic for cold lines for hot lines, or two layers of

hydraulic cement reinforced with wire mesh and finished with vinyl acrylic weather barrier mastic shall be used.

2. Metal Jacketing (Aluminum):

a. Cover the following insulated systems with metal jacketing:

- (1) Piping installed outdoors
- (2) Exposed piping indoors (all)

b. Cover with .016 in. thick aluminum jacket and hold in place with 2 in. wide aluminum bands on 9 in. centers. Fittings shall be covered with mitered segments of jackets or two piece preformed fitting covers. Provide angle ring escutcheons at wall, ceiling or floor penetrations.

c. Machine cut the jacket to produce a straight, smooth edge. Lap longitudinal and circumferential seams not less than 2 in. Install jackets on horizontal piping with the longitudinal seam approximately midway between horizontal centerline and the bottom side of pipe. Install with the top edge of jacket overlapping the bottom edge of jacket and with the seam of each jacket slightly offset from the seam of the adjacent jacket. Install jackets on vertical piping and on piping pitched from the horizontal from low point to high point so that the lower circumferential edge of each jacket overlaps the jacket below it.

3. Paint:

a. Exposed or exterior installations of elastomeric closed cell insulation shall be painted with two coats of water base latex enamel.

Domestic Water Piping		
Insulation Thickness for Pipe Sizes (Fiberglass)		
Temperatures °F	Up to 1 1/4 in. (In.)	1-1/2 in and Larger (in.)
Cold Water	0.5	1.0
105-140	1.0	1.5
141-200	1.5	2.0

END OF SECTION 22 0700

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SECTION 221001 - PLUMBING PIPING**PART 1 - GENERAL****1.1 DESCRIPTION OF WORK:**

- A. The work required under this section includes all work necessary for a complete installation of sanitary waste piping, storm piping and domestic water piping inside the building to [5 feet] [30 inches] outside the building, unless otherwise noted on drawings.

1.2 SUBMITTALS:

- A. Submittals shall include the following:

1. Valves
2. Fittings

- B. Submit test results for:

1. Pressure
2. Disinfection

PART 2 - PRODUCTS**2.1 GENERAL:**

- A. Refer to design drawings for approximate locations of pipe and for pipe size.
- B. Domestic Water Piping:
1. Water piping within building:
 - a. 3 inch and smaller shall be copper tube, type "L" hard temper, ASTM B-88.
 2. Piping below ground:
 - a. 2-1/2" and larger, type "K" hard temper; ASTM B-88.
 - b. 2" and smaller type "K" soft temper; ASTM B-88.
- C. Storm Drainage, Sanitary Waste, and Vent Piping:
1. Above Ground:
 - a. Hubless cast iron soil pipe, CISPI Standard 301 with coupling assembly CISPI Standard 310.
 - b. Horizontal piping for fixture rough-ins may be DWV copper, ASTM B-306.
 - c. Schedule 40 PVC-DWV ASTM D-2665 using solvent cement ASTM D2564.
 2. Below Ground:
 - a. Cast iron soil pipe, ASTM A74, tar coated inside and outside with gaskets ASTM C-564.
 - b. Schedule 40 PVC-DWV ASTM D-2665 using solvent cement ASTM D2564.
- D. Fittings - Domestic Water Piping:
1. Wrought copper, solder type, ASTM B-75, ANSI B16.22.
- E. Fittings - Storm, Sanitary Waste and Vent Piping:

1. Above ground:
 - a. No hub cast iron soil pipe fittings with coupling assembly CISPI Standard 310.
 - b. Schedule 40 PVC-DWV, ASTM D-2665 using solvent cement ASTM D-2564
 2. Below ground:
 - a. Cast iron soil pipe fittings ASTM B-74, tar coated inside and outside.
 - b. Schedule 40 PVC-DWV, ASTM D-2665 using solvent cement ASTM D-2564
- F. Unions:
1. Solder unions shall be wrought copper, with copper ground joint. ASTM B75, ANSI B16.22.
 2. Di-electric, EPSO, 250 lb. WOG.
- G. Solder:
1. Solder Metal shall conform to ASTM B32-alloy grade 95TA: 95 percent tin, 5 percent antimony. Joints shall be made with approved solder containing not more than 0.2 percent lead.
- H. Valves:
1. Approved manufacturers: Hammond, Stockham, Crane, Nibco, Apollo, Milwaukee, or approved equal.
 2. Valves 2 inches and smaller shall be equal to Nibco T-585-70, full port ball type with bronze body, chrome plated ball and bronze threaded ends, 600 psi WOG or Nibco S-585-70 in copper lines.
 3. Valves 2-1/2 and 3 inches shall be equal to Nibco T-111 solid wedge disc gate valve with bronze body, screwed ends, screwed bonnet, rising stem, 200 lb. WOG or Nibco S-111 in copper lines.
 4. Check valves 3 inches and smaller shall be equal to Nibco T-413-B body, bronze disc, swing check, threaded ends, 200 psi WOG or Nibco S-413-B in copper lines.
 5. Globe valves 3 inches and smaller shall be equal to Nibco T-211-B, bronze body, bronze disc and stem, threaded bonnet, threaded ends, 200 psi WOG, or Nibco S-111-B in copper lines.

PART 3 - EXECUTION

3.1 GENERAL:

- A. All piping shall be routed to conserve building space, be coordinated with items installed by other trades and not interfere with access to or operation of the facility.
- B. Provide roof flashings for pipe penetrations through roof, to be installed by roofing contractor. Install roof drains as recommended by manufacturer and such that piping does not carry weight of roof drain.
- C. Water piping within building shall be size indicated on plans and risers. In the event no size is shown, pipe size or size required by the Plumbing Code. Piping shall be sloped toward a system drain and toward outlets, to provide for system drain-down. If installed near exterior walls, piping shall be located on the interior side of insulation. Install piping to prevent direct contact between ferrous and non-ferrous materials. Allow flexibility for expansion in piping.
- D. Domestic water piping system shall be tested with potable water at a pressure of 125 psig or 25 psig above design working pressure, whichever is greater for 12 hours. Test shall be conducted with plumbing inspector unless approved otherwise in writing.
- E. Water distribution piping shall be disinfected prior to occupancy or system start-up with a chlorine solution 50 ppm. Allow system to stand for six hours minimum, then exercise all valves to ensure treatment of all branches and components. System shall be flushed with potable water after

disinfection and prior to placement into service.

- F. Storm drainage and sanitary waste and vent piping shall be tested in accordance with water and air tests as specified in the Plumbing Code, in addition to any tests required by the local plumbing official. (10 feet of head with no apparent leaks. Hold for 30 minutes minimum). Flush all gravity piping including floor drains and roof drains prior to turning over to the Owner.

3.2 PREPARATION:

- A. All pipe shall be cut square. Ream pipe and tube ends and remove burrs. Clean the ends of pipes to remove oil, grease and oxides.
- B. Prepare piping connections to equipment with flanges or unions.
- C. All soldered piping and equipment connections shall be properly prepared in accordance with good piping practice. Apply a thin layer of flux to only the male tubing. Rotate into the fitting with one or two revolutions.

3.3 INSTALLATION:

- A. Domestic Water Piping:
1. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
 2. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
 3. Provide clearance for installation of insulation and access to valves and fittings.
 4. Provide access where valves and fittings are not exposed.
 5. Install valves with stems upright or horizontal. Provide drain valves at low points in systems.
 6. Test cold water piping before being insulated, or concealed in walls or ceiling.
- B. Storm Drainage, Sanitary Waste, and Vent Piping:
1. Horizontal soil, waste and drainage lines within building shall have a minimum uniform slope of 1/8 inch per foot on 3 inch and larger, and 1/4 inch per foot on lines 2 inch and smaller.
 2. Turns in sanitary, soil, and drain piping shall be made using 45 degree elbows, wyes, quarter-, eighth-, or sixteenth bends, or other bends approved by the Plumbing Code.
 3. Do not use sanitary tees or crosses except where discharging from horizontal to vertical.
 4. Make changes in pipe sizes with reducing fittings and recessed reducers. Do not reduce line size in direction of flow.
 5. Provide cleanouts in all horizontal turns in waste piping greater than 45 degrees.
 6. Provide deep seal traps on all floor drains, and trap primers where required by code or as indicated on drawings.
 7. Indirect waste lines dumping into floor or hub drains shall maintain a 2-inch air gap between the end of the waste line and the rim of the floor or hub drain.

3.4 APPLICATION:

- A. Install unions downstreams of valves and at equipment or apparatus connections. Install dielectric unions where joining dissimilar materials.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Install brackets at cast iron no hub cleanouts to protect the integrity of the joint.

END OF SECTION 221001

SECTION 221005 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This specification describes the requirements for labor and materials required for the installation of plumbing specialties included as part of the building plumbing system.

1.2 SUBMITTALS:

- A. Manufacturer’s literature indicating model numbers and options.
 - 1. Cleanouts
 - 2. Water Hammer Arresters
 - 3. Balancing Valves
 - 4. Pressure Reducing Valves
 - 5. Trap Seals
 - 6. Floor Drains
 - 7. Backflow Preventer
 - 8. Wall Hydrants
 - 9. Thermostatic Mixing Valves
 - 10. Washing Machine Valve Box
 - 11. Ice Machine Valve Box
- B. Format shall include a schedule of the specialties submitted and include identification number of each item, such as “FD-1 Floor Drain,” a list of each component, accessory, and option of the item being submitted. This schedule must be included in the front of the submittal page.

PART 2 - PRODUCTS

2.1 CLEANOUTS:

- A. Cleanouts shall consist of a coated cast iron body with threaded top with spigot or no-hub connection and gasketed bronze closure plug with countersunk slot. Head shall be adjustable in height; provide non-skid covers for floor cleanouts. Provide thread shield to protect adjustment threads from concrete as required.

- B. Cleanout Covers:

<u>Location</u>	<u>Adjacent Finish</u>	<u>Material</u>	<u>Features</u>
Interior	Terrazo	Nickle Bronze	Round Recessed Top
Interior	Tile	Nickle Bronze	Square Recessed Top
Interior	VCT	Nickle Bronze	Square Recessed Top
Interior	Carpet	Nickle Bronze	Round, Carpet Maker
Interior	Concrete	Nickle Bronze	Round
Exterior	Concrete	Cast Iron	Vandal Proof Secured Top
Wall	All	Chrome	Plated Covers

- C. Cleanouts shall be Jay R. Smith, Wade, Josam or Zurn.

2.2 WATER HAMMER ARRESTERS:

- A. Water Hammer Arresters shall be constructed of a stainless steel or copper shell, stainless steel or elastomer bellows, with precharge of air, nitrogen, or argon. Arresters shall conform to ASSE Std. 1010, and shall be Zurn "Shoktrol", Josam "Absorbtron", Wade "Shokstop", or Precision Plumbing Products "Shock Arrester". Sizing shall be in accordance with PDI Standards.

2.3 BALANCING VALVES (DOMESTIC HOT WATER RETURN):

- A. Valves shall be Bell and Gossett CB-LF series circuit setter. Presettable balance valve, variable orifice flow meter and positive shut-off service valve. Provide with capped readout valves fitted with

internal check valves, ¼ inch NPT tapped and plugged drain port. Brass Body, stainless steel ball construction with glass and carbon filled TFE seat rings, and solder connections. Valves to have differential pressure read-out ports across valve seat area. Furnish with preformed insulation to permit access for balance and read-out. Valve shall be ANSI/NSF-61 Compliant. Taco and Watts are approved equals.

2.4 PRESSURE REDUCING VALVES:

- A. Pressure Reducing Valves 2½ inch and larger shall be equal to Watts Series LFN223FS with iron body, reinforced Buna-N diaphragm and stainless steel piston, stainless steel strainer on inlet side, and flanged ends. All parts shall be serviceable without removing the valve from inline. Valve shall have adjustable reduced pressure range of 25-75 psi. Provide separate, pipe mounted pressure gauge on discharge piping.

2.5 TRAP SEALS:

- A. Provide an elastomeric, normally closed trap guard device to prevent evaporation of the trap seal and to protect against sewer gases from backing up into habitable areas. Device shall open with fluid and allows liquid drainage to flow through into the building drain. Trap seal shall be Trap Guard by Pro-Vent Systems or approved equal.

2.6 FLOOR DRAINS (FD):

- A. FD-1: General duty floor drain, coated cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar, round polished nickel-bronze strainer top, square heelproof openings, and secured grate. Jay R. Smith 2005Y-A or equal by Zurn, Wade, or Josam.

2.7 REDUCED PRESSURE ZONE BACKFLOW PREVENTERS (RPZ):

- A. The RPZ assembly shall consist of an internal pressure differential relief valve located in a zone between two positive seating check modules with captured springs and silicone seat discs. Seats and seat discs shall be replaceable in both check modules and the relief valve. There shall be no threads or screws in the waterway exposed to line fluids. Service of all internal components shall be through a single access cover secured with stainless steel bolts. Body and shutoffs shall be constructed using Lead Free cast copper silicon alloy materials. Lead Free reduced pressure zone assembly shall comply with local codes and standards. The assembly shall also include two resilient seated isolation valves, four resilient seated test cocks, and an air gap drain fitting. The assembly shall meet the requirements of ASSE Std. 1013; AWWA Std. C511; CSA B64.4. RPZ shall be Watts Series LF009QT-S or equal by Wilkins, Febco, and Conbraco are approved equal.

2.8 WALL HYDRANTS (WH):

- A. General: Wall hydrants shall be bronze, with integral vacuum breaker, ¾ inch hose thread, key operator. Units shall be non-freeze type. Jay R Smith, Zurn, Woodford, Wade, and Josam are approved manufacturers.
- B. WH-1: Lockable, recessed wall hydrant, nickel bronze plated, quarter turn stainless steel box with hinged locking cover. Jay R Smith 5509 QT.

2.9 THERMOSTATIC MIXING VALVES (TMV):

- A. Thermostatic type with liquid filled motor. Bronze body construction with replaceable corrosion resistant components. Valve construction shall be sliding piston control mechanism. Piston and liner shall be of stainless steel material. Valves shall be equipped with removable union end stop and check inlets with stainless steel strainers. Valve shall provide protection from hot and cold supply line failure and thermostat failure.
- B. Include dial thermometer and shut off valve on tempered water outlet. Lawler Model 801.
- C. Holby, Symmons, Leonard, and Watts are also approved manufacturers.

2.10 WASHING MACHINE VALVE BOX:

- A. White powder coated cold rolled steel outlet box with 2" threaded drain fitting and ½" brass quarter

turn valves that comply with ASME A112.18.1.

- B. Guy Gray Model #T200 or prior approved equivalent.

2.11 **ICE MACHINE VALVE BOX:**

- A. White powder coated cold rolled steel outlet box with brass plated quarter turn, complying with ASME A112.18.1 and NSF61/ANSI 372.
- B. Guy Gray Model #M1B1AB or prior approved equivalent.

PART 3 - EXECUTION

3.1 **INSTALLATION:**

A. CLEANOUTS:

1. Cleanouts shall be installed in horizontal runs at spacing of no more than 75 feet. Install cleanouts at the base of every soil and waste stack, and at each 90 degree change in direction. Install cleanouts which are not easily accessible up through floor or wall and provide applicable covers. Install cleanouts to allow at least 18" for rodding.

B. WATER HAMMER ARRESTER:

1. Water hammer arrester sizing shall be in accordance with PDI Standards. Arrester shall be installed in accordance with manufacturer's instructions and as near the shock source as practical. Install to allow unobstructed path from shock source to arrester.

C. BALANCING VALVES:

1. Install balancing valve in accordance with manufacturer's instructions.
2. Balance domestic hot water return system at each balancing station to within 5% of flow shown on drawings.

D. PRESSURE REDUCING VALVES:

1. Install Pressure Reducing Valves where shown on drawings in accordance with manufacturer's instructions.
2. Set final outlet pressure for 60 psi unless otherwise indicated. Install in horizontal and accessible location. Install shut off valves and strainer (unless integral with unit) upstream of pressure reducing valve and shut off valve downstream of the pressure reducing valve. Install pressure gage, unless integral with unit, downstream of pressure reducing valve.

E. TRAP SEALS:

1. Trap seals shall be provided for all floor drains, floor sinks, hub drains, etc., as noted on the plans.
2. Install trap seals and accessories in accordance with manufacturer's instructions.

F. FLOOR DRAINS AND FLOOR SINKS:

1. Flush-floor drains shall be able to support traffic. Drains installed in building floor shall be sealed in such a manner as to prevent leakage of water around trap and body to ceiling below.
2. Provide 3 ft. sq., 6 mil butyl membrane, at each floor drain. Clamp membrane. ! [Membrane shall be placed below tile grout.

G. BACKFLOW PREVENTERS:

1. Backflow preventers shall be installed by qualified personnel per manufacturer's instructions. After installation, but before system is put into service, test backflow preventer for

functionality with test kit as recommended by manufacturer. Pipe discharge from backflow preventer vent to nearest floor drain with connection-size copper tubing. Ensure air gap is provided in relief line either by air gap fitting or elevated discharge above drain. Backflow preventers shall have unions for removal. Backflow preventers shall be provided on domestic water lines as indicated on the drawings.

H. WALL HYDRANTS / HOSE BIBBS:

1. Install hose bibbs and wall hydrants as indicated on drawings, minimum height 18" A.F.F. unless otherwise indicated.

I. THERMOSTATIC MIXING VALVES:

1. Install thermostatic mixing valve as indicated on the drawings. Provide isolation valves and install the thermometer where it is readily visible.

END OF SECTION 221005

SECTION 222010 - GAS PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. Provide complete installation of gas piping from the “point of delivery” noted on plans up to and including connection to all gas-fired equipment.

1.2 CODES AND STANDARDS:

- A. International Plumbing Code
- B. International Gas Code
- C. NFPA 54 - Fuel Gas Code/ANSI - Z223.1
- D. American National Standards Institute (ANSI)
- E. CSA America
- F. American Society of Mechanical Engineers (AMSE)
- G. American Society for Testing and Materials (ASTM)

1.3 SUBMITTALS:

- A. Submit manufacturer's literature on all materials and equipment including:
 - 1. Pipe
 - 2. Pipe Coating
 - 3. Anodes
 - 4. Valves
 - 5. Flexible Connectors
 - 6. Fittings
 - 7. Regulators
 - 8. Relief Valves
 - 9. Gauges

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS:

- A. Pipe/Tubing:
 - 1. Steel Pipe: ASTM A53 Grade A or B, Type F, ERW or seamless. Schedule 40.
 - 2. ASTM A106 seamless. Schedule 40.
 - 3. Tubing (steel) ASTM A539.
 - 4. Plastic Pipe ASTM D2513 polyethylene. Drisco pipe 6500 or prior approved equal.
- B. Fittings:
 - 1. Welded (Steel):
 - a. Welding fittings shall be carbon steel butt welding type conforming to ASTM-234. Elbows shall be long radius type. Welding tees shall be used on branch connections equal to or greater than ½ the diameter of the main run. Fittings shall be Ladish, Tube-Turn or Weldband.
 - b. Carbon steel reinforced branch, welding fittings up to 3 inches, but not greater than

½ the diameter of the main run may be used. Fittings shall be Bonney Forge or Phoenix Forging.

2. Threaded (Malleable, Iron):
 - a. Screwed fittings shall be malleable Iron ASTM A-197 class 150 conforming to ANSI B16.3. Dimensions conforming to Federal Spec WW-P-521. Fittings shall be Grinnell, Flagg or Stockham.
3. Heat Fusion/Compression (Polyethylene):
 - a. Socket type fusion shall meet the requirements of ASTM 2683.
 - b. Fittings shall be listed and marked ASTM D2513.
 - c. Butt type fusion fitting shall meet the requirements of ASTM D3261.

2.2 UNIONS (DIELECTRIC):

- A. Class 250 malleable, screwed ASTM A-197.

2.3 VALVES:

- A. General
 1. Valves shall be of an approved type and constructed of materials compatible with the piping.
 2. Valves shall comply with ANSI Z21.15, CSA requirement 3-88, ASME B16.44, and ASME B16.33 as noted in International Fuel Gas Code.
- B. 1 Inch and Smaller:
 1. Ball valve - Class 125 brass full port, 2 piece body, chrome plated ball, blowout proof steam, TFE seats.
- C. 2 Inches and Smaller:
 1. Plug Cock - Class 125 cast iron, screwed, full port. ANSI B16.33 Homestead Figure 601.

2.4 PIPE COATING:

- A. X-Tru Coat or prior approved equal including joints and fittings.

2.5 PRESSURE REGULATORS/PRESSURE GAUGES:

- A. Cast iron or aluminum body and spring case with stainless steel valve stem, seat ring and valve plug, plated steel springs, neoprene diaphragm and gaskets and TFE disc. Regulating valves shall be sized for the flow indicated and for inlet and outlet pressures indicated. Outlet pressure shall be maintained under the design flow condition and at no flow. Regulating valves two psi and below shall have leak limiting devices. Regulating valves over two psi shall be vented full size to outside of the building. Other regulating valves requiring access to the atmosphere shall be equipped with vent piping leading to outside. Provide a pressure relief valve if the regulator connection size exceeds two-inches. Regulating valves shall be Fisher, Maxitrol or prior approved equal meeting ANSI Z21.18 and ANSI Z21.80.
- B. Pressure Gauge:
 1. For medium pressure gas; 0-5 psi range. For low pressure gas; 0-30 inch W.C. range. Use low pressure type 2-1/2 inch dial pressure gauge with appropriate range, OCI Model CO 34, Terrice, Weksler or approved equal.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Route gas service entrance piping into building to avoid interference and damage.
- B. Provide manual shutoff valve, gas cock and gauge, fire safety shutoff valve.
- C. Emergency gas shut off valves shall be installed outside the building. Valves shall be labeled.

3.2 UNDERGROUND PIPING:

- A. Underground piping shall be:
 - 1. Carbon steel - A53/A106-welded.
 - 2. Polyethylene
- B. Where pipes penetrate basement walls and foundations install Thunderline Link Seal.
- C. Underground steel piping shall have at least 18 inch of proper backfill cover.
- D. Underground piping shall be protected from corrosion. Provide coated piping and fittings. Repair damaged coating at welds.
- E. Install sacrificial anodes on steel piping intervals not exceeding 100 ft.
- F. Gas lines routed under a building shall be steel and shall be encased in a sch 40 outer conduit (at least 3 pipe sizes larger than the gas line).
 - 1. Conduit shall be seal welded to the gas pipe inside the building.
 - 2. Conduit shall be vented to outdoors.
 - 3. See paragraph D above for sealing conduit through wall penetration.
 - 4. Conduit shall be protected from corrosion. See paragraph B above.

3.3 GAS SERVICE:

- A. Coordinate installation of gas service line with local gas company. Pay all fees.
- B. Provide 12 inch elevated meter mounting pads on top of a 4 inch thick concrete pad for support of gas meter and piping.
- C. Provide (two) 8 inch diameter pipe bollards for gas meter protection.
- D. Bollards shall be six feet long (3 feet below grade), mounted in a 24 inch diameter hole, filled with 3,000 psi concrete.

3.4 INTERIOR PIPING:

- A. Connect to entering line and distribute gas to equipment items requiring gas and as indicated. Perform work in accord with applicable A.G.A., N.F.P.A. 54, State and Local codes. Install gas stop valves and drip legs at each equipment item. Piping shall be adequately drained with a minimum slope of 1/4 inch per 15 feet and drip legs (full size of pipe) installed at additional points where condensate may collect. Install pressure reducing valves as required to provide pressure within equipment manufacturer's requirements.

3.5 EXTERIOR PIPING:

- A. Exterior piping shall be schedule 40 carbon steel.
- B. Piping 2 inch and smaller may use threaded fittings. Piping 2 ½ inch and larger shall use welded fittings and flanged valves.
- C. Exterior piping shall be coated with an alkyd enamel primer (minimum dry thickness 3 mils).

- D. Exterior piping shall be supported on galvanized B-line channels and pipe clamps.

3.6 CONNECTING:

- A. Connect equipment items furnished under other sections of specifications.

3.7 VENT PIPING FROM REGULATORS:

- A. Extend separate full size vent pipes from each regulator outside. Terminate each vent separately with a screened opening.

3.8 TESTS:

- A. Test system in accordance with A.G.A., International Fuel Gas Code, N.F.P.A. 54, and applicable State and Local codes.

3.9 ACCESS PANELS:

- A. Provide access panels for valves and other items requiring maintenance in enclosed spaces. See Section 15050 for access panel specification. Avoid installing gas appurtenances in enclosed spaces where possible. Install in enclosed spaces only as allowed by applicable codes.

END OF SECTION 222010

SECTION 223005 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This specification describes the requirements for labor and materials necessary for the installation of plumbing equipment included as part of the building plumbing system.

1.2 SUBMITTALS:

- A. Submittals shall include:
1. Water Heaters
 - a. Manufacturers Data Sheets
 - b. Certified Dimensional Drawings
 2. Booster Pumps/Circulating Pumps/Sump Pumps
 - a. Manufacturers Data Sheets
 - b. Certified Dimensional Drawings
 - c. Central Panel Wiring Diagram
- B. Format shall include a schedule of the items of equipment submitted and include identification number of each item, such as "WH-1 Water Heater", and list of each component, accessories, and options. Include the schedule in the front of the submittal package.

PART 2 - PRODUCTS

2.1 INSTANTANEOUS GAS WATER HEATERS:

- A. Commercial, gas-fired, wall-mounted water heaters shall be outdoor direct vent model nc199 series as manufactured by Noritz, Rheem, or Rinnai. The water heaters shall exceed the energy efficiency requirements of ashrae 90.1.
- B. The water heaters shall have a 5-year limited heat exchanger warranty and a 5-year limited parts warranty.
- C. Units shall be designed to burn natural gas and certified by CSA international to the latest edition of ANSI standard Z21.10.3/CSA 4.3.
- D. Water heaters shall be rated for 150 psi working water pressure and 300 psi test pressure. Gas supply pressure shall be 4.0" to 10.5" wc for natural gas.
- E. Units shall have a coated steel case, copper heat exchanger, stainless steel dual-flame burner, aluminum gas control valves, 3/4" inlet gas connection, 3/4" brass inlet/outlet water connections, and water holding capacity of 0.2 gallons.
- F. Units shall include temperature lockout and 14 temperature options from 100-150°F in 5°F intervals and 160-180°F in 10°F intervals.
- G. The heaters shall be controlled by an internal circuit board that monitors the inlet and outlet temperatures with installed thermistors, sensing and controlling flow rate to set point temperature with air-fuel ratio controls in order to maintain thermal combustion efficiency. Units shall include flame sensor system, thermal cut-off fuses, lightning protection device, overheat prevention device, freeze protection device, and fan rotator detector.
- H. Multi-system applications shall be controlled by a multi-unit central control system.

2.2 CIRCULATING PUMP:

- A. Domestic hot water circulating pump shall be Taco, Armstrong, Bell and Gossett, or prior approved

equal in line centrifugal pump with stainless steel construction, provided with flanged connections, nonmetallic impellers, and mechanical seals. Motors shall be rigid coupled, supported from pump casing. Motor shall have internal overload protection. Water or oil lubricated motors are acceptable.

2.3 THERMAL EXPANSION TANK (Domestic Water):

- A. Pre-charged hydropneumatic steel expansion tank, constructed in accordance with Section VIII of ASME Boiler and Pressure Code, with all welds conforming to ASME Section IX. Tank must be stamped with a maximum working pressure of 125 psi, and a maximum working temperature of 200 degrees F. All internal wetted parts must comply with FDA regulations and approvals. An internal butyl diaphragm will be used to isolate air from water. Amtrol or approved equal AST series sized as shown on plans.

PART 3 - EXECUTION

- A. See details on drawings for installation of water heaters, circulating pumps, etc.
- B. Provide written report of the training sessions including list of attendees.

END OF SECTION 223005

SECTION 224005 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This specification describes the requirements for plumbing fixtures and their installation.

1.2 SUBMITTALS:

- A. Submittals shall include manufacturer's data sheets and dimensional information on all fixtures and accessories according to 22 0505 Plumbing Submittals.
- B. Format shall include a schedule of the fixtures submitted and include identification number of each item, such as "WC-1 Water Closet", and list of each component and accessory of the fixture, including manufacturer's model number. This schedule must be included in the front of the submittal booklet.

1.3 CODES AND STANDARDS:

- A. American National Standards Institute (ANSI)
- B. American Society of Safety Engineers (ASSE)
- C. American Society of Mechanical Engineers (ASME)
- D. American Society for Testing and Materials (ASTM)
- E. International Plumbing Code

PART 2 - PRODUCTS

2.1 GENERAL:

- A. Vitreous ware shall be white, regular section, of weight required, free from cracks, flaws, blisters, crazes or other defects. Provide with mounting brackets for wall mounted fixtures unless floor carriers are indicated.
- B. Stainless steel shall have machine ground finish. Decks and sink compartment sides shall be buffed. Exposed surfaces shall have no. 4 satin finish. Interior surfaces shall be deadened. Exposed metal parts shall be chromium plated and protected during construction by a coat of grease.
- C. Water closet and urinal carriers shall have tapered thread face plate, plastic coupling with test cap, and neoprene rubber gasket. Lavatory, sink and urinal carriers shall have rectangular structural steel uprights. Carriers shall have necessary accessories for proper installation. Carriers shall be according to ANSI A112.6.1M.
- D. Water closets and urinals shall have bolt caps.
- E. Seats shall be white, solid plastic, with internal check and molded stainless steel hinge without visible metal parts, except as hereinafter specified.
- F. Chromium plated traps shall be brass with chromium plated nipple to wall and escutcheon.
- G. Fittings and accessories specified designate type only; provide modifications to make fittings work properly with fixture and piping.
- H. Provide necessary tailpiece and shanks.

2.2 FIXTURES

- A. Provide fixtures, in complete working order, as described below and on the drawing.

WC-1: WATER CLOSET (ADA COMPLIANT, WALL HUNG, FLUSH VALVE):

1. Kohler K-4325, wall mounted, vitreous china, flush valve water closet, ADA compliant, elongated bowl, siphon jet flushing, 1-1/2" top spud and bolt caps, 1.28 gallons per flush.
2. Sloan G2 Optima Plus 8111-1.28-YJ exposed flush valve, sensor operated, battery powered, low battery indicator light, manual flush override button, 1.28 gallons per flush. Provide with wall mounted split ring pipe support.
3. Kohler K-4670-C elongated toilet seat with check hinges.
4. Carrier System with appropriate arrangement for installation and use on siphon jet flushing water closet; Zurn, Smith, Josam or equal.

WC-2: WATER CLOSET (WALL HUNG, FLUSH VALVE):

1. Kohler K-4325, wall mounted, vitreous china, flush valve water closet, elongated bowl, siphon jet flushing, 1-1/2" top spud and bolt caps, 1.28 gallons per flush.
2. Sloan G2 Optima Plus 8111-1.28-YJ exposed flush valve, sensor operated, battery powered, low battery indicator light, manual flush override button, 1.28 gallons per flush. Provide with wall mounted split ring pipe support.
3. Kohler K-4670-C elongated toilet seat with check hinges.
4. Carrier System with appropriate arrangement for installation and use on siphon jet flushing water closet; Zurn, Smith, Josam or equal.

UR-1: URINAL (ADA COMPLIANT, WALL MOUNTED, FLUSH VALVE):

1. Kohler K-5016-ET vitreous china, siphon jet design, 3/4" top spud inlet, 2" I.P.S. outlet, lip minimum 14" from wall and mounted with lip 17" above finished floor.
2. Sloan G2 Optima Plus 8196-0.5-YJ exposed flush valve, sensor operated, battery powered, low battery indicator light, manual flush override button, 0.5 gallons per flush. Provide with wall mounted split ring pipe support.
3. Zurn Z-1222 Urinal Carrier with bearing plate, or equal.

UR-2: URINAL (WALL MOUNTED, FLUSH VALVE):

1. Kohler K-5016-ET vitreous china, siphon jet design, 3/4" top spud inlet, 2" I.P.S. outlet, lip minimum 14" from wall.
2. Sloan G2 Optima Plus 8196-0.5-YJ exposed flush valve, sensor operated, battery powered, low battery indicator light, manual flush override button, 0.5 gallons per flush. Provide with wall mounted split ring pipe support.
3. Zurn Z-1222 Urinal Carrier with bearing plate, or equal.

LAV-1: LAVATORY (ADA COMPLIANT, WALL MOUNTED, SINGLE HOLE FAUCET):

1. Kohler K-2007 wall mounted, vitreous china, with overflow and single faucet hole, drilled for concealed arm wall carrier.
2. Sloan Optima EAF-150, sensor faucet, single hole, battery powered, 0.35 gpm, vandal resistant outlet, and low battery indicator.
3. McGuire LFBV Series, quarter-turn ball valve stop, 1/2" sweat to 3/8" compression lavatory supplies.
4. McGuire 8902, 1-1/4 inch x 1-1/2 inch p-trap with escutcheon. Grid strainer. Provide offset drain piping as required for ADA compliant installation.
5. Provide Zurn ZW1070XL thermostatic mixing valve mounted below countertop. Set discharge temperature to 100 F.

6. Zurn Z-1231 lavatory concealed arm wall carrier.
7. ADA compliant trap and supplies covers by Truebro or equal.

SK-1: STAINLESS STEEL SINK (WALL HUNG, SINGLE COMPARTMENT):

1. Just Manufacturing Co. A-554-912, 20 gauge, 304 stainless steel sink, two faucet holes on 8" centers, with support brackets and wall clip.
2. Just Manufacturing Co. JS-47-TGSA backsplash mounted faucet with gooseneck spout.
3. Just Manufacturing Co. J-15-FS drain with 1- ½" chromed brass tail piece.
4. McGuire 8912 1-1/2" x 1-1/2", 17 gauge brass p-trap with tubular wall bend.
5. McGuire 171 1/2" x 1/2" chrome-plated supplies with stops.

SK-2: STAINLESS STEEL SINK (SINGLE DEEP COMPARTMENT):

1. Elkay DLR-2222-10 single deep compartment self-rimming, 18 gauge 302 stainless steel sink, satin finish, fully undercoated, three faucet holes on 4" centers, 10" deep bowl.
2. Zurn Z-871C4 polished chrome-plated 8" brass deck faucet with 8" centerline rigid or swing gooseneck spout and quarter turn ceramic disc cartridge. 2.0 gpm variable orifice aerator. 4" vandal-resistant brass wrist blade color-coded handles, ADA designed.
3. Elkay LK-99 heavy gauge stainless steel body. Conical stainless steel strainer plate with movable lift up knob with neoprene stopper. Chrome-plate 1-1/2" tailpiece.
4. McGuire 8912 1-1/2" x 1-1/2", 17 gauge brass p-trap with tubular wall bend.
5. McGuire 171 1/2" x 1/2" chrome-plated supplies with stops.

EWC-1: WATER COOLER (TWO LEVEL WHEELCHAIR ACCESS):

1. Elkay EZWS-ERPBM28K no lead, barrier free cooler with two levels and bottle filler meeting ADA dual height requirements. Water system free of lead-containing brass parts. Wall mounted with stainless steel cabinet and stainless steel basin with integral drain grid.
2. McGuire 8902 p-trap.
3. McGuire 170 stops and supplies.

EWC-2: WATER COOLER (SINGLE STATION):

1. Elkay EZWS-ERPBM8K no lead, barrier free cooler with single station and bottle filler. Water system free of lead-containing brass parts. Wall mounted stainless steel cabinet and stainless steel one-piece basin with integral drain grid.
2. McGuire 8902 p-trap.
3. McGuire 170 stops and supplies.

JMB-1: JANITOR MOP BASIN (36" X 24"):

1. Stern Williams Model SB-300-BP mop service basin, 36" x 24" x 12"; tiling flange on wall side (as job requires); splash catcher panel, 20 gauge, type 304 stainless steel. Drain shall be cast brass with stainless steel strainer, cast integral with 3" drain size. Receptor composed of pearl gray marble chips and white cement ground smooth. Stainless steel cap of one piece 20 gauge, type 302 stainless steel cast integral on all four sides.
2. Stern Williams T-10-VB sink fitting with vacuum breaker, adjustable top brace, 3/4" hose thread on

spout with bucket hook inlets 8" on center, chrome finish.

SH-1: SHOWER:

1. Kohler "Terracina" #K-1538 three foot shower module with integral soap ledges, molded in textured floor, and K9132 shower drain, K701217 shower door.
2. Kohler "Purist" #K-T1s14422-4 shower assembly with K-2971-KS pressure balancing valve with screw driver stops and k-997 multi-function showerhead. Finish shall be polished chrome.

SH-2: SHOWER:

1. Kohler "Sonata" # K-1688 five foot shower module, one piece, high gloss acrylic, with K-9132 shower drain.
2. Integral molded seat.
3. Kohler "Neuville" # K-T6469-4B shower assembly, with K-304-KS pressure balancing valve with screw driver stop. Finish shall be polished chrome.

WMVB-1: WASHING MACHINE VALVE BOX:

1. Guy Gray Model FB-200 for 2" drain, 2-1/2" valves, 16 gauge steel with epoxy finish.
2. Box with 3/4" overflow guard.

IMVB-1: ICE MAKER VALVE BOX:

1. Guy Gray Model BIM 875.
2. ½" FIP x 1/4" O.D. outlet compression angle valve.
3. Box is 16 gauge steel with epoxy finish.

2.4 ACCEPTABLE MANUFACTURERS:

- A. Fixtures, Vitreous China - American Standard, Zurn, Kohler
- B. Fixtures, Stainless Steel - Just, Elkay
- C. Flush Valves - Sloan, Zurn
- D. Toilet Seats - Olsonite, Sperzel, Church, Beneke, Bemis
- E. Faucets - T&S Brass, Speakman, Chicago, Symmons, Eljer
- F. Terrazzo - Fiat, Cutler, Florestone, Stern-Williams
- G. Trim, Chromed Brass - McGuire, Sanitary Dash, Bridgeport
- H. Shower Mixing Valves - Powers, Leonard, Lawler, Symmons, Speakman, Zurn
- I. Shower Heads - Symmons, Speakman, Zurn
- J. Electric Water Coolers - Elkay, Halsey Taylor, Sunroc, Oasis, Haws.
- K. Carriers - J. R. Smith, Josam, Zurn, Wade

PART 3 - EXECUTION

3.1 GENERAL:

- A. Verify all dimensions by field measurements. Verify that all plumbing fixtures are installed in accordance with pertinent codes and regulations and reference standards.
- B. Verify location of rough-in for potable water and waste piping.

- C. Examine walls, floors, and millwork for conditions suitable for fixture installation.
- D. Securely anchor bars, shower heads, shower head bars, etc. to metal studs in dry wall construction by angle irons.
- E. Carriers shall have short feet. Lavatory carriers shall have concealed arms. Bolt carrier feet to the floor with 1/2 inch bolts and anchors.
- F. Flush valves shall be ASSE 1001 diaphragm type, quiet, screwdriver stop with cover, vacuum breaker, solder sweat kit, and handle.
- G. Fixture connections may be made using "AquaFlo" flexible connectors of polymer and stainless steel braided covering.

3.2 INSTALLATION:

- A. Install plumbing fixture level and plumb, in accordance with fixture manufacturer's published literature, rough-in drawings, codes regulations, and reference standards.
- B. Fasten plumbing fixtures securely to supports or building structure. Rigidly support water supplies behind or within wall construction.
- C. Provide stop valve in the water supply to each fixture in an accessible location.
- D. Connect wall hung urinals to waste piping with red brass nipples.
- E. Connect fixtures to water supply with copper or brass (no steel).
- F. Each fixture, floor drain and piece of equipment requiring connection to drainage system to have separate traps installed as close to fixture as possible.
- G. Provide iron or steel backing for all wall mounted fixtures (or wood backing only if building structure is wood).
- H. Provide escutcheons at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- I. Apply SCP3154 primer and General Electric Co.'s No. 1702 silicone sanitary sealant around plumbing fixtures to conceal voids at wall and contact points of fixture after walls have been painted.
- J. Apply SCP3154 primer and General Electric Co.'s Silpruf Sealant on plain concrete walls.

3.3 TESTING AND QUALITY CONTROL:

- A. Inspect each unit for damage. Replace damaged fixtures.
- B. Test fixtures to demonstrate operation. Replace malfunctioning units and retest.
- C. Adjust water pressure at faucets, shower valves, and flush valves to provide proper flow.
- D. Replace washers of leaking or dripping faucets and stops.

3.4 CLEANING:

- A. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials. Remove labels.
- B. Re-clean fixtures prior to owner occupancy.

3.5 PROTECTION:

- A. Provide protection covering for installed fixtures, water coolers, and trim.

3.6 MOUNTING HEIGHTS SCHEDULE:

- A. Typical mounting heights are noted below. Refer to architectural details for additional information and exact mounting locations.

<u>Fixture</u>	<u>Mounting Height</u>
Lavatory or Sink	31 inches floor to rim (34 inches for handicap)
Water Closet	15 inches floor to rim (16-3/4 inches for handicap)
Urinal	24 inches floor to lip (17 inches for handicap)
Drinking Fountain	42 inches floor to bubbler (36 inches for handicap)

END OF SECTION 22 4005

SECTION 230500 - MECHANICAL GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The "General Conditions", "Supplementary Conditions", Statutory Declarations, Special Conditions and Division 1 of the specifications as written and referred to are adopted and made part of Division 23.

1.2 SUBMITTALS:

- A. Submittals shall include the documents listed below:
 - 1. Certificates of Inspection and Approval.
 - 2. Qualifications of Superintendent.
 - 3. Warranties.
 - 4. List of proposed material manufacturers.
 - 5. Operating and Maintenance Manuals.
 - 6. Record electronic as-built drawings.

1.3 DESCRIPTION OF WORK:

- A. Provide equipment, labor, material, etc., required to make a complete working installation as shown or as specified.
- B. Equipment and materials used in the work shall be:
 - 1. In accordance with the contract documents.
 - 2. The best quality and grade for the use intended.
 - 3. New and unused.
 - 4. The manufacturer's latest standard or current model.
- C. All equipment and method shall be installed and connected in accordance with the best engineering practices and in accordance with the manufacturer's recommendations.
 - 1. Where the Engineer determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
 - 2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.
 - 3. Contractor is responsible for dimensions and sizes of equipment. Inform Architect in writing of equipment differing from that shown.
- D. Mechanical work includes, but is not limited to:
 - 1. Obtain all permits and inspections including: building permits and health department permits.
 - 2. Complete insulation on piping, ductwork and equipment.
 - 3. Complete the air cooled condensers.
 - 4. Complete air handling systems and ventilating systems.

5. Complete the ductwork.
6. Install devices furnished by the Temperature Controls sub-contractor.
7. Testing and Balancing will be by others.
8. Provide vibration isolation devices for all rotating or reciprocating equipment and piping connected to that equipment.
9. Provide roofing including flashing, and counter flashing for roof mounted equipment, roof penetrations and supports for work in this Division, unless noted otherwise.

1.4 UTILITY CONNECTIONS:

- A. Arrange with local utility companies for utility service connections, taps, meters and installation. Pay all fees and charges (if any) necessary for the utility services shown on the drawings or listed in the specifications.
- B. It is the responsibility of the Contractor to re-confirm with the Utility Companies, prior to bidding, that locations, arrangements, line sizes, pressures, interruptions, shut downs, etc. are in accordance with their regulations and requirements.
- C. If the utility company requirements are at variance with these drawings and specifications, this Contractor shall include the utility company requirements in his work without additional cost to the Owner.
- D. Obtain from Utility Company any additional charges for service of type, size and location called for. Include charges in bid to be paid by Contractor to appropriate party. Provide payment of these charges so as to allow logical progression of construction and avoid delay of completion.
- E. Should cost above not be available prior to bid, submit with bid a letter signed by responsible Utility Company personnel stating that cost is not available. Prime Contractor shall submit letter with his bid to Owner. Cost will then be omitted from contract and become responsibility of Owner.
- F. Furnish with shop drawings a signed document from each utility company describing location and type of service to be supplied and requirements for service. Document shall be signed by the appropriate responsible representative of the respective utility company.

1.5 WORK NOT INCLUDED:

- A. Finish painting of piping, ductwork or equipment.
- B. Electrical wiring and conduits shown on the electrical drawings.
- C. Asbestos removal.

1.6 RELATED WORK SPECIFIED ELSEWHERE:

- A. Electrical: Division 26.

1.7 REQUIREMENTS OF REGULATORY AGENCIES:

- A. Obtain and pay for all permits required for the work. Comply with all ordinances pertaining to work described herein.
- B. Install the work under this Division in accordance with drawings and specifications and the standards and codes (latest edition) that apply to this work. In the event of a conflict, install work in accordance with the most stringent code requirements determined by ![Architect (or) Engineer.]
- C. Arrange, pay for and complete work to pass required tests by agencies having authority over work. Deliver to Architect Certificates of Inspection and approval issued by authorities.

1.8 QUALIFICATION OF CONTRACTOR:

- A. Has completed minimum two projects same size and scope in past five (5) years.

- B. This qualification applies to Sub-Contractors.
- C. Use workmen experienced in their respective trade. Submit qualifications of Superintendent for review.
- D. Owner reserves right to reject bid of any Contractor failing to meet these qualifications.

1.9 **GENERAL JOB REQUIREMENTS:**

- A. Drawings and Specifications:
 - 1. Work for the mechanical trades are shown on the drawings series M (HVAC).
 - 2. Drawings and specifications are complementary. Work called for by one is binding as if called for by both.
 - 3. Drawings are drawn to a small scale and are diagrammatic only. The drawings indicate size and general arrangement of equipment.
 - 4. Do not scale drawings for exact locations. Refer to architectural drawings. Field measurements take precedence.
- B. Provide necessary offsets, elbows and fittings as required to avoid conflict with equipment of other Divisions and to obtain proper headroom and clear passageways. This shall be done at no additional cost to the Owner.
- C. Visit to Site/Work in other Division:
 - 1. Examine not only the plans and specifications for this Division, but plans and specifications of the other Divisions of work and visit the site to become acquainted with existing conditions. Execution of Contract is evidence that Contractor has examined all drawings and specifications, and that all conditions which have a bearing in any way on the manner of installing the work in this Division are known. Later claims for labor and materials required due to difficulties encountered, which could have been foreseen had examination been made, will not be recognized.
- D. Underground Utilities/Concealed Utilities:
 - 1. All utilities and services, whether shown on the drawings or not, shall be suitably protected and maintained, and any damages thereto shall be promptly repaired. Owner shall be advised immediately of any damages sustained. If any extra expense is incurred due to the existence of buried utilities not shown on the drawings, or the location of which is not made known to the Contractor, the contract price shall be adjusted in accordance with the General Conditions. The Contractor shall advise the Owner three (3) days in advance of any operation which could possibly disrupt any underground utility. The Contractor shall utilize locator services to mark any underground utilities in the area he is working in, and shall make any other measure deemed necessary to avoid utility disruption.
- E. Definitions:
 - 1. Concealed: Materials or systems not visible. Work installed above a ceiling, furred behind a wall or enclosed in a chase.
 - 2. Exposed: Materials or systems that are visible. Work installed in a room without a ceiling. Work not enclosed by walls.
 - 3. Provide: Furnish, install and make complete.
 - 4. Install: Receive, unload, move into place, and make connections.
 - 5. Work: Materials completely installed and connected.
 - 6. ADC: Air Diffusion Council.
 - 7. AGA: American Gas Association.

8. AMCA : Air Movement and Control Association.
9. ANSI: American National Standard Institute.
10. API: American Petroleum Institute.
11. ARI: American Refrigeration Institute.
12. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
13. ASME: American Society of Mechanical Engineers.
14. ASTM: American Society of Testing Materials.
15. AWS : American Welding Society.
16. FM: Association of Factory Mutual Fire Insurance Company.
17. INT'L: Building Code, Gas Code, Mechanical Code, Plumbing Code.
18. MSS: Manufacturer's Standard Society of the Valve and Fittings Industry, Inc.
19. NEC: National Electrical Code.
20. NEMA: National Electrical Manufacturer's Association.
21. NFPA: National Fire Protection Association.
22. NRCA : National Roofing Contractors Association.
23. OSHA: Occupational Safety and Health Act.
24. SMACNA: Sheet Metal and Air Conditioning Contractors National Association.
25. UL: Underwriters Laboratories.

F. Workmanship, Warranty and Acceptance:

1. Work under this Division shall be first class with emphasis on neatness and workmanship.
2. Install work using competent mechanics, under supervision of foreman, all duly certified by local authorities. Installation subject to Architect's or Engineer's observation, final approval, and acceptance. Architect or Engineer may reject unsuitable work.
3. Furnish Architect written warranty, stating that if workmanship and/or materials executed under this Division is proven defective within one (1) year after final acceptance, such defects and other work damaged will be repaired and/or replaced.
4. In event that project is occupied or system placed in operation in several phases at Owner's request, warranty will begin on date each system or item of equipment is accepted by Owner.

G. Observations of Work and Demonstration of Operation:

1. When observations are scheduled, provide sufficient personnel to expedite removal of access doors, coverplates, manholes covers, etc.
2. Contractor to assist Architect or Engineer in demonstration of operation of new systems to satisfaction of Owner. Contractor to have manpower available for demonstration of systems where requested by Owner.

H. Materials and Substitutions:

1. All materials shall be new. All materials and equipment for which a UL Standard, an AGA approval, an AWWA standard, FM listing or ASME requirements is established, shall be so

approved and labeled or stamped.

2. Wherever in these specifications products are specified by manufacturer's name, bids shall be based on the named products. Where more than one manufacturer's name is mentioned, the one first listed establishes the standard for that product. If the bidder desires to submit a product of a manufacturer other than that listed first, it must be the equivalent of the one listed first.
 3. The drawings are based on the use of products specified and listed first. If any revision in piping, conduit work, foundations, anchor bolts, connections, etc., is required by other named products or approved substitutions, it shall be the Contractor's responsibility to make such revisions at no additional expense to the Owner.
 4. If any bidder desires to submit products of manufacturers not listed, he may submit a request for prior approval to the Engineer no later than 10 days prior to the bid date. If the Engineer decides to accept the manufacturers, they will be listed as "Approved" by written addendum.
 5. If the manufacturers are not listed as approved either by addendum or in the specifications, they will not be accepted.
 6. Submit to ![Architect (or) Engineer] a complete list of proposed material manufacturers. List does not preclude submission of shop drawings. Approval of manufacturer or list does not constitute approval of specific material or equipment.
- I. Operating and Maintenance Manuals:
1. Provide maintenance and operating manuals bound in 8-1/2" x 11" hardback, three-post binders. Manuals shall contain written instructions for each system, shop drawings, schematic drawings, equipment catalog cuts, manufacturer's instructions, manufacturers warranties, and valve tag list.
 2. Arrange information in the following sequence: title of job, Owner, address, date of submittal, name of Contractor, name of Engineer, index, shop drawings, operating instruction, Contractor's purchase order numbers, supplier's name and address, date of start-up of each piece of equipment and valve tag list.
 3. Submit one (1) copy for review. Make required corrections, and submit two (2) record copies.
- J. Record As-Built:
1. Provide Record as-builts at the completion of job. Keep set of prints on job and record day to day changes to Contract drawings with red pencil. Indicate actual location of piping, ductwork, valves, dampers, and equipment. Turn over prints to Architect at final observation.
 2. Provide the following items for Owner at time of substantial completion:
 - a. Certificates of inspection and approval from authorities having jurisdiction.
 - b. Warranties.
 - c. Record as-built electronic plans in auto cad format.
 - d. Operating and Maintenance Manuals - PDF Files.
 - e. Spare Parts (furnish receipt).
 - f. Affidavit of Owner Instruction (1 copy).
 - g. Release of Liens.

1.10 PROTECTION AND STORAGE:

- A. Provide warning lights, bracing, shoring, rails, guards and covers necessary to prevent damage or injury.

- B. Protect all equipment and materials, from damage by weather, entrance of water or dirt. Cap open piping, use plastic covers made for that purpose. Do not use rags or construction debris.
- C. Avoid damage to materials and equipment in place. Repair, or remove and replace damaged work and materials.
- D. Protect all surfaces from weld spatter, solder and cutting oil.
- E. Deliver equipment and materials to job site in original, unopened, labeled container. Store to prevent damage and injury. Store ferrous materials to prevent rusting. Store finished materials and equipment to prevent staining and discoloring. Store materials affected by condensation in warm dry areas. Provide heaters. Storage space on site and in building designated by Owner/Architect.

END OF SECTION 230500

SECTION 230505 - MECHANICAL SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY:

- A. This Section includes procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

1.3 DEFINITIONS:

- A. Action Submittals: Written and graphic information that requires Engineer's through the Architect responsive action.

1.4 SUBMITTAL PROCEDURES:

- A. General: Electronic copies of CAD Drawings of the Contract Drawings will not be provided by Engineer for Contractor's use in preparing submittals.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Submittals Schedule: Comply with requirements in Division 1 for list of submittals and time requirements for scheduled performance of related construction activities.
- D. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal.
 - 1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer through the Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Concurrent Review: Where concurrent review of submittals by other consultants, Owner, or other parties is required, allow 21 days for initial review of each submittal.
 - a. Division 23 equipment requiring electrical connection
 - 3. If intermediate submittal is necessary, process it in same manner as initial submittal.
 - 4. Allow 15 days for processing each resubmittal.
 - 5. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.
- E. Identification: Place a permanent label or title block on each submittal for identification.
 - 1. Indicate name of firm or entity that prepared each submittal on label or title block.
 - 2. Provide a space approximately 4 by 5 inches on label or beside title block to record

Contractor's review and approval markings and action taken by Engineer.

3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name and address of Contractor.
 - e. Name and address of Sub-Contractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Unique identifier, including revision number.
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Other necessary identification.

- F. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.

- G. Number of Copies:
 1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.
 2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.

- H. Transmittal:
 1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
 2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
 3. Transmittal Form: Provide locations on form for the following information:
 - a. Project name.
 - b. Date.
 - c. Destination (To:).
 - d. Source (From:).
 - e. Names of subcontractor, manufacturer, and supplier.
 - f. Category and type of submittal.
 - g. Submittal purpose and description.
 - h. Submittal and transmittal distribution record.
 - i. Remarks.
 - j. Signature of transmitter.

- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

- J. Use for Construction: Use only final submittals with mark indicating action taken by Engineer in connection with construction.

PART 2 - PRODUCTS

2.1 SUBMITTALS:

- A. General: Prepare and submit Submittals required by individual Specification Sections.
 1. Number of Copies: Submit copies of each submittal, unless otherwise indicated. Engineer through Architect will return copies. Mark up and retain one returned copy as a Project

Record Document.

- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Manufacturer's catalog cuts.
 - f. Wiring diagrams showing factory-installed wiring.
 - g. Printed performance curves.
 - h. Operational range diagrams.
 - i. Mill reports.
 - j. Standard product operating and maintenance manuals.
 - k. Compliance with recognized trade association standards.
 - l. Compliance with recognized testing agency standards.
 - m. Application of testing agency labels and seals.
 - n. Notation of coordination requirements.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Shopwork manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Design calculations.
 - j. Compliance with specified standards.
 - k. Notation of coordination requirements.
 - l. Notation of dimensions established by field measurement.
 2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
 3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-½ by 11 inches, but no larger than 30 by 40 inches.
 4. Number of Copies: Submit one correctable, translucent, reproducible print and one blue- or black-line print of each submittal. Engineer through Architect will return the reproducible print.
 5. Number of Copies: Submit 6 prints where prints are required for operation and maintenance manuals. Engineer and Architect will retain one print each; remainder will be returned.

PART 3 - EXECUTION**3.1 GENERAL:**

- A. Review of submittals by Engineer is to insure general quality conformance with the contract documents. The contractor assumes all responsibility for dimensions, quantities, conditions that pertain to the fabrication and installation, and for processes and techniques of construction.

- B. Review of submittals or shop drawings by Engineer does not relieve Contractor of responsibility for errors or omissions during the submittal process. Submittal review does not relieve the contractor of any obligation in the contract documents.
- C. Products of one manufacturer have been scheduled or specified as the basis of design. Any modifications to ductwork, piping, wiring, building structure, etc. that results from the use of any other products shall be coordinated by this contractor with all trades prior to delivery of approved product from the manufacturer. All modifications required shall be performed without incurring any additional cost to the Contract. Contractor shall document all modifications on the as-built record plans.

3.2 CONTRACTOR'S REVIEW:

- A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.3 ENGINEER'S ACTION:

- A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
 - 1. Approved - Fabrication/Installation may be undertaken.
 - 2. Approved as Noted - Fabrication/Installation may be undertaken.
 - 3. Revise and Resubmit - Fabrication/Installation MAY NOT be undertaken. In resubmitting, limit corrections to items marked.
 - 4. Rejected - Fabrication/Installation MAY NOT be undertaken. In resubmitting, limit corrections to items marked.
- C. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION 230505

SECTION 23 0510 - BASIC MATERIALS AND METHODS**PART 1 - GENERAL****1.1 DESCRIPTION OF WORK:**

- A. Provide equipment, labor, materials, etc. required to make a complete working installation as shown or as specified.

1.2 SUBMITTALS:

- A. Provide submittals for:
1. Access panels
 2. Sound stopping
 3. Piping seals

PART 2 - PRODUCTS**2.1 CONCRETE HOUSEKEEPING PADS:**

- A. Concrete shall be 3000 psi at 28 days minimum.

2.2 ACCESS PANELS:

- A. Access panels shall have welded steel frame, one piece doors, and self latching door locks.
- B. Panels shall be Milcor, Cesco, Karp or prior approved equal. Milcor model numbers are cited as examples.

<u>Construction or Material Surface</u>	<u>Model No.</u>
Fire rated walls or ceiling 1-1/2 Hr, B-Label 16 ga frame, 20 ga door	Fire Rated-Primer Finish
Drywall walls and ceilings 16 ga frame, 14 ga door panel	DW primer finish
Plaster walls and ceilings 16 ga frame, 14 ga door	K - primer finish
Masonry and Tile	M - primer finish MS - stainless steel

- C. Locks: Standard locks shall be screw driver operated with case hardened steel cam.

2.3 FIRESTOPPING AND SOUNDSTOPPING:

- A. Penetration Sealants:
1. Flame Stop Distribution, Inc., Flame Stop V.
 2. 3M Brand "Fire Barrier" CP 25 WB Caulk
 3. 3M Brand Moldable Putty "Pads" and Moldable Putty MPS-2 "Stix"
- B. Sound stopping material shall be .75 lb per cu. ft. density fiberglass.
- C. Other acceptable manufacturer's include GE "Pensil", Dow Corning, Hilti.

2.4 PIPING SEALS:

- A. Thunderline Corp. "Link Seal" LS Series.

2.5 MISCELLANEOUS STEEL:

- A. ASTM A-36 Structural Steel

2.6 PIPE SLEEVES:

- A. Sleeves in concrete walls, floors or masonry - Sch 40 steel pipe, machine cut.
- B. Sleeves in gypsum board or plaster walls - 14 gauge, rolled galvanized sheet metal. Tack welded on the longitudinal seam.

2.7 WALL AND CEILING PLATES:

- A. Beaton and Cadwell, Keeney or Grinnell, nickel plated steel, split plates with set screw.

2.8 FLOORPLATE:

- A. Concrete floor plate, Grinnell figure 400.

PART 3 - EXECUTION

3.1 CONCRETE HOUSEKEEPING PADS:

- A. Provide concrete housekeeping pads under all floor mounted equipment, pipe support and duct supports and where indicated.
- B. Housekeeping pads shall be not less than 3 ½ thick, sized at least 8 in. larger than the equipment.
- C. Pads shall be doweled to floor with not less than 4 No. 4 bars grouted in place.
- D. Pads shall have chamfered edges.
- E. Pads shall receive a broom finish.

NOTE: Anchor bolts for equipment shall be poured integral with the pad.

- F. Pads shall be reinforced with at least one No. 4 bar (stirrups).

3.2 ACCESS PANELS:

- A. Provide access panels in walls and ceilings as needed to allow access to valves, equipment, shock absorbers, trap primers, etc. and where noted.
- B. Access doors shall be selected for the type of wall or ceiling where needed.

3.3 FIRE STOPPING AND SOUND STOPPING:

- A. Provide penetrations for piping through floors and walls for work under this contract.
- B. Penetrations through floors and fire resistant walls shall be sealed to the rated fire resistance equal to the wall. Installation shall be done by a qualified installer, approved by the manufacturer.
- C. Provide sound proofing through non-rated walls.

3.4 WATER STOP PIPE SEALS:

- A. Provide modular, resilient seals around pipes penetrating all exterior walls, and floors below grade.

3.5 ANCHORS:

- A. Mount all equipment, brackets, hangers, anchors, etc. to safely resist the vibration or thrust forces and support the unit's weight.

- B. Floor mounted rotating or vibrating equipment shall be anchored to the floor using grouted-in-place or cast-in-place anchor bolts with three inch hook and sleeve. Anchor bolts shall be of the size recommended by the manufacturer.
- C. Floor mounted static items, wall and ceiling mounted equipment bracket and hangers shall be installed using drilled anchors or cast in place inserts. Anchors shall be Phillips Drill Company "Red Head" or Multi-Set II. Size anchors and inserts for four times the applied load. Bolts used outdoors or in a wet environment shall be hot dip galvanized.

3.6 PIPE SLEEVES:

- A. Provide pipe sleeves where pipes pass through floors and walls above or below ceilings. Provide pipe sleeves in new walls and floors as the work progresses. Provide split pipe sleeves in new walls built up around existing pipes. Tack weld split sleeves together.
- B. Size pipe sleeves to allow continuous insulation, but not less than two pipe sizes larger than pipe.
- C. Sleeves in walls shall be flush with wall, sleeves in floors shall extend 3/4 inches above floor and be flush with structure below.

3.7 SOUND LEVELS:

- A. Select diffusers, grilles, terminal boxes, and equipment so as not to exceed the NC curve rating for the various areas. Equipment and materials furnished shall be rated in accordance with the sound power tests measured in accordance with ASHRAE Standard 36B-63. Room attenuation and ceiling transmission loss shall depend on the spaces and architectural finishes.
- B. Attenuation allowances shall be as follows unless scheduled otherwise:

Acoustical tile	-4dB
Plaster ceiling	-1dB
5/8 in. gypsum ceiling	-1dB
Room attenuation effect	-8dB
- C. Air performance tests shall be conducted in accordance with Air Diffusion Council (ADC) Equipment Test Code 1062 RI and ratings approved by the ADC.

3.8 WALLS AND FLOOR PLATES:

- A. Provide plates around pipes extending into exposed areas where they pass through walls, floors and ceilings. Size plates to completely cover pipe sleeves.

3.9 FLASHING:

- A. Provide flashing at piping and duct penetrations through roof and roof mounted structures furnished under this Division. Flash in accordance with roofing manufacturers details.
- B. Flashing materials shall be in accordance with the roofing manufacturers system 20 oz copper or .040 in. aluminum or 20 ga galvanized steel.
- C. Provide flashing at pipes passing through floors with waterproof membrane. Flashing shall be in accordance with waterproofing manufacturer's details.

3.10 ROOF TOP WORK:

- A. Protect roof surface by using plywood walkouts, work platforms, and cribbing during construction.
- B. Provide counterflashing unless specifically included in the work of another Division. Counterflashing shall be in accordance with roof manufacturers instructions such that roof warranty is maintained.
- C. Provide a certificate of inspection from the roof manufacturer stating that the roof has been repaired in accordance with their specifications and that the warranty remains in effect.

3.11 EQUIPMENT IDENTIFICATION:

- A. Stencil on the equipment the functional name and equipment number of each piece of equipment as it is scheduled, i.e. pumps, tanks, fans, chillers, air handling units, water softeners, etc.
- B. Stencil letters shall be black 1 in. high, located on a white background.
- C. Fasten nameplates to equipment in a conspicuous location using self-tapping stainless steel screws, except use contact epoxy adhesive where screws cannot or should not penetrate substrate.

3.12 WORKMANSHIP:

- A. Pipe size changes shall be made at reducing fittings. Bushings shall not be used.
- B. Blowout or flushout all lines prior to final connection or start-up, to remove foreign matter.
- C. Make allowance in piping for expansion and contraction, for installation of insulation and to avoid air pockets.
- D. Do not tap small pipes into larger pipes. Provide fittings or reinforced branch connections.
- E. Cut pipes ends square, ream and de-burr. Cut threads clean and sharp. Pipe threads shall conform to ANSI B 2.1.
- F. Pull up threaded fittings to a tight fit with an approved good quality pipe joint compound applied to male threads.
- G. Inspect screwed joints for leakage and remake each joint that appears to be faulty. Do not wait for rust to form. Clean threads on both parts apply compound and remake joints.
- H. Clean piping strainers after start-up by removing strainer screen and wire brushing.
- I. Conceal pipes in pipe shafts, partitions and furred spaces except where otherwise distinctly indicated on the drawings. Each riser shall be separately valved.
- J. Install NO piping in electrical switchgear room, transformer vaults, telephone rooms or electrical closets. Provide drip pans under drain piping above electrical switchgear in mechanical rooms.
- K. Install piping in alignment with and parallel to the walls of the building. All risers shall be plumb.
- L. Support piping at the proper intervals. Adjust pipe hangers and supports for correct pitch and alignment. Brace piping systems which sway.
- M. Remove rust, scale, and foreign materials from equipment and renew any defaced surfaces. If equipment is marred, provide new materials.
- N. Protect insulation. Repair insulation that is damaged. Keep it dry and free of tears. Allow no punctures in vapor barrier. Insure good tape adhesion. Provide smooth surfaces in finished areas.
- O. Install ductwork to allow adequate clearance for maintenance. Locate fire dampers and access doors to allow replacement of fusible links. All dampers shall be accessible.
- P. All copper tubing shall be hard drawn unless noted otherwise. Annealed tubing where used shall be stretched, and installed with tool formed bends.

END OF SECTION 230510

SECTION 230514 - MOTOR STARTERS (Manual and Magnetic)

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. The work included in this specification consists of providing manual and magnetic motor starters for all Division 15 equipment with electric motors, except equipment furnished with factory mounted starters.

1.2 CODES AND STANDARDS

- A. NFPA-70 National Electrical Code
- B. NECA - Standard of Installation

1.3 SUBMITTALS:

- A. Manufacturers data including:
1. Master wiring diagrams.
 2. Elementary or control schematics.
 3. Interior elevation of unit.
 4. Exterior elevation.
 5. Coordination wiring and control interface with external devices.
 6. Outline drawings to locate conduit rough-ins.
 7. Component descriptions (panels, switches, pilot lights)
- B. Performance Data:
1. Protective Devices
 2. Capacity

PART 2 - PRODUCTS

2.1 GENERAL:

- A. All motor starters shall be rated for 600 volts, and complete with thermal overload protection in each ungrounded phase conductor.
- B. Units shall be shipped to job site without overload elements. Overload elements shall be furnished based on the full load current of motor actually installed.
- C. Enclosure shall be ANSI/NEMA type 1 and 3R. Enclosure shall be oversized.
- D. Power and control wiring within the starter shall be copper. Power wiring shall be sized and selected in accordance with NEC. Control wiring shall be a minimum of #16 AWG stranded, 90 degree C MTW or equivalent.
- E. Magnetic Type Motor Starter:
1. Coil operating voltage, 120 volts. 60Hz encapsulated type.
 2. Auxiliary contacts (two) field convertible in addition to seal-in contact.
 3. Rotary selector switch, (Hand-Off-Auto)
 4. Control power transformer 120 volt secondary for each motor starter. Provide fused primary and secondary, and bond unfused leg of secondary to enclosure. Transformer shall be selected for 100 VA greater capacity than required for contactor coil operation (unless noted otherwise).
 5. Indicating pilot lights shall be red (off) and green (running).

2.2 MANUAL MOTOR STARTER (INTEGRAL HORSEPOWER)

- A. NEMA AC general purpose Class A, manually operated full-voltage controller with overload element, NO auxiliary contact and push button operator.
- B. Starter shall be Square D Class 2510, 2511, or 2512 type M, Allen Bradley and General Electric are approved equals.

2.3 MANUAL MOTOR STARTER (FRACTIONAL HORSEPOWER)

- A. NEMA AC general-purpose Class A manually operated, full-voltage starter for fractional horsepower induction motor with thermal overload, red pilot light and toggle operator.
- B. Starter shall be Square D Class 2510, 2511 or 2512 type F. Allen Bradley and General Electric are approved equals.

2.4 FULL VOLTAGE NON-REVERSING:

- A. NEMA AC general-purpose Class A magnetic motor starter for induction motors rated in horsepower.
- B. Contacts shall be totally enclosed, double-break type. Wiring shall be straight through with all terminals clearly marked.
- C. NEMA with one-piece thermal unit construction. Thermal units shall be interchangeable. Overload relay control circuit contact shall be replaceable. Thermal units shall be required for starter to operate.
- D. Starter shall be Square D Class 8536 Type S. Allen Bradley and General Electric are approved equals.

2.5 FULL VOLTAGE-REVERSING

- A. NEMA AC general-purpose Class A magnetic motor starter for induction motors rated in horsepower.
- B. Contacts shall be totally enclosed, double-break type. Wiring shall be straight through type with all terminals clearly marked.
- C. NEMA with one-piece thermal unit construction. Thermal units shall be interchangeable. Overload relay control circuit contact shall be replaceable. Thermal units shall be required for starter to operate.
- D. Include electrical interlock [and integral time delay transition] between FORWARD and REVERSE rotation. Starters shall be electrically and mechanically interlocked to prohibit both starters being energized simultaneously.
- E. Contacts: Totally enclosed, double-break, silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.
- F. Wiring: Straight-through wiring with all terminals clearly marked.
- G. Overload Relay: NEMA with one-piece thermal unit construction. Thermal units shall be interchangeable. Overload relay control circuit contact shall be replaceable. Thermal units shall be required for starter to operate.
- H. Starter shall be Square D Class 8736 Type S. Allen Bradley and General Electric are approved equals.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Furnish motor starters for all motors unless noted otherwise.

3.2 INSTALLATION

- A. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed controllers plumb. Provide supports in accordance with Section 16190.

- C. Height: 5 ft (1.6 M) to operating handle.
- D. Install fuses in fusible switches.
- E. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- F. Provide engraved plastic nameplates.
- G. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

END OF SECTION 230514

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SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This section specifies the requirements and procedures for total mechanical systems testing, adjusting, and balancing (T/A/B) as required to meet design specifications, plus recording and reporting the results.
- B. Prior to acceptance and before final inspection, test and balance the air and water systems as listed herein and as specified hereinafter and submit reports as specified hereinafter.
- C. The mechanical contractor has numerous responsibilities associated with the test and balance, it is imperative that the test and balance contractor coordinate these responsibilities with them.
- D. Test, adjust, and balance the following mechanical systems:
 - 1. Supply air systems, all pressure ranges
 - 2. Return air systems
 - 3. Exhaust air systems
 - 4. Air Cooled Chillers
 - 5. Boilers
 - 6. Pumps & Hydronic systems
 - 7. Verify temperature control system operation
- E. This Section does not include:
 - 1. Testing boilers and pressure vessels for compliance with safety codes;
 - 2. Specifications for materials for patching mechanical systems;
 - 3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.

1.2 CODES AND STANDARDS:

- A. Applicable publications: The following publications form a part of this specification, to the extent that they represent minimum standards. Where this specification exceeds these standards, this specification shall be followed.
- B. Associated Air Balance Council (AABC) National Standards or Field Measurement and Instrumentation, latest edition.
- C. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook Fundamentals, latest edition.
- D. Chapters on Testing, Adjusting, and Balancing of Environmental Systems and Related Subjects, ASHRAE Handbook Systems, latest edition.
- E. National Environmental Balancing Bureau (NEBB)
- F. Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, latest edition.
- G. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) HVAC System Testing, Adjusting and Balancing, latest edition.

1.3 QUALIFICATIONS FOR TEST AND BALANCE CONTRACTOR:

- A. The test and balance contractor shall be an independent contractor that regularly performs air and water systems testing and balancing. Minimum qualifications for acceptance shall be general membership in NEBB or AABC, except that affiliation with manufacturers, installing, contractors, or

engineering firms may not preclude acceptance.

- B. Supervisor directly in charge of the water and air testing and balancing work shall be a registered professional engineer, in the state where the project is located, with not less than five (5) years experience in the mechanical contracting industry and not less than two (2) years experience in testing and balancing of heating, ventilating, and air conditioning systems. The supervisor shall stamp the title page of the test and balance report with his professional engineer's stamp.
- C. The supervisor and the lead test and balance mechanic shall be certified as test and balance technicians by one or more of the following groups, AABC, NEBB, SMACNA, ASHRAE, or the Sheet Metal Workers Union.
- D. Instrument calibration: Calibrate all instruments required for air and water balancing within a period of six months prior to their use on this project, per NEBB or AABC standards and the instrument manufacturers.
- E. Tests shall be conducted in presence of the Architect-Engineer and/or the Owner or their representatives. Notify the Architect-Engineer and Owner in writing five working days before the start of testing.

1.4 **DEFINITIONS:**

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to increase or reduce fan speeds or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including sub-mains, branches, and terminals, according to design quantities.
- C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- E. Report Forms: Test data sheets for recording test data in logical order.
- F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- K. Test: A procedure to determine quantitative performance of a system or equipment.
- L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.
- M. AABC: Associated Air Balance Council.
- N. AMCA: Air Movement and Control Association.
- O. ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
- P. NEBB: National Environmental Balancing Bureau.
- Q. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.5 SUBMITTALS:

- A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the Testing, Adjusting, and Balancing Agent and this Project's Testing, Adjusting, and Balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
- B. Contract Documents Examination Report: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.
- C. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.
- D. Certified Testing, Adjusting, and Balancing Reports: Submit 8 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
- E. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.
- F. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

1.6 QUALITY ASSURANCE:

- A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.
- B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports
 - 2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
- C. Testing, Adjusting, and Balancing Reports: Use testing, adjusting, and balancing Agent's standard forms approved by the Engineer.
- D. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.
- E. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.7 COORDINATION:

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.
- B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.
- C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)**PART 3 - EXECUTION****3.1 THE MECHANICAL CONTRACTOR'S RESPONSIBILITIES:**

- A. Furnish the test and balance contractor one complete set of accepted equipment data and one complete set of accepted mechanical shop drawings.

- B. The mechanical contractor shall be responsible for advising the test and balance contractor of any change(s) made to the system(s) during the construction process.
- C. Mechanical contractor shall provide drawings, specifications, shop drawings, control diagrams, etc. detailing the change(s) to the test and balance contractor.
- D. Replace and/or install pulleys, belts, dampers and trim pump impellers as required for the correct balance as directed by the test and balance contractor.
- E. Existing air systems having variable pitch pulleys shall have them replaced with fixed pitched pulleys prior to final; acceptance. Belts and pulleys shall be provided as directed by test and balance contractor.
- F. Allocate time in the construction schedule for test and balance procedure.
- G. Assist the test and balance contractor in coordinating work with the other trades.
- H. Place all systems and necessary allied devices required, and only those required, for each working day of the testing and balancing procedures into "Full Call" operation. At the completion of the testing and balancing procedures for the day, the mechanical contractor shall return the systems to normal operation or shut them down.
- I. Prepare the air side system for testing and balancing as follows, (all new and existing devices are included):
 - 1. Mechanically check all rotating air devices, to insure that the devices are capable of operation under normal design modes and have correct rotation and the related automatic controls are functional and calibrated.
 - 2. All balancing, splitter, volume, fire and smoke control, and V.A.V. dampers shall be in their respective neutral position or fully open. All locking devices shall be functional and secured.
 - 3. All air distribution inlet and outlet devices (i.e., grilles, registers, diffusers, and etc.) shall be fully open. All locking devices shall be functional and secured.
 - 4. All automatic controls (i.e., direct digital, electronic, electric, pneumatic, hydraulic and/or any combination thereof) shall be mechanically and electrically checked and be available to operate under design conditions.
 - 5. Air control locking devices (i.e., control rods, quadrants, and etc.) shall be permanently marked to represent the true position of their respective control surfaces. The locking devices markings shall be inconspicuous in occupied areas.
 - 6. Install new air filters before the start of testing and as directed by the test and balance contractor in order to meet design conditions of the air handling devices. Provide air control devices, such as balancing dampers, as per the drawings and specifications, and as directed by the test and balance contractor in order to obtain the proper balance conditions.
 - 7. Mechanically check variable volume air devices for all operational modes. Verify devices operate, no loose linkage, damper blades, parts move freely as intended.
- J. Prepare the water side of systems for testing and balancing as follows (all new and existing devices are included):
 - 1. Open all balancing and normally open isolation valves to the full open position. Control valves shall be fully open to their coils. Close all bypass valves. All line strainers shall be removed and cleaned.
- K. Check and verify that all manual and automatic air vents and the expansion tank and water fill systems are installed and operating properly. Verify that systems are full of water and not air bound.
- L. The system's operational cost during testing and balancing procedures is the Owner's responsibility.

3.2 EXAMINATION:

- A. Examine Contract Documents to become familiar with project requirements and to discover conditions

in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers are installed as required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- E. Examine system and equipment test reports.
- F. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- G. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- H. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.
- J. Examine plenum ceilings, utilized for supply or return air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- K. Examine strainers for clean screens and proper perforations.
- L. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine piping system pumps to ensure absence of entrained air in the piping.
- O. Examine equipment for installation and for properly operating safety interlocks and controls.
- P. Examine Building Automation System and automatic temperature control system components to verify the following:
1. Dampers, valves, and other controlled devices operate by the intended controller.
 2. Dampers and valves are in the position indicated by the controller.
 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in mixing boxes, and variable-air-volume terminals.

4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 6. Sensors are located to sense only the intended conditions.
 7. Sequence of operation for control modes is according to the Contract Documents.
 8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 9. Interlocked systems are operating.
 10. Changeover from heating to cooling mode occurs according to design values.
- Q. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.3 PREPARATION:

- A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 1. Permanent electrical power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so design conditions for system operations can be met.

3.4 GENERAL TESTING AND BALANCING PROCEDURES:

- A. Perform testing and balancing procedures on each system according to the procedures contained in *ASHRAE Applications Handbook* Chapter 39, AABC or NEBB national standards and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
- C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.5 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES:

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.

- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Check the airflow patterns from the outside air louvers and dampers and the return and exhaust air dampers, through the supply fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and verify they are functional.
- K. Check for proper sealing of air handling unit components.

3.6 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES:

- A. The procedures in this Article apply to constant-volume supply, return, and exhaust air systems. Additional procedures are required for variable-air-volume systems and process exhaust air systems. These additional procedures are specified in other articles in this Section.
- B. Adjust fans to deliver total design airflow within the maximum allowable rpm listed by the fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each air handling unit component.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices under final balanced conditions.
 - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. The Contractor shall make recommended corrective changes to align design and actual conditions.
 - 5. Adjust fan speed higher or lower than design, as necessary to attain design flow and pressure values. The Contractor shall make required replacements or adjustments to pulleys and belts to accommodate fan-speed changes.
 - 6. Do not make fan speed adjustments that result in motor overload. Consult equipment manufacturers about fan speed safety factors. Modulate dampers and measure fan motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower. The Contractor shall replace any equipment that does not perform as stated in the submitted product literature.
- C. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to design airflows within specified tolerances.
 - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

- a. Where sufficient space in sub-mains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
- 2. Remeasure each sub-main and branch duct, after all have been adjusted. Continue to adjust sub-mains and branch ducts to design airflows within specified tolerances.
- D. Measure terminal outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.
- E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.
 - 1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 VARIABLE-AIR-VOLUME SYSTEMS' ADDITIONAL PROCEDURES:

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set outside air dampers at minimum, and return and exhaust air dampers at a position that simulates full cooling load.
 - 2. Select the terminal unit that is most critical to the supply fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge duct losses.
 - 3. Measure total system airflow. Adjust to within 10 percent of design airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use the terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 - 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return air ducts and inlets as described for constant volume air systems.
 - 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply air sensing station to ensure adequate static pressure is maintained at the most critical unit.
 - 8. Record the final fan performance data.

3.8 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS:

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check expansion tank liquid level.
 - 3. Check makeup water station pressure gage for adequate pressure for highest vent.
 - 4. Check flow control valves for specified sequence of operation and set at design flow.
 - 5. Set differential pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive displacement type, unless several terminal valves are kept open.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.
 - 7. Check pump motor load. If motor is overloaded, throttle main flow balancing device so motor nameplate rating is not exceeded.
 - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.9 HYDRONIC SYSTEMS' BALANCING PROCEDURES:

- A. Determine water flow at pumps. Use the following procedures, except for positive displacement pumps:
 - 1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.
 - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head capacity curve. Adjust pump discharge valve until design water flow is achieved.
 - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 - 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 - 1. System components that have C_v rating or an accurately cataloged flow pressure drop relationship may be used as a flow indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.
- E. Adjust balancing stations to within specified tolerances of design flow rate as follows:
 - 1. Determine the balancing station with the highest percentage over design flow.
 - 2. Adjust each station in turn, beginning with the station with the highest percentage over

design flow and proceeding to the station with the lowest percentage over design flow.

3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.10 **MOTORS:**

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer, model, and serial numbers.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating if high-efficiency motor.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.11 **CHILLERS:**

- A. Balance water flow through each evaporator to within specified tolerances of design flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
 1. Evaporator water entering and leaving temperatures, pressure drop, and water flow.
 2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by the chiller manufacturer.
 3. Power factor if factory-installed instrumentation is furnished for measuring kW.
 4. The kW input if factory-installed instrumentation is furnished for measuring kW.
 5. Capacity: Calculate in kW of cooling.

3.12 **CONDENSING UNITS:**

- A. Verify proper rotation of fans and measure entering and leaving air temperatures. Record compressor data.

3.13 **HEAT-TRANSFER COILS:**

- A. Water Coils: Measure the following data for each coil:
 1. Entering and leaving water temperatures.
 2. Water flow rate.
 3. Water pressure drop.
 4. Dry-bulb temperatures of entering and leaving air.

5. Wet-bulb temperatures of entering and leaving air.
6. Airflow.
7. Air pressure drop.

3.14 TEMPERATURE TESTING:

- A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature control system.
- B. Measure indoor wet and dry bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside air wet-bulb and dry-bulb temperatures.

3.15 TEMPERATURE CONTROL VERIFICATION:

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Verify free travel and proper operation of control devices such as damper and valve operators.
- F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.
- G. Confirm interaction of electrically operated switch transducers.
- H. Confirm interaction of interlock and lockout systems.
- I. Verify main control supply air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine if the system operates on a grounded or non-grounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.16 TOLERANCES:

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
 2. Air Outlets and Inlets: 0 to minus 10 percent.
 3. Heating Water Flow Rate: 0 to minus 10 percent.
 4. Cooling Water Flow Rate: 0 to minus 5 percent.

3.17 REPORTING:

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 **FINAL REPORT:**

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems. All data may not apply to all project devices. Provide data as applicable to the piece of equipment being tested.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of the instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to the certified field report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
- D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of testing, adjusting, and balancing Agent.
 - 3. Project name.
 - 4. Project location.
 - 5. Engineer's name and address.
 - 6. Contractor's name and address.
 - 7. Report date.
 - 8. Signature of testing, adjusting, and balancing Agent who certifies the report.
 - 9. Summary of contents, including the following:
 - a. Design versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 10. Nomenclature sheets for each item of equipment.
 - 11. Data for terminal units, including manufacturer, type size, and fittings.
 - 12. Notes to explain why certain final data in the body of reports vary from design values.
 - 13. Test conditions for fans and pump performance forms, including the following:
 - a. Settings for outside, return, and exhaust air dampers.

- b. Conditions of filters.
 - c. Cooling coil wet-bulb and dry-bulb temperature entering and leaving conditions.
 - d. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - e. Settings for supply air static pressure controller.
 - f. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
 2. Water flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
- F. Air Handling Unit Test Reports: For air handling units with coils include the following:
1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Sheave dimensions, center-to-center and amount of adjustments in inches.
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
 2. Motor Data: Include the following:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center and amount of adjustments in inches.
 3. Test Data: Include design and actual values for the following:

- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg..
 - f. Preheat coil static pressure differential in inches wg.
 - g. Cooling coil static pressure differential in inches wg.
 - h. Heating coil static pressure differential in inches wg.
 - i. Outside airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outside air damper position.
 - l. Return air damper position.
- G. Apparatus Coil Test Reports: For apparatus coils, include the following as applicable to the installed equipment:
1. Coil Data: Include the following:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch.
 - f. Make and model number.
 - g. Face area in sq. ft.
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 2. Test Data: Include design and actual values for the following:
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outside air wet-bulb and dry-bulb temperatures in deg F.
 - e. Return air wet-bulb and dry-bulb temperatures in deg F.
 - f. Entering air wet-bulb and dry-bulb temperatures in deg F.
 - g. Leaving air wet-bulb and dry-bulb temperatures in deg F.

- h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head.
 - j. Entering water temperature in deg F.
 - k. Leaving water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data: Include the following:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center and amount of adjustments in inches.
 - 2. Motor Data: Include the following:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center and amount of adjustments in inches.
 - g. Number of belts, make, and size.
 - 3. Test Data: Include design and actual values for the following:
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:
 - a. System and air handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area (sq. ft).
 - g. Design airflow rate in cfm.
 - h. Design velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

- J. Air Terminal Device Reports: For terminal units, include the following:
 1. Unit Data: Include the following:
 - a. System and air handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air terminal device make.
 - f. Air terminal device number from system diagram.
 - g. Air terminal device type and model number.
 - h. Air terminal device size.

 2. Test Data: Include design and actual values for the following:
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

- K. System Coil Reports: For reheat coils and water coils of terminal units, include the following:
 1. Unit Data: Include the following:
 - a. System and air handling unit identification.

- b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
2. Test Data: Include design and actual values for the following:
- a. Airflow rate in cfm.
 - b. Entering water temperature in deg F.
 - c. Leaving water temperature in deg F.
 - d. Water pressure drop in feet of head.
 - e. Entering air temperature in deg F.
 - f. Leaving air temperature in deg F.
- L. Packaged Chiller Reports: For each chiller, include the following:
- 1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Make and model number.
 - c. Manufacturer's serial number.
 - d. Refrigerant type and capacity in pounds.
 - e. Starter type and size.
 - f. Starter thermal protection size.
 - 2. Condenser Test Data: Include design and actual values for the following:
 - a. Refrigerant pressure in psig.
 - b. Refrigerant temperature in deg F.
 - 3. Evaporator Test Reports: Include design and actual values for the following:
 - a. Refrigerant pressure in psig.
 - b. Refrigerant temperature in deg F.
 - c. Entering water temperature in deg F.
 - d. Leaving water temperature in deg F.
 - e. Entering water pressure in feet of head.
 - f. Water pressure differential in feet of head.
 - 4. Compressor Test Data: Include design and actual values for the following:
 - a. Make and model number.
 - b. Manufacturer's serial number.
 - c. Suction pressure in psig.

- d. Suction temperature in deg F.
 - e. Discharge pressure in psig.
 - f. Discharge temperature in deg F.
 - g. Oil pressure in psig.
 - h. Oil temperature in deg F.
 - i. Voltage at each connection.
 - j. Amperage for each phase.
 - k. The kW input.
 - l. Crankcase heater kW.
 - m. Chilled water control set point in deg F.
 - n. Refrigerant low-pressure-cutoff set point in psig.
 - o. Refrigerant high-pressure-cutoff set point in psig.
5. Refrigerant Test Data: Include design and actual values for the following as applicable for the equipment installed:
- a. Oil level.
 - b. Refrigerant level.
 - c. Relief valve setting in psig.
 - d. Unloader set points in psig.
 - e. Percentage unloaded.
 - f. Bearing temperatures in deg F.
 - g. Low-temperature-cutoff set point in deg F.
- M. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units include the following:
- 1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Unit make and model number.
 - d. Manufacturer's compressor serial numbers.
 - e. Compressor make.
 - f. Compressor model and serial numbers.
 - g. Refrigerant weight in pounds.
 - h. Low ambient temperature cutoff in deg F.
 - 2. Test Data: Include design and actual values for the following as applicable to the equipment installed:
 - a. Inlet duct static pressure in inches wg.

- b. Outlet duct static pressure in inches wg.
 - c. Entering air dry-bulb temperature in deg F.
 - d. Leaving air dry-bulb temperature in deg F.
 - e. Control settings.
 - f. Unloader set points.
 - g. Low pressure cutout set point in psig.
 - h. High pressure cutout set point in psig.
 - i. Suction pressure in psig.
 - j. Suction temperature in deg F.
 - k. Condenser refrigerant pressure in psig.
 - l. Condenser refrigerant temperature in deg F.
 - m. Oil pressure in psig.
 - n. Oil temperature in deg F.
 - o. Voltage at each connection.
 - p. Amperage for each phase.
 - q. The kW input.
 - r. Crankcase heater kW.
 - s. Number of fans.
 - t. Condenser fan rpm.
 - u. Condenser fan airflow rate in cfm.
 - v. Condenser fan motor make, frame size, rpm, and horsepower.
 - w. Condenser fan motor voltage at each connection.
 - x. Condenser fan motor amperage for each phase.
- N. Pump Test Reports: For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.
- 1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head.

- h. Required net positive suction head in feet of head.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
2. Test Data: Include design and actual values for the following:
- a. Static head in feet of head.
 - b. Pump shutoff pressure in feet of head.
 - c. Actual impeller size in inches.
 - d. Full open flow rate in gpm.
 - e. Full open pressure in feet of head.
 - f. Final discharge pressure in feet of head.
 - g. Final suction pressure in feet of head.
 - h. Final total pressure in feet of head.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- O. Instrument Calibration Reports: For instrument calibration, include the following:
- 1. Report Data: Include the following:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.19 ADDITIONAL TESTS:

- A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

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SECTION 23 0700 - HVAC INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. All work covered in this section consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to piping, equipment, and ductwork.

1.2 DEFINITIONS:

- A. Exposed piping and ductwork is that which can be seen when the building is complete without opening or removing access door panels, or ceilings tiles. This also includes all mechanical equipment rooms and pipe tunnels.
- B. Concealed piping and ductwork are those elements above ceilings, in chases, interstitial space and pipe spaces. Other piping and ductwork is considered to be exposed.
- C. Exterior piping and ductwork is that which is exposed to the weather and/or outside the building envelope. Piping and ductwork protected by overhangs, areaways, etc., exterior to the building envelope are considered exterior.
- D. ASJ: All service jacket, white finish facing or jacket.
- E. Air conditioned space: Space directly supplied with heated or cooled air.
- F. Cold: Equipment, ductwork or piping handling media at design temperature of 60 degrees F or below.
- G. FRK: Foil reinforced kraft facing.
- H. FSK: Foil-scrim-kraft facing.
- I. Hot: Ductwork handling air at design temperature above 60 degrees F; equipment or piping handling media above 105 degrees F.
- J. Pcf: Density, pounds per cubic foot.
- K. Runout: Branch pipe connection up to one inch nominal size to a one terminal piece of equipment (fan coil, terminal box).
- L. Thermal conductance: Heat flow rate through materials.
 - 1. Flat surface: BTU per hour per square foot.
 - 2. Pipe or cylinder: BTU per hour per linear foot.
 - 3. Thermal conductivity (k): BTU per inch thickness, per hour, per square foot, per degree Fahrenheit temperature difference.

1.3 QUALITY ASSURANCE:

- A. Products of the manufacturers, herein, will be acceptable for use for the specific functions noted. All materials shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such materials in either the wet or dry state.
- B. Materials shall be applied subject to their temperature limits. Any methods of application of insulation materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.
- C. Insulation shall be applied by experienced workers regularly employed for this type work.

1.4 RATING:

- A. All insulation shall have composite surface burning characteristic rating as tested by ASTM E 84, UL 723, or NFPA 255 not exceeding:
- | | |
|-----------------|----|
| Flame Spread | 25 |
| Smoke Developed | 50 |
- B. Composite shall include insulation, jacketing and adhesive used to secure jacketing or facing. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement, tape and cloth shall have the same component rating as specified above.

1.5 **STANDARDS:**

- A. ANSI/ASHRAE Standard 90.1 - 2007 Energy Standard for Buildings Except Low-rise Residential Buildings.
- B. Midwest Insulation Contractors Association “Commercial and Industrial Insulation Standards” - Third Edition.

1.6 **SUBMITTALS:**

- A. Submittals shall include all materials used, including:
- Insulation
 - Jacketing
 - Tapes
 - Hardware
 - Mastics
 - Adhesives
- B. Submittals shall be formatted to include a list of materials for each service:
- C. Submittals shall use pages from Midwest Insulation Contractors Association - “Commercial and Industrial Insulation Standards” for defining how insulation materials will be applied.

PART 2 - PRODUCTS

2.1 **GLASS FIBER INSULATION:**

- A. Ductwork (Insulation):
- Insulation shall be 250 deg. F rated as manufactured by Owens Corning, Manville, Knauf, or Certainteed.
 - Duct Wrap: 2 in. thick, 1.0 PCF with aluminum or FRK facing, having a maximum vapor transmission of .02 perms.
 - Insulation Board: 2 in. thick 3 PCF with FRK facing.
 - Commercial Ductwrap: 2-1/2 in. thick 3 PCF semi-rigid, flexible board type with FRK facing.

2.2 **ELASTOMERIC CLOSED CELL INSULATION:**

- A. Tubing and Sheet insulation shall be flexible fire retardant closed cell, conforming to ASTM C 534, and ASTM 1056. Thermal resistivity shall be 3.70 sq.ft.-hr-F/BTU-in. Insulation shall be Rubatex or Armaflex.

2.3 **FINISHES:**

- A. Metal jacketing, smooth .016 in. thick, type T 3003 aluminum with laminated moisture barrier. Jacketing shall be Childers, aluminum roll jacketing with Polykraft moisture barrier. Jacketing shall be embossed "No Asbestos" on a 6 inch spacing.
- B. Metal fitting covers shall be two piece aluminum. Covers shall be EII-Jac.

- C. Foil scrim kraft (FSK) jacket, flame retardant vapor barrier. Jacket shall be Alpha Temp 10651, all service jacket.
- D. Fitting covers shall be one piece 20 mil PVC, covers shall be Ceel-Tite 550 PVC-UVR by Ceel-Co. Zeston and Proto are approved equals.
- E. Water based latex enamel equal to Armstrong WB Armaflex Finish.

2.4 **MISCELLANEOUS:**

- A. Adhesives:
 - 1. Glass & Mineral Fiber - Foster 85-20 / Vimasco 795.
 - 2. Cellular Glass - Pittcote 300 / Childers CP-30.
- B. Mastic (Weather Barrier):
 - 1. Foster 35-00 Mastic / Vimasco.
 - 2. Childers Vi-Cryl CP10/11.
 - 3. Vimasco WC-5.
- C. Coatings:
 - 1. Foster - Monolar Coating / Vimasco
 - 2. Foster Sealfas 30-36 / Vimasco
 - 3. Foster Tite-Fit 30-56 / Vimasco
 - 4. Pittcote 300
- D. Vapor Barrier Sealant: Foster Flextra 95-50
- E. FSK tape 3 in. wide, equal to Nashua FSK.
- F. Insulpins
- G. Roll on Corner bead (2 in. x 2 in., 26 ga. galvanized steel).
- H. Fiber reinforced tape - Nashua 357, or 398.
- I. Insulation protection shields - Grinnell fig 167.
- J. Rigid insulation inserts - Hamfab.
- K. Reinforcing Cloth - Vimasco, Elastafab 894, conforming to ASTM D1668.
- L. Bands - .020 in., aluminum, ½ in. wide, embossed continuously with the legend "No Asbestos".
- M. Hexagonal Wire Netting - One inch mesh, 22 ga. galvanized steel.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Insulation shall be applied to clean and dry surfaces after tests and approvals required by this specification have been completed.
- B. On cold surfaces where a vapor barrier must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.
- D. All pipe or duct insulation shall be continuous through walls, ceiling or floor openings, or sleeves; except where firestop or firesafing materials are required.

- E. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed as required between the pipe and the insulation shields. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required.
- F. All clevis type pipe supports shall be sized to fit the outside diameter of the insulation.
- G. Insulate items mounted in ductwork with the same thickness of insulation as specified for ductwork: including air measuring stations, smoke dampers, and automatic dampers.
- H. Repair insulation damaged by work under this contract to match existing work or replace damaged portion with insulation specified for new work.
- I. Standing seams and other projections in ductwork or casings shall have insulation applied so that at least ½" of insulation will cover such projections.

3.2 HVAC SYSTEMS:

- A. Concealed Ductwork:
 - 1. Apply jacketed ductwrap to all concealed ductwork providing conditioned air, or outside air. Insulate return ductwork in non-conditioned spaces and in ceiling spaces below a roof.
 - 2. Pull insulation snug, but do not compress insulation more than 1/4 inch.
 - 3. Secure ductwrap insulation to ductwork using adhesive. Secure insulation on bottom on sides of horizontal ductwork and all sides of vertical ductwork with insulpins welded to duct on 12 to 18 inch centers and with clips slipped over the pins. Apply clips without compressing insulation. Make joints by lapping the facing a minimum of 2 inch and stapling with T-5 flared staples. Vapor - seal with Childers CP-30 Low Odor at all staples, clip locations and other penetrations. Seal joints with 3 inch wide FSK tape.
 - 4. See schedule at end of this section for insulation thicknesses.
- B. Exposed Interior Ductwork (Rectangular):
 - 1. Apply insulation board with FRK facing to all exposed ductwork providing conditioned air, or outside air. Insulate return ductwork in non-conditioned spaces.
 - 2. Secure insulation with insulpins (all surfaces) welded to duct on 12 to 18 in. centers and with clips slipped over pins. Seams and joints shall be vapor sealed with 3 in. wide FSK tape.
 - 3. Corners and edges of ductwork shall be reinforced with roll-on corner bead.
 - 4. Seal all break and punctures with vapor barrier sealant and FSK tape.
 - 5. See schedule at end of this section for insulation thicknesses.
- C. Exposed Ductwork (Round):
 - 1. Apply commercial semi-rigid flexible board insulation with FRK facing to all exposed round or flat oval ductwork providing conditioned air or outside air.
 - 2. Secure insulation to ductwork using adhesive. Tightly butt insulation sections together. Longitudinal joint shall be lapped 2 in., stapled and taped. Tape circumferential joints with FSK tape at a 50 percent overlap. Tape entire girth at mid-point between joints.
 - 3. Secure insulation with pins on vertical ductwork and the bottom surface of flat oval ductwork. Pins shall be spaced on 12 to 18 in. centers with clips slipped over the pins.
 - 4. See schedule at end of this section for insulation thicknesses.
- D. Expansion Joints/flexible Connectors:
 - 1. Insulate expansion joints with oversized sections of molded insulation. Use same material as on adjacent piping. Allow for pipe growth, and contraction.

2. Insulate flexible connectors with a flexible material as follows:

<u>Service</u>	<u>Insulation</u>
Refrigerant Suction Lines	3/4" Elastomeric Tubular

E. Elastomeric:

1. Apply closed cell elastomeric insulation to all pipes, equipment and surfaces listed below.
2. Secure insulation with contact adhesive in accordance with manufacturers instructions.
3. Insulate fittings and valves with miter cut pieces of insulation same thickness as piping.
4. DX Systems:
 - a. Apply one layer of 1 inch thick elastomeric closed cell tubular insulation to the refrigerant suction line, and the refrigerant liquid line after the expansion valve and the hot gas bypass line when it is installed outdoors.
5. Cooling coil condensate piping - 1 in. thick
6. Covers and caps for all valve stems and operators, gauge cocks, thermometer wells and other appurtenances subject to sweating.

F. Finishes:

1. Metal Jacketing (Aluminum):
 - a. Cover the following insulated systems with metal jacketing:
 - (1) Piping installed outdoors
 - (2) Exposed piping indoors within 8 ft. of finished floor
 - b. Cover with .016 in. thick aluminum jacket and hold in place with 2 in. wide aluminum bands on 9 in. centers. Fittings shall be covered with mitered segments of jackets or two piece preformed fitting covers. Provide angle ring escutcheons at wall, ceiling or floor penetrations.
 - c. Machine cut the jacket to produce a straight, smooth edge. Lap longitudinal and circumferential seams not less than 2 in. Install jackets on horizontal piping with the longitudinal seam approximately midway between horizontal centerline and the bottom side of pipe. Install with the top edge of jacket overlapping the bottom edge of jacket and with the seam of each jacket slightly offset from the seam of the adjacent jacket. Install jackets on vertical piping and on piping pitched from the horizontal from low point to high point so that the lower circumferential edge of each jacket overlaps the jacket below it.
2. Metal Jacketing (Galvanized):
 - a. Insulated ductwork installed outdoors [and insulated ductwork within 8 ft. of the finished floor in a mechanical room] shall be covered with 30 gauge galvanized steel. Covering shall be hemmed, and flanged. Secure with self tapping screws on eight inch centers. Do not puncture vapor barrier.
3. All Service Jacket/fitting Covers:
 - a. Exposed piping finish covering indoors shall be the All Service Jacket. Fittings shall be covered with molded fitting covers.
 - b. Concealed Piping finish covering shall be the All Service Jacket. Fittings shall be covered by wrapping the fitting with fiber reinforced tape, with a 5 percent overlap.
 - c. Pipe fittings larger than cataloged aluminum two piece or PVC covers shall be covered with vapor barriers mastic for cold lines, or two layers of hydraulic cement reinforced with wire mesh and finished with vinyl acrylic weather barrier mastic.

4. Paint:

- a. Exposed or exterior installations of elastomeric closed cell insulation shall be painted with two coats of water base latex enamel.

MINIMUM DUCT INSULATION REQUIREMENTS				
	EXTERIOR	ATTIC	UNCONDITIONED SPACES	INSIDE CONDITIONED SPACES
SUPPLY DUCT				
Duct wrap	--	4"	2"	2"
Rigid board	2"	--	2"	2"
Comm. duct wrap	2"	4"	2"	2"
RETURN DUCT				
Duct wrap	--	2"	2"	1"
Rigid board	2"	--	--	--
Comm. duct wrap	2"	2"	2"	1"
OUTSIDE AIR				
Duct wrap	--	2"	2"	2"
Rigid board	2"	--	--	--
Comm. duct wrap	2"	2"	2"	2"
EXHAUST DUCT				
Duct wrap	--	1"	1"	--
Rigid board	1"	--	--	--
Comm. duct wrap	1"	1"	1"	--

END OF SECTION 230700

SECTION 23 0923 -DIRECT DIGITAL CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. The work in this section defines the minimum hardware and performance requirements for a programmable microprocessor based control system (DDC).
- B. The work included in this specification consists of furnishing all labor, material, accessories and equipment necessary for the temperature control system.
- C. The scope of the work related to the control system will be the extension of the existing Alabama Controls system currently installed for the Board of Education.

1.2 SUBMITTALS:

- A. Submittal data shall include the following as a minimum:
 - 1. Communications network schematic showing all microprocessors, user I/O devices and locations, and all required communications data.
 - 2. List of connected data points, including microprocessors to which they are connected and input/output devices (sensor, contactor, etc.).
 - 3. DDC central configuration complete with all peripheral devices, communication interface devices, etc., and interconnection diagrams.
 - 4. Technical specification data sheet for each component. Descriptive data and sequence of operation of all operating, user and application software, with the exception of operating system software.
 - 5. A separate system schematic diagram for each system, e.g., HVAC, etc., depicting the type of system, e.g., single zone, reheat, double duct, etc. The system diagram shall logically illustrate the various system components, e.g., fans, pumps, cooling coils, heating coils, boilers, heat exchangers, chillers, etc., as well as the various control components, e.g., field interface devices, final control elements (valves, dampers, switches, etc.), sensors, controllers, etc. All components shall be labeled to match their respective DDC alphanumeric I/O point names.
 - 6. A separate "ladder" (elementary line) diagram type drawing depicting all new and existing DDC control and conventional interlocks for each system. Control device descriptions as well as terminal block designations shall be included on this drawing.

1.3 PERFORMANCE AND SCOPE:

- A. DDC system shall consist of the following elements:
 - 1. Microcomputer based remote control panels interfacing directly with sensors, actuators and environmental delivery systems (i.e., HVAC equipment, etc.).
 - 2. A two-wire communication network to allow data exchange between remote panels and between remote panels and the Operator Work Station.
 - 3. Electric and electronic controls for all items indicated on drawings and described hereinafter including dampers, panels and electrical installation.
 - 4. All materials and equipment used shall be standard components, regularly manufactured for this and other systems and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use.
 - 5. Any items of work not listed in description of work, but shown on the drawings or specified else where in this section shall be included in the DDC work.

6. The DDC shall interface, either directly or through a gateway, with the existing BAS.

1.4 **CODES AND STANDARDS:**

- A. The complete installation shall be in strict accordance to the national and local electrical codes and the electrical section of these specifications. All devices designed for or used in line voltage applications shall be UL listed. Unless noted otherwise, the latest edition shall apply.
- B. The following UL Standards are applicable:
- | UL No. | Title of Standard | Category |
|--------|---|----------|
| 294 | Access Control System & Control Units | ALVY |
| 268A | Smoke Detectors for Duct Application | UROX |
| 429 | Electrically Operated Valves | |
| 873 | Temperature Indicating and Regulating
Regulating Equipment | XAPX |
| 916 | Energy Management Equipment | PATZ |
- C. The following NFPA Standards and Guides are applicable:
- | | |
|----------|------------------------------------|
| NFPA 70 | National Electric Code |
| NFPA 90A | Air Conditioning Systems |
| NFPA 90B | Warm Air Heating, Air Conditioning |
| NFPA 101 | Life Safety Code |
- D. All electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

PART 2 - PRODUCTS

2.1 **GENERAL:**

- A. The DDC system shall be of a fully modular architecture permitting expansion by adding computer memory, application software, operator peripherals and field hardware.
- B. All system components are to be designed and built to be fault tolerant.
- C. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be A. C. coupled or equivalent so that any single device failure will not disrupt or halt bus communication.

2.2 **UNITARY DIGITAL CONTROLLER (UDC):**

- A. Controls shall be microprocessor based Unitary Digital Controllers (UDC's). UDC's shall be provided for Unit Ventilators, Fan Coils, Heat Pumps and other applications as shown on the drawings. UDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the UDC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter.
- B. Contractor shall provide a minimum of one UDC controller per unitary system as shown on the drawings.
- C. The BAS contractor shall provide and install all UDC's specified under this section. Mechanical equipment manufacturers desiring to provide UDC type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors,

which are specified to be provided by the BAS/Temperature control contractor.

- D. All input/output signals shall be directly hardwired to the UDC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.
- E. UDC's shall be in continuous, direct communication with the network which forms the facility wide building automation system. The UDC's shall communicate with the SDC at a baud rate of not less than 9,600 baud.
- F. All control sequences programmed into the UDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the UDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The UDC shall allow for the creation of unique application control sequences. Systems that allow only selection of sequences from a library or table are not acceptable.
- G. All control sequences shall be fully configurable at the UDC, allowing for the creation and change of a sequence while at the unit.
- H. The UDC shall be provided with the ability to interface with the HHOT. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the HHOT to have full functionality as described in HHOT section of this specification. From the interface port, the HHOT shall be able to directly access any AHDC, LIDC, UDC or VAVDC in the network.
- I. The UDC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples per input/output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken.
- J. Systems unable to provide the above capability shall provide for the individual input/output point trending at the SDC. Specifics as to how each UDC point will be trended, at the SDC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the SDC and the number of UDC's per SDC that can be expected.
- K. The UDC shall provide LED indication of transmit/receive communication performance, as well as for the proper/improper operation of the controller itself.
- L. To simplify controls and mechanical service troubleshooting, the UDC shall be mounted directly in the controls compartment of the unitary system. The UDC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment. The UDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.
- M. For compatibility to the environment of the unitary equipment, UDC's shall have wide ambient ratings. UDC's shall be rated for service from 32 Deg F (Degrees Fahrenheit) to 140 Deg F.
- N. Contractor shall submit description of location of UDC's on all mechanical and unitary equipment.

2.3 AUTOMATIC DAMPERS:

- A. All control dampers shall be standard products of the temperature control manufacturer unless noted otherwise. Local fabrication of dampers is not allowed.
- B. Damper construction shall be as follows:
 1. Damper frames: 13 gauge galvanized steel.
 2. Blades: not over 6 inches wide nor less than 22 gauge galvanized steel roll formed.
 3. Bearings: ailed, ball bearings or nylon with ½ inch shafts.

4. Side seals: stainless steel of the tight-seal spring type.
 5. Dampers and seals suitable for temperature ranges of -40 to 200 degrees F.
- C. Dampers shall be minimum leakage type to conserve energy , and the manufacturer shall submit leakage and flow characteristic data for all control dampers with the temperature control submittal.
 - D. Maximum leakage is 3 percent at static pressure of three inches of W.G. at duct approach velocity of 2000 fpm.
 - E. All exhaust or discharge dampers shall be parallel blade; all outside air dampers shall be opposed blade.

2.4 ACTUATORS:

- A. Size to operate their appropriate dampers with sufficient reserve power to provide smooth modulating action or two-position action as specified.
- B. Where two or more actuators are to be operated in sequence with each other, provide positive positioners for accuracy and non-overlapping operation.
- C. Modulating dampers controlled in sequence with other dampers or larger than 20 square feet area shall be provided with damper operators with pilot positioners for accurate sequencing and positioning.
- D. All damper motors shall be piston damper operators of the proper size and number to secure throttling or two position action as required. Damper motors shall be located outside of the air stream. Actuators located in fresh air intake and relief shall be such that motor will not be subject to freezing temperature.
- E. Actuators shall be manufactured by Seibe, Siemens or Johnson Controls.

2.5 ELECTRONIC DATA INPUTS AND OUTPUTS:

- A. General:
 1. Input/output sensors and devices shall be closely matched to the requirements of the digital control panels (DCH) for accurate, responsive, noise free signal matched to the loop gain requirements for precise and responsive control. In no case shall computer inputs be derived from pneumatic sensors.
- B. Temperature Sensors:
 1. Temperature sensors shall be Resistance Temperature Detector (RTD) type, 100 ohm platinum, DIN 43760, Class 4, 3 or 4 wire type.
 2. Space temperature sensors shall provide digital read-out, setpoint adjustment, and over-ride control.
 3. Duct temperature sensors shall be rigid stem or averaging type as specified in the sequence of operation. Water sensors shall be provided with a separable copper, Monel or stainless steel well.
 4. Return air, discharge air, return air space sensors and well sensors shall be linear with plus or minus 7 degrees F. between F. 32 degrees F. and 212 degrees F. This linearity shall be that of the sensor itself and not be accomplished by software.
 5. Freeze protection thermostats shall include two single pole, single throw snap switches with 1/8 inch by 20 feet long bulb which responds to the lowest temperature in any 1 foot length. Range 15 to 55 degrees F. Main switch shall open on a drop in temperature to setpoint; auxiliary switch closes. Unit shall be manual reset, U. L. listed, pilot duty, 125 VA, 24 to 600 V. H.

PART 3 - INSTALLATION AND EXECUTION

3.1 GENERAL:

- A. All existing control systems shall be modified for the application of direct digital control (DDC) as outlined in these specifications or as shown on the drawings. The new DDC shall be interfaced with the existing control system interlocks in order to perform the functions listed in the I/O point schedule and/or as outlined in the specified, all new control sequences. Unless indicated otherwise, all new control strategies shall be accomplished by means of DDC.
- B. Unless indicated otherwise, all modulating control loops are to be PID (proportional, integral and derivative) type loops emanating from the DCPs. Wherever indicated, existing or new conventional type control loops shall be configured to provide backup or standby control in the event of a malfunction or failure.
- C. As a minimum, the DDC shall be capable of maintaining an overall accuracy, including errors associated with sensing elements, lead wires, analog to digital (A/D conversion, CPU resolution and digital to analog (D/A) conversion, as follows, plus or minus:
 - 1. 0.5 degrees F for space temperature
 - 2. 0.5 degrees F for duct temperatures
 - 3. 1.0 degrees F for water temperatures
- D. Unless indicated otherwise, the multiplexing of I/O points, i.e., the use of one input point to monitor multiple variables or the use of one output point to control multiple output devices, is not permissible.
- E. Remote panels shall be provided where listed or shown with capacity to accommodate the equipment, system or area being monitored. Remote panels shall be configured with analog and digital inputs and outputs and pulse counting totalizers as required for the application and such that the primary input, the output, and all control logic shall be resident in a single microprocessor to provide network independent standalone closed loop DDC.
- F. All panel inputs shall be selected for the application utilizing sensor types listed under the sensor section of this specification.
- G. Valve Failure Position:
 - 1. Recommended valve failure positions (open or closed) shall be provided for each valve in submittal data furnished to the Engineer. Final determination of valve failure positions shall be by the Engineer.
 - 2. Unless noted otherwise, chilled water valves shall be normally closed and hot water valves shall be normally open. Upon failure, valve shall return to normal position.

3.2 CONTROL DEVICES AND COMPONENTS:

- A. Contractor shall submit tentative locations of all control devices and components (including temperature sensors) to the Architect for written approval prior to installation.
- B. Contractor shall pay particular attention to location of control devices and components to location of control devices and components. Effects of drafts, radiant heat, vibration, etc are to be considered when installing control devices and components.
- C. The ranges (temperature, pressure, relative humidity, etc.) of all sensors and control devices and components shall require approval of the Engineer. In addition to the Contractor's recommendation, the Contractor shall also provide to the Architect a list of the available ranges for each sensor, control device and component.
- D. Prior to ordering factory assembled equipment which contains integral control devices and components, the Contractor shall obtain a written statement from both the manufacturer and the installing contractor that they have reviewed the appropriate submittal data and are aware of the make, model, type, size, characteristics, etc. of the factory assembled control devices and components which they shall be required to interface to and/or control.
- E. Tubing, passing through openings in the unit cabinets shall be installed with bulkhead fittings.

- F. All new control devices (both field and panel mounted) shall be labeled to indicate both their control systems designation, e.g., ZONE 1 TEMP SENSOR. Unless indicated otherwise, abbreviations and acronyms for all ID tags and panel faceplates shall be approved by the Engineer.
- G. All new control devices are to be mounted in accessible locations wherever practical. All devices exposed to the weather shall be housed in weatherproof enclosures.
- H. Unless indicated otherwise, all analog type sensing devices will be new.
- I. The Contractor shall provide new and/or modify existing control interlocks as required to accomplish the required control functions.
- J. The transducing of pneumatic transmitters or sensors, e.g., temperature, pressure, relative humidity, flow rate, etc., is not an acceptable means of analog sensing.
- K. Unless indicated otherwise, filter status shall be monitored by means of a differential pressure air flow switch.

3.3 TEMPERATURE SENSORS:

- A. Analog sensing elements for remote indication are to be independent of local sensors if used for local control loops.
- B. RTD temperature sensors are the only acceptable means of temperature sensing. The use of transmitters for temperature sensing inputs is not acceptable.
- C. Duct mounted sensors shall mount through a hole in the duct and be positioned to be easily accessible for repair or replacement. A seal shall be used on the sensor assembly to prevent air leaks.
- D. Room temperature sensors are to be provided with a protective cover to prevent accidental damage.
- E. Mixed air temperature sensors and freezestats shall be located as required to provide for sensing of the mixture of outside air and return air prior to its entering any coils.
- F. Supply air sensors shall be located as required to sense the temperature of the supply air downstream of all central system coils and fans.

3.4 WIRING:

- A. The entire DDC system shall be installed by skilled electricians and mechanics, all of whom are properly trained and qualified for this work. All electrical work shall be installed in accordance with the requirements of the appropriate section(s) of DIVISION 16 - ELECTRICAL of these specifications and in accordance with the current editions of the NEC (National Electrical Code) and the NFPA (National Fire Protection Association), and all requirements of all codes and laws in the locality in which the work is to be performed.
- B. Location of Field Devices: The Contractor is responsible of the actual location of field devices and must avoid interference between conduits, pipes, equipment, and instruments while providing maximum accessibility.
- C. Connections: Unless indicated otherwise, the Contractor is responsible for all required process and electrical connections to all equipment, control devices and components, and field instruments.
- D. Calibration: The Contractor shall calibrate and operationally check all instruments, both new and existing, except those items that are passively involved in the system, e.g., thermowells, relief valves, rupture disc, etc. The calibrated instruments shall be inspected and calibrated using accepted practices and techniques.
- E. Instrument identification tagging: All field mounted instrument items shall have an approved identification tag permanently attached by the Contractor upon completion of the initial inspection and calibration. This tag shall reflect the device's identification as shown on the appropriate control drawings.
- F. Unless indicated otherwise, all indoor wiring external to control panels, including sensor wiring, shall

be installed in approved metallic wireways or raceways, e.g., EMT, rigid metallic conduit, metallic surface raceways, etc. All wiring exposed to the weather shall be installed in rigid metallic conduit.

- G. All I/O wiring shall be in accordance with the manufacturer's recommendations. The minimum I/O wire size shall be 18 AWG.
- H. All communications (data transmission network) wiring shall be in accordance with the manufacturer's recommendations.
- I. I/O and communications wiring shall be shielded where required by either the Contractor or the controlled equipment manufacturer. Shield terminations shall be in accordance with manufacturer's requirements.
- J. All wiring and tubing shall be properly supported and run in a neat and workmanlike manner. All wiring and tubing exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosure shall be neatly bundled and anchored to prevent obstruction to devices and terminals.

3.5 HVAC UNITS SEQUENCE OF OPERATIONS:

A. General:

1. The heating and cooling setpoints shall be individually adjustable in the program schedule. The thermostat shall have a minimum deadband of 2°F. No mechanical heating or cooling shall operate within this deadband. Space temperature deviation above the cooling setpoint or below the heating setpoint shall generate a demand signal to control the system.
2. The thermostat shall control the heating or cooling output based on the demand signal communicated from the thermostat program, taking into account both space temperature deviation (proportional gain) and the duration of that temperature deviation (integral gain).
3. The thermostat shall provide heating and cooling temperature range stops to limit temperature setpoint adjustments.
4. The thermostat shall provide two occupied and two unoccupied periods per day. When all or a portion of a manually programmed schedule is unavailable, the thermostat shall control to the default program schedule.
5. The thermostat shall provide adjustable recovery ramps for heating and cooling. The thermostat will begin heating or cooling recovery early to ensure that the temperature is reached at the scheduled time.
6. On loss of power, the thermostat shall maintain programmed times and temperatures for 10 years. Current time and date shall be maintained for a minimum of 4 years assuming 2 weeks of power outages each year.
7. The thermostat shall provide three levels of keypad lockout to prevent changes to the thermostat: Unlocked, Partial Lockout and Full Lockout.

B. Heating:

1. The thermostat shall energize heating equipment when space temperature falls below the heating setpoint. Heating setpoint shall be 68°F (adjustable).

C. Cooling:

1. The thermostat shall energize cooling equipment when space temperature exceeds the cooling setpoint. Cooling setpoint shall be 73°F (adjustable).

D. Fan Operation:

1. Fan shall operate continuously during Occupied mode and intermittently during Unoccupied mode.

E. Ventilation Air:

1. Units with Carbon Dioxide (CO₂) sensors: Outside air damper shall open to its minimum position (see note 5 on packaged unit schedule) when unit is activated. This position shall also be minimum position for low setpoint for CO₂ sensor. Upon a rise in CO₂ concentration level to 1000 ppm, outside air damper shall gradually open to its maximum position to dilute CO₂ concentration level to 650 ppm. When this level of concentration has been maintained for a period of 5 minutes, OA damper shall return to its minimum position. Economizer sensor (OA enthalpy) shall override CO₂ sensor for primary control of unit. See Economizer Control below. Upon deactivation of unit, OA damper shall move to its closed position.
 2. Units without Carbon Dioxide (CO₂) sensors: Outside air damper shall move to its open position (scheduled OA volume) when unit is activated and maintain this position while unit is operating. Upon deactivation of unit, OA damper shall move to its closed position.
- F. Economizer:
1. The unitary equipment controller shall enable the economizer cycle. Outside air (OA) enthalpy shall be compared with the reference enthalpy control setpoint (23 BTU/lb adj.).
 2. The economizer shall enable when OA enthalpy is 0.5 BTU/LB less than enthalpy control setpoint.
 3. The economizer shall disable when OA enthalpy is 0.5 BTU/LB greater than enthalpy control setpoint or the outdoor air temperature above 75.0 deg. F, the humidity sensor maximum operating limit.
 4. When economizer is enabled and the unit is operating in the cooling mode, the economizer damper shall be modulated between its minimum position and 100% to maintain the discharge air temperature setpoint. The economizer damper shall modulate toward minimum position in the event the discharge air temperature falls below the discharge low limit temperature setpoint. Compressors shall be delayed from operating until the economizer has opened to 100%.
- G. Dehumidification Cycle:
1. On a rise in space humidity, dehumidification cycle is initiated.
 2. Economizer shall close to minimum position.
 3. The hot gas reheat solenoid valve shall energize and activate hot gas reheat coil.
 4. Dehumidification cycle terminates on a fall in space humidity, if space temperature requires second stage cooling, or if space temperature requires heating to be engaged.
 5. Simultaneous heating and cooling are not permitted.
 6. Humidity setpoint shall be 60% RH (adjustable).
- H. Overrides:
1. Temporary Override: After touching the OVERRIDE button or adjusting the temperature setpoint, the thermostat shall use a pre-set occupied temperature. The new temperature will be maintained for 1 hour and can be adjusted up to the maximum override duration set by the owner.
 2. Initiate Occupancy: The thermostat shall keep the temperature at an energy saving level until the user touches "Press to Start Occupancy" on the home screen. The thermostat returns to an energy saving level after the hold until time expires or the Occupied period ends.
- I. Alarms:
1. The thermostat shall provide an alert on the display when the HVAC filter requires replacement or cleaning.

2. The thermostat shall provide an alert on the display when maintenance is required.
3. Unit shall shutdown on alarm from smoke detector or fire alarm system. Smoke detector alarm/trouble pilot shall be indicated on remote panel.

3.6 OPERATION TEST:

- A. At completion, TCSC shall operate the system for a period of at least three days of eight hours each on the new systems to demonstrate fulfillment of the requirements of the contract. During this time, all adjustments shall be made to the equipment so that it is in first-class operating condition. The entire system is to be left in operating condition acceptable to the Engineer.

3.7 OWNER'S INSTRUCTION:

- A. Upon completion of the work and acceptance by the Owner, TCSC shall provide one scheduled four-hour period of formal instruction to the Owner's operating personnel who have responsibility for the mechanical system.

END OF SECTION 230923

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SECTION 23 3113 - LOW PRESSURE DUCTWORK

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. The work required under this section includes all work necessary for a complete installation of ductwork and accessories.

1.2 CODES AND STANDARDS:

- A. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
1. HVAC Duct Construction Standards: Metal and Flexible
 2. Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
 3. HVAC Air Duct Leakage Test Manual
- B. National Fire Protection Association (NFPA):
1. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
 2. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning System
 3. 101 - Life Safety Code
- C. American Society of Heating, Refrigerating and Air Conditioning Engineering (ASHRAE):
1. Fundamentals Handbook
 2. Equipment Handbook

1.3 SUBMITTALS:

- A. Submittals (for each duct system) shall include the following:
1. Sheet Metal:
 - a. Gages by sizes
 - b. ASTM Standards
 2. Duct Fabrication Standards and Reinforcement:
 - a. Joint construction
 - b. Fitting construction
 - c. Joint and reinforcement spacing
 - d. Splitter damper and duct tap details
 - e. Flange details
 3. Hangers:
 - a. Rods - sizes by duct
 - b. Straps
 - c. Trapeze
 - d. Spacing
 4. Duct sealers
 5. Flexible connectors
 6. Flexible ductwork
 7. Dampers:
 - a. Factory fabricated
 - b. Fire dampers
 - c. Damper hardware

- 8. Access doors
- 9. 1/4-inch scale shop drawings indicating location and mounting height of duct.
- B. Submittals shall include testing or listing certification, dimensional data and manufacturers literature on all manufactured products.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. Ductwork shall be fabricated from sheet metal products conforming to the following material standards:
 - 1. Galvanized Steel - ASTM A653 (G60)
- B. Duct system shall be fabricated with sheet metal thicknesses and reinforced in accordance with SMACNA as shown on the drawings and as described herein.
- C. Unless noted otherwise the minimum pressure/velocity classification shall be 2 inch W.G. plus or minus, at 2500 ft. per minute, duct seal class "A".
- D. Ducts 18 inches and larger on any side shall be stiffened by beading on not to exceed 12 inch centers.
- E. All longitudinal seams shall be grooved, double or Pittsburgh type (except on watertight ducts or on heavy gauge ducts).
- F. Branch connections in supply ducts shall be fabricated per the following schedule:

<u>Maximum Branch Size</u>	<u>Branch Connection</u>
Up to, Rectangular equivalent to 12 inch round	45 deg. tap collar with volume damper in branch
All other duct branches	Proportioned duct, with adjustable splitter damper

- G. Branch connections in return or exhaust ductwork shall be made with 45 degree entry fittings. If ducts are the same depth use parallel branch connection.
- H. Where acoustical or thermal insulation is applied on the inside of ductwork, size of ductwork shall be increased so that the duct size shown on the drawings are the dimensions of the inside of the insulation.

2.2 GALVANIZED STEEL DUCTWORK:

- A. Exposed galvanized steel duct work shall be surface treated for painting.
- B. Ductwork outside the building shall be fabricated of not less than no. 16 gauge galvanized steel.

2.3 FITTINGS:

- A. All junctions, bends, turns or elbows in all ducts or risers shall have a large radius (centerline radius equal to 1-½ times duct width) in the throat in order to minimize the frictional resistance.
- B. Vanes shall be provided in elbows with 90 degree throats and throat radii less than 1-½ times duct width, and shall be located in accordance with ASHRAE standards. Double-vane airfoil-type turning vanes shall be provided for all square turns.
- C. Round fittings shall be factory fabricated by approved manufacturers.

2.4 HANGERS AND SUPPORTS:

- A. Building Attachments: Concrete inserts or structural steel fasteners appropriate for building materials.
- B. Hanger Materials: Galvanized, sheet steel or round, threaded steel rod.

1. Hangers installed in non-conditioned spaces and outdoors: Electrogalvanized, all-thread rod or galvanized rods with threads painted after installation.
2. Straps and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.
- C. Duct Attachments: Sheet metal screws, blind rivets or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A36.
 1. Supports for Galvanized Steel Ducts: Galvanized steel shapes and plates.

2.5 **SEALANT MATERIAL:**

- A. Duct Sealer: Solvent or water based type U.L. classified meeting NFPA 90A Class 1 with zero fire and smoke development rating. Sealer shall be United Sheet Metal, United Duct Sealer, or Hardcast Iron Grip No. 601.

2.6 **FLEXIBLE CONNECTORS:**

- A. Flexible connectors shall be U.L. listed, neoprene coated heavy glass fabric. Fabric shall be Ventglas, manufactured by Ventfabrics, Inc.

2.7 **FLEXIBLE DUCTWORK:**

- A. Flexible duct shall be UL listed and labeled as Class 1, Air Duct Connector, in accordance with U.L. Standard 181 and shall meet the requirements of the latest NFPA Bulletin, No. 90A and No. 90B for flame spread and smoke development rating.
- B. Flexible duct shall be rated for a maximum pressure of 6 inch positive and 5 inch negative and 5500 fpm maximum velocity. Air duct shall consist of: CPE liner, coated spring steel wire helix, fiberglass insulating blanket, fiberglass scrim and reinforced aluminum vapor barrier. Insulation valve shall be a minimum of R-6. Edges of liner shall be protected by sheet-metal noisings.
- C. Duct shall be Flexmaster Type 8M or prior approved equal.

2.8 **DAMPERS:**

- A. Single Blade Dampers:
 1. Single Blade Dampers shall be constructed of 22 gauge galvanized steel (blade and frame). Single blade dampers shall be limited to a 12 inch high blade. Blade edges shall be crimped or reinforced. Damper levers shall indicate positively the open and closed position. End bearings shall be molded synthetic. Dampers shall be Ruskin MD25 or approved equal (Ruskin MDRS25 for round ducts).
- B. Multiblade Dampers:
 1. Multiblade dampers shall be constructed of sheet metal the same material as the adjacent ductwork. Damper frame shall be not less than 16 ga., damper blades not wider than 6 inches crimped or reinforced. Damper levers shall indicate positively the open and closed position. End bearings shall be molded synthetic. Damper shall be Ruskin MD35 or approved equal.
- C. Fire Dampers:
 1. Fire dampers shall be Underwriters approved and labeled (UL555). Dampers shall be fabricated of galvanized steel and shall be of such a design and length as to function as a wall mounting sleeve, which shall be a part of the fire damper. Sleeves shall be of welded or bolted construction. Crimping or tabs will not be acceptable substitutes for welding or bolting.
 2. Fire dampers shall be Ruskin DIBD2 Series for 1-½ hour rating.

- D. Acceptable Manufacturers:
 - 1. Ruskin, Greenheck, Air Balance or prior approved equal.

2.9 **DAMPER HARDWARE:**

- A. All hardware shall be SMACNA accepted.
- B. Insulated ductwork (concealed) - Ventlok 639 elevated dial regulator.
- C. Insulated ductwork (exposed) - Ventlok 644 - self locking regulator.
- D. Uninsulated ductwork - Ventlok 555 or 560 Quadrants.
- E. Insulated ductwork (inaccessible damper) - Ventlok 666 or 677 concealed damper regulator. Provide cable and remote manual actuator.

2.10 **ACCESS DOORS:**

- A. Access doors shall be hinged, constructed of the same material as the ductwork. Door edges shall be sealed with 3/4 inch wide x 1/8 inch thick neoprene sponge gasketing. Door hardware shall be Ventlok #100 latches. Access doors on insulated ductwork shall be double wall construction with 1 inch of rigid 3 PCF fiberglass insulation.
- B. Access doors shall be approximately 18 inches high by 24 inches wide. In smaller ductwork, the height shall be reduced to be 2 inches less than that of the ductwork.

PART 3 - INSTALLATION

3.1 **GENERAL:**

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction - Metal and Flexible," unless noted otherwise.
- B. Ductwork hangers shall be supported from fasteners attached to structure.
- C. Provide angles (same material as duct) at points where duct penetrates walls, to close off space between wall opening and duct.
- D. Install in the ductwork dampers and air measuring devices furnished by the Temperature Controls Sub-Contractor.
- E. Install smoke detectors in ductwork.
- F. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- G. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction" guidelines.
- H. Repair fire proofing which was removed for ductwork installation. Installation to be done by an approved qualified tradesman.
- I. Paint interiors of metal ducts, that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer.

3.2 **INDOOR DUCTWORK:**

- A. Suspend horizontal ducts on not to exceed 6 ft. spacing by galvanized steel straps 1 inch x no. 16 ga. for sizes up to 60 inch width, 1-1/2 inch x no. 16 ga. for sizes up to 96 inch width, and 2 x 2 x 1/4 inch trapeze shelf angles for ducts wider than 96 inches. Unless noted otherwise straps shall be fastened to sides of ducts with not less than two sheet metal screws. Bottom ends of straps shall hook 2 inches under ducts and be secured with a sheet metal screw through bottom of ducts (except watertight

ducts).

- B. Vertical ducts shall be supported at each floor by steel angles attached to the long sides of the duct. Angles shall rest on floor or steel framework and be secured to duct with sheet metal screws.
- C. Support angles shall be sized according to duct size:

<u>Duct Size</u>	<u>Riser Support Size</u>
Up to 36"	1- $\frac{1}{4}$ x 1- $\frac{1}{4}$ x $\frac{1}{4}$
Up to 48"	1- $\frac{1}{2}$ x 1- $\frac{1}{2}$ x $\frac{1}{4}$
Up to 60"	2- $\frac{1}{2}$ x 2- $\frac{1}{2}$ x $\frac{1}{4}$
Up to 72"	3 x 3 x 5/16
Up to 84"	3 x 3 x 5/16
Up to 96"	4 x 4 x $\frac{1}{4}$

- D. Support vertical ductwork or risers at every floor. Provide structural steel framing channels or wide flange shapes in shaft openings to support ductwork.
- E. Water and other pipes shall not be allowed to pass through air risers or ducts, unless approved by the Engineers, and when this occurs, the size of said duct or riser shall be proportionately increased. Sanitary waste and vent piping shall not penetrate any ductwork.

3.3 DUCT SEALER:

- A. All ductwork shall be as airtight as possible. Transverse seams shall be taped and sealed with two layers of United Sheet Metal, Uni-Cast or caulked with duct sealer.

3.4 FLEXIBLE CONNECTORS:

- A. Install flexible connectors at all supply and exhaust fans and other air handling units with inlet and outlet duct or casing connections.
- B. Connectors shall be suitable for the pressure of the units involved and shall be sealed airtight.
- C. Connectors shall be not less than 4 inches long (in clear) and properly attached to duct and fan connection collar by 1 x 1/8 inch draw band (fabricated of the same material as adjacent ductwork) firmly clamped around collars in such a manner as to be airtight and secured to collars with sheet metal screws. Connectors shall not be painted.
- D. Connectors shall not be used as transition pieces between fan and ductwork.

3.5 FLEXIBLE DUCTWORK:

- A. Flexible ducts shall be used for straight runs of duct or offsets up to 45 degrees, but not exceeding 48 inches in length. The use of flexible ducts as elbows with more than a 45 degree bend will not be permitted.
- B. Flexible ductwork shall be secured to rigid ductwork and unit openings by sliding the flexible duct over the rigid duct, sealing with an approved adhesive, clamping with a suitable clamp and taping.

3.6 DAMPERS:

- A. Install dampers where shown or called for on the drawing. Install damper operating hardware.
- B. Fire dampers shall be installed in accordance with manufacturer's instructions.
- C. Install style A fire dampers behind ducted grilles and registers in rated walls. Install style B or C fire dampers in ducted openings in rated walls.

3.7 DUCT ACCESS DOORS:

- A. Provide duct access doors at all duct mounted devices requiring adjustment or resetting (e.g. fire dampers), at all ducted fan inlets, at the up stream side of all ducted filters and at the upstream side of all air measuring stations.

3.8 LOUVERS:

- A. Make connections to louvers. Where duct size is less than full louver opening, close off remaining unused louver opening with an insulated panel assembly consisting of 24 ga galvanized sheet metal screwed to the louver, 2 in. thick 3 PCF fiberglass rigid board and covered with a 22 ga galvanized sheet metal outer skin. Seal all openings.

3.9 TESTING:

- A. Perform the field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare tests reports.
- B. The first 100 lin ft. section of ductwork installed shall be tested for leakage. Ductwork shall be tested at the duct pressure class (positive or negative depending on duct service), leakage shall be limited to 8 percent. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.
- C. Owner may request additional tests at any time up to the time outlet devices or insulation is installed. Cost of additional testing will be paid by Owner, cost of repairing leaks and retesting shall be at no additional cost to the Owner.

END OF SECTION 23 3113

SECTION 233115 - DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. The work required under this section includes all work necessary for a complete installation of ductwork and accessories.

1.2 SUBMITTALS:

- A. Submittals shall include data sheets on the following.
1. Backdraft Dampers
 2. Volume Dampers
 3. Fire Dampers
 4. Flexible Ductwork
 5. Flexible Connectors
 6. Air Outlets and Inlets

1.3 CODES AND STANDARDS:

- A. National Fire Protection Association:
1. NFPA 90A
 2. NFPA 90B
- B. Underwriters Laboratories:
1. UL-555
- C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
HVAC Duct Construction Standards - Metal and Flexible
- D. Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
- E. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - Fundamentals Handbook

PART 2 - PRODUCTS

2.1 DUCTWORK:

- A. Low Pressure Rectangular, Galvanized Steel:
1. All ductwork shall be low pressure rectangular galvanized steel. Ductwork shall be fabricated of galvanized steel sheets in accordance with SMACNA "HVAC Duct Construction Standards - Metal and Flexible", for gauges and stiffening.
 2. Duct system reinforcement shall be selected based on a pressure velocity classification of 2500 feet per minute and positive or negative 2 inches W.G.
 3. All exposed ductwork shall have paint grip type finish or shall be treated to facilitate painting. All longitudinal seams shall be grooved, double or Pittsburgh seams.
 4. Ducts 18 inches and larger on any side shall be stiffened by cross breaking or by beading on not to exceed 12 inch centers.
 5. All junctions, bends, turns or elbows in all ducts or risers shall have a large radius (centerline radius equal to 1-1/2 times duct width) in the throat in order to minimize the friction resistance. Vanes shall be provided in elbows with 90 degree throats and throat radii less than 1-1/2 times duct width, and shall be located in accordance with ASHRAE standards. Double-vane airfoil-type turning vanes shall be provided for all square turns.

6. Branch ducts shall be fabricated per the following schedule:

<u>Maximum Branch Size</u>	<u>Branch Connection</u>
Rectangular equivalent to 12 inch round	45 degree tap collar with volume damper in branch

7. All other duct branches, Proportioned duct with adjustable splitter damper

2.2 DAMPERS AND DEFLECTORS:

A. Backdraft - Counterbalanced:

1. Where indicated on the drawings, provide heavy duty counterbalanced backdraft dampers with adjustable counter-balance assembly. Frame shall be 10 gauge galvanized steel, blades shall be air foil type, gauge steel, maximum width 7 inches. Axles shall be plated steel and bearings shall be prelubricated steel, pressed into frame. Damper assembly shall be able to withstand temperatures up to 250 degrees F. Backdraft dampers shall be Ruskin CBS8, or prior approved equal.

B. Volume - Single Blade:

1. In low pressure ductwork where indicated on the drawings, branch ducts shall have adjustable hinged deflectors, or volume dampers having solid rod connections outside of ducts provided with handle, quadrant and locknuts, so damper can be fastened securely in position after adjustment. Damper levers shall indicate positively the open and closed positions. Edges of dampers shall be crimped or reinforced. Dampers shall be constructed of the same materials as ductwork. Single blade dampers shall be limited to a 12 inch high blade. Dampers less than 18 inches long shall be 22 gauge; dampers over 18 inches long shall be 16 gauge.

C. Volume - Multi-Louvered:

1. In low pressure ductwork where indicated on plans, furnish and install multi-louvered opposed blade volume dampers with handle, quadrant and locknuts so the damper can be fastened securely in position after adjustment. Dampers shall have 16 gauge galvanized sheet metal blades not exceeding 6 inches width set in a steel channel frame. Dampers shall be constructed of the same materials as ductwork.

D. Fire Dampers:

1. Fire dampers shall be Underwriters approved and labeled (UL555). Fire dampers in low pressure ductwork shall be Ruskin, Phillips-Aire Co., or Air Balance, Inc. model 119BL. Dampers shall be fabricated of galvanized steel and shall be of such a design and length as to function as a wall mounting sleeve, which shall be a part of the fire damper. Sleeves shall be of welded or bolted construction. Crimping or tabs will not be acceptable substitutes for welding or bolting.

E. Deflectors:

1. Deflectors shall be Titus Volume Extractor model AG-225.

2.3 FLEXIBLE DUCTWORK:

- A. Flexible duct shall be UL listed and labeled as Class 1, Air duct connector, in accordance with U.L. Standard 181 and shall meet the requirements of the latest NFPA Bulletin, No. 90A and No. 90B for flame spread and smoke development rating.

- B. Flexible duct shall be rated for a maximum pressure of 6 inch positive and 3/4 inch negative and 4000 fpm maximum velocity. Air duct shall consist of: CPE liner, coated spring steel wire helix, fiberglass insulating blanket, fiberglass scrim and polyethylene film vapor barrier. Thermal conductance shall be .23 or less.

- C. Duct shall be Thermaflex G-KM, Certainteed Certaflex G.25 or prior approved equal.

- D. No flexible ductwork shall be allowed on exhaust systems.

2.4 FLEXIBLE CONNECTORS:

- A. Flexible connectors shall be U.L. listed, neoprene coated heavy glass fabric. Fabric shall be Ventglas, manufactured by Ventfabrics, Inc.

PART 3 - EXECUTION

3.1 DUCTWORK:

- A. Ductwork hangers shall be supported by drilled anchors into concrete slabs.
- B. Provide angles (same material as duct) at points where duct penetrates walls, to close off space between wall opening and duct.
- C. Provide supports from roof or wall brackets for ductwork mounted outdoors.
- D. Install in the ductwork dampers and air measuring devices furnished by the Temperature Control Contractor.
- E. Suspended horizontal ducts shall be hung on not to exceed 6 feet spacing by galvanized steel straps 1 inch X no. 16 ga. for sizes up to 60 inch width. Straps shall be fastened to sides of ducts with not less than two pop rivets. Bottom ends of straps shall hook 2 inches under ducts and be secured with a pop rivet through bottom of ducts.
- F. Steam, water and other pipes will not be allowed to pass through ducts.

3.2 DAMPERS AND DEFLECTORS:

- A. Install dampers where indicated.
- B. Install deflectors at each supply grille and register connection.

3.3 FLEXIBLE DUCTWORK:

- A. Flexible ducts shall be used for straight runs of duct or offsets up to 45 degrees, but not exceeding 48 inches in length. The use of flexible ducts or elbows more than 45 degrees will not be permitted. No flexible duct shall be allowed in exhaust systems.
- B. Flexible ductwork shall be secured to rigid ductwork and unit openings by sliding the flexible duct over the rigid duct, sealing with an approved adhesive, clamping with a suitable clamp and taping.

3.4 FLEXIBLE CONNECTORS:

- A. Install flexible connectors at all supply and exhaust fans and other air handling units with inlet and outlet duct or casing connections.
- B. Connectors shall be suitable for the pressure of the units involved and shall be sealed airtight.
- C. Connectors shall be not less than 4 inches long (in clear) and properly attached to duct and fan connection collar by 1 X 1/8 inch galvanized steel draw band firmly clamped around collars in such a manner as to be airtight and secured to collars with sheet metal screws. Connectors shall not be painted.
- D. Connectors shall not be used as transition pieces between fan and ductwork.

END OF SECTION 233115

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SECTION 233423 - POWER VENTILATORS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This specification describes the requirements for labor and materials necessary for the installation of power ventilators included as part of the building mechanical system.

1.2 SUBMITTALS:

- A. Submit catalogue literature pertaining to the power ventilator listed within this Section to Architect/Engineer for approval.
- B. Submittals shall include the following:
1. Dimensional information
 2. Electrical connection and motor data
 3. List of accessories or auxiliary items
 4. Sound power levels at the mid frequency of each band.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. Power ventilators which are scheduled or referred to by model number or catalogue number are intended to include all materials covered by such number. Any required accessories for the installation of the fan are to be by the same manufacturer unless otherwise noted.
- B. All wiring and electrical components shall comply with the National Electric Codes (NEC). All materials shall be U.L. Listed.
- C. Fans shall be listed by Underwriters Laboratories (UL 705).
- D. Fans shall bear the AMCA certified ratings seal for sound and air performance.
- E. Fan assembly shall bear an engraved aluminum nameplate.
- F. Back Draft Damper:
1. Back draft damper shall be 6063T5 extruded aluminum frame, .025 in thick formed aluminum blades, extruded vinyl edge seals, synthetic bearings, mill finish. Leakage shall be limited to 12cfm per square foot at ½ in. W.G.
 2. Damper shall be Ruskin BD2/A1 or approval equal.

2.2 INLINE CABINET EXHAUST FAN - DIRECT DRIVE:

- A. Fan shall be inline mounted, direct driven, centrifugal exhaust fan.
- B. GN 200-900 Series:
1. The fan housing shall be minimum 20 gauge galvanized steel and acoustically insulated.
 2. Blower and motor assembly shall be mounted to a minimum 14 gauge reinforcing channel and shall be easily removable from the housing. Motor shall be mounted on rubber-in-shear vibration isolators. Unit shall be supplied with integral wiring box and receptacle.
 3. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings.
 4. Wheel shall be centrifugal forward curved type, constructed of galvanized steel.

5. Wheel shall be balanced in accordance with AMCA Standard 204-96, *Balance Quality and Vibration Levels for Fans*.
- C. Motor shall be open drip proof type with permanently lubricated sealed bearings and include impedance or thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage and phase.
- D. Fan shall be model GN as manufactured by Loren Cook Company. Greenheck, Acme and Penn Ventilator are approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install fan in accordance with manufacturer's installation instructions.
- B. Install fans with clearances for service and maintenance.
- C. Make final duct connections to fans with flexible connectors.
- D. Isolate fans from structure using vibration isolation hardware specified.

END OF SECTION 233423

SECTION 233713 - REGISTERS, GRILLES, AND DIFFUSERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This specification describes the air distribution outlets, exhaust and return air devices, and the accessories required for complete installation.

1.2 CODES AND STANDARDS:

- A. ANSI/ASHRAE 70 *Method of Testing For Rating The Performance of Air Outlets and Inlets.*
 B. ASHRAE 113 *Method of Testing For Room Air Diffusion.*

1.3 SUBMITTALS:

- A. Submittals shall include the following:
1. Manufacturers technical literature for
 - a. Performance
 - b. Static pressure drop
 - c. Throw
 - d. Sound pressure loss (NC)
 2. Pictorial literature.

1.4 ACCEPTABLE MANUFACTURERS:

- A. Acceptable Manufacturers are Titus, Price, Krueger or prior approved equal.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. Product performance data shall be taken from tests conducted in accordance with ANSI/ASHRAE 70, and ARI-890.
- B. Grilles and registers including volume controllers shall be constructed of the same materials specified for the grille.
- C. The grille finish shall be white unless noted otherwise. The finish shall be an anodic acrylic paint baked at 315°F for 30 minutes.
- D. Refer to architectural drawings for the various types of ceilings, i.e., mineral tile or plaster to assure that air devices have the correct type of mounting. Refer to drawings of reflected ceiling plans for location of ceiling diffusers and grilles.
- E. Supplier shall check all air distribution and return air devices for proper performance, noise and accessories. Any device exceeding noise level herein specified shall be brought to the attention of the Engineers.
- F. Contractor shall coordinate openings in hard ceilings, furred walls, masonry walls, and floors.
- G. The nominal or duct connection size of grilles (not overall dimensions) is given on plans.
- H. Mounting frames shall be provided for all grilles and registers mounted in drywall, plaster, concrete or masonry openings.
- I. Devices are defined in the following manner in this section:

Abbreviation used

<u>Device</u>	<u>on the Drawings</u>
Ceiling Diffuser	CD
Sidewall Grille	SG
Return Grille	RG
Exhaust Grille	EG

J. A third letter following these abbreviations refers to the type of device which is defined herein.

2.2 CEILING DIFFUSER:

A. Type A - Titus Model TDC steel louvered face diffuser with 24 x 24 inch module with an 18 x 18 inch uniform back pan. Diffuser shall include round neck, removable core of fixed deflection louvers and equalizing grid. Diffuser shall be suitable for lay-in installation with air pattern as shown on drawings. Provide with manufacturer's molded insulation backpan.

2.3 SIDEWALL GRILLES:

A. Type A - Titus Model 300 RS steel supply grille. Grille shall include double deflection blades spaced on 3/4 inch centers. Blades shall be individually adjustable to provide air pattern as shown on drawings.

2.4 RETURN GRILLES:

A. Type A - Titus Model 350 RL steel grille. Grille shall include one set of fixed blades set at 35° deflection on 3/4 inch spacing. Grille [and register] shall be suitable for lay-in installation.

B. Type B - Titus Model 33R steel heavy duty bar grille. Grille shall include one set of fixed blades set at 38° deflection on 1/2 inch spacing. Bars shall be 14 gauge steel. Bars shall be reinforced by perpendicular steel bars spaced on 6 inch maximum centers. Grille shall be suitable for surface mounted installation.

2.5 EXHAUST GRILLES:

A. Type A - Titus Model 50F aluminum egg crate grille. Grille shall include 1/2 x 1/2 x 1/2 inch aluminum grid. Grille shall be suitable for lay-in installation.

B. Type B - Titus Model 350 RL steel grille. Grille shall include one set of fixed blades set at 35° deflection on 3/4 inch spacing. Grille shall be suitable for surface mounted installation.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Provide air devices as indicated on the drawings. Mount each device securely to avoid rattling and vibration

B. Devices shall be parallel to the plane of the surfaces they are mounted.

END OF SECTION 23 3713

SECTION 235533 - UNIT HEATERS - GAS FIRED**PART 1 - GENERAL****1.1 DESCRIPTION OF WORK:**

- A. This specification describes the requirements for labor and materials necessary for the installation of gas fired unit heaters included as part of the building mechanical system.

1.2 SUBMITTALS:

- A. Submit catalogue literature listed within this Section to the Engineer for approval.
- B. Submit data for selected units including:
1. Capacity
 2. Design Conditions
 3. Derating
 4. Temperature Rise
 5. Throw (ft)
 6. Spread (ft)
 7. Motor Data
 8. Sound Levels
 9. Controls

PART 2 - PRODUCTS**2.1 GENERAL:**

- A. Performance shall be as indicated on the equipment schedule and plans.
- B. Unit heaters shall have A.G.A. (American Gas Association) design certification.

2.2 CEILING MOUNTED UNIT HEATER - HORIZONTAL THROW:

- A. Casing:
1. Casings shall be a minimum of 22-gauge die-formed steel. All corners shall be rounded with no breaks.
 2. Casing shall be provided with threaded hanger connections for unit suspension.
 3. Fan venturi shall be formed into casing.
 4. All metal surfaces of the casing shall be treated to prevent the formation and spread of rust. Heaters shall be painted with an electrostatically applied paint for optimum corrosion protection.
 5. Casing shall be coated with a minimum 2 mil dry film thickness coating. Coating shall pass the 1000 hour salt spray test under ASTM 117.
- B. Motor:
1. Each unit heater shall have a single motor and propeller. Motor shall be totally enclosed with thermal overload protection (single phase only). Propeller shall be statically balanced and shall be quipped with a safety fan guard.
 2. All motor wiring shall be terminated in an electrical junction box either supplied with the unit heater or as an integral part of the motor.
 3. Motors shall be rated and tested in accordance with NEMA standards. Motors shall include the manufacturer's warranty.

4. Motors shall be rated to operate in 104 degrees F ambient air continuously.
- C. Burner:
1. Burner material shall be aluminized steel with non-clogging, slotted ports and 409 stainless steel separator strip designed for good lighting characteristics without noise of extinction.
- D. Heat Exchanger:
1. Unit heat exchanger shall be constructed of 20 gauge aluminized steel. Heat exchanger shall be heliarc machine-welded and designed with contoured stress-free tubes.
- E. Controls (Standard):
1. Unit heater shall be equipped with a 115V/25V control transformer, a factory supplied terminal board for connection of low voltage thermostat and accessory field wiring, overheat control, 25V automatic gas valve, intermittent pilot with 100% shut-off, gas valve pressure regulator, and electric fan timed delay relay.
 2. All controls shall be rated for a maximum inlet pressure of ½ psi gas pressure. The gas valve and fan timer shall be energized by the thermostat (or manual switch) upon call for heat. The fan shall be delayed for approximately 30 seconds after main burner ignition.
 3. Controls shall be designed for nature gas. Controls shall be fully exposed for easy access.
- F. Intermittent Pilot:
1. Pilot shall be intermittent type, 100% shut-off with continuous retry.
 2. Upon a call for heat from the thermostat, power is supplied to the ignition control and at the same time power is supplied to the fan timer. Sparking will start at the pilot immediately and at the same time the first operator of the combination gas control opens to allow gas to flow to the pilot burner.
 3. The pilot flame should light and be sensed (proven) in a few seconds. As soon as the pilot flame is sensed the sparking will stop and the second operator of the combination gas control will open allowing gas to flow to the main burner. 15 to 45 seconds after the thermostat calls for heat, the fan motor will start.
 4. The system will attempt to light the pilot for 70 seconds once there is a demand for heat. If the pilot is not sensed for any reason, the ignition control will wait for a predetermined time with combination gas control closed and no spark.
 5. After the predetermined time lapses, the cycle will begin again. The time that lapses between cycles is at pre-programmed intervals (approximately six minutes). After three cycles, controller shall lock out for one hour before cycle begins again. This will continue indefinitely until the pilot flame is sensed or until power is interrupted to the system.
 6. When the thermostat has been satisfied, power is turned off to the ignition control and the combination gas control, both the main gas and pilot gas are turned off. The fan shall continue to operate for 45 to 75 seconds to allow the exchanger to cool down.
- G. Thermostat:
1. Single-stage room thermostat:
 - a. 1.5 amp at 30VAC
 - b. 55 to 95 degrees Fahrenheit temperature range
 - c. Heat anticipator 0.18 to 0.8 amp rating
 - d. Honeywell T822D1008

PART 3 - INSTALLATION

3.1 GENERAL:

- A. Examine areas to receive unit heaters for compliance with requirements for installation clearances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation.

3.2 INSTALLATION:

- A. Install unit heaters level and plumb in accordance with manufacturer's instructions.
- B. Suspend unit heaters from structure with rubber-in-shear vibration isolators.

3.3 CONNECTIONS:

- A. Install shutoff valve and union on each heater.
- B. Install piping to allow service and maintenance.
- C. Coordinate installation of disconnects with electrical contractor.
- D. Provide unit with type B vent. Provide roof thimble and cap. Terminate vent 3 feet above roof.
- E. Paint vent to match roof.

END OF SECTION 235533

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SECTION 237413 - PACKAGED AIR CONDITIONING UNITS**PART 1 - GENERAL****1.1 DESCRIPTION OF WORK:**

- A. The work required under this section includes all work necessary for a complete installation of packaged air conditioning units.

1.2 COORDINATION:

- A. The air handling units of one manufacturer have been used as the basis of design. Any modifications to ductwork, piping, wiring, or building structure, that results from the use of any other units shall be coordinated with all trades prior to delivery of approved equipment from the manufacturer. Any modifications required shall be performed without incurring any additional cost to the Contract.

1.3 SUBMITTALS:

- A. Shop drawings shall include complete data on the following:

1. Casing construction,
2. Compressors,
3. Refrigerant circuits,
4. Evaporator and condenser coils,
5. Hot gas reheat coil,
6. Gas heating components,
7. Condensate drain pan,
8. Filters,
9. Motorized outside air dampers,
10. Controls

- B. Fan data shall include:

1. Capacity,
2. Fan curve,
3. V-belt drive,
4. RPM brake horsepower,
5. Fly wheel effect (WK^2),
6. Vibration Isolation,
7. Class,
8. Arrangement,
9. Sound power levels for each octave band.

PART 2 - PRODUCTS**2.1 GENERAL:**

- A. Packaged air conditioning units shall be completely factory assembled including all items and accessories specified in an insulated weather resistant casing.
- B. Units shall be rated and tested in accordance with ARI standard 210 and 360. Units shall be UL listed and labeled and classified in accordance with UL 1995.
- C. The operating range shall be between 115°F and 0°F in cooling as standard from the factory.

2.2 CASING:

- A. Unit casing shall be constructed of zinc coated, heavy gauge, ASTM A527 G90 galvanized steel. Exterior surfaces shall be cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Seams shall be gasket sealed to be water tight. Unit's surface shall be tested 500 hours in a salt spray test in compliance with ASTM B117. Cabinet construction shall allow for all maintenance on one side of the unit.

- B. All exposed vertical panels and top covers in the indoor air section shall be insulated with a cleanable foil-faced, fire-retardant permanent, odorless glass fiber material. The base of the unit shall be insulated with ½ inch, 1 pound density foil-faced, closed-cell material. All insulation edges shall be either captured or sealed. The unit's base pan shall have no penetrations within the perimeter of the curb other than the downflow supply/return openings.
- C. The top cover shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed. The cover shall prevent water from pooling on unit top.
- D. Service panels shall be hinged with integrated non-corrosive hinges and air tight seal. Service panels shall provide access to all sections of the unit for maintenance. Each panel shall use multiple quarter-turn latches and handles.
- E. The base of the unit shall be suitable for mounting on a roof curb and shall have provisions for lifting by crane.

2.3 COMPRESSORS:

- A. Compressors shall be sealed hermetic scroll type with centrifugal oil pumps.
- B. Compressors shall be equipped with crankcase heater, internal overcurrent and temperature protection as well as high and low pressure protection.
- C. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage.
- D. Compressors shall be mounted on spring vibration isolators within the unit.

2.4 REFRIGERANT CIRCUITS:

- A. Each refrigerant circuit shall have independent thermal expansion valve. Service pressure ports, and refrigerant line filter driers are factory-installed as standard. An area shall be provided for replacement suction line driers.

2.5 EVAPORATOR AND CONDENSER COILS:

- A. Evaporator and condenser coils shall be seamless copper tube type with mechanically bonded aluminum fins. Coils shall be factory leak tested to 200 psig and pressure tested to 450 psig.
- B. Provide coil guards for exterior condenser coils.

2.6 HOT GAS REHEAT COILS:

- A. Provide factory installed hot gas reheat coil located on the leaving air side of the evaporator coil. Coil shall be pre-piped and circuited. Provide all necessary unit accessories and control logic to provide complete dehumidification cycle.
- B. Refer to schedule for specific unit requirements.

2.7 INDOOR FANS:

- A. Indoor fans shall be forward curved blade centrifugal type statically and dynamically balanced with adjustable V-belt drive. Motors shall be thermally protected. Fan and motor assemblies shall be spring isolated from the rest of the unit.
- B. All indoor fan motors meet the U.S. Energy Policy Act (EPACT).

2.8 OUTDOOR FANS:

- A. Outdoor fans shall be direct drive, vertical discharge propeller type, statically and dynamically balanced. Fan motors shall be permanently lubricated with built-in thermal overload protection.

2.9 GAS HEATING SECTION:

- A. The natural gas heating section shall have a tubular heat exchanger constructed of aluminized steel and stainless steel burners. An induced draft combustion blower shall be used to pull the combustion products through the firing tubes. The heater shall use a direct spark ignition system. On initial call for heat, the combustion blower shall purge the heat exchanger before ignition. Safety controls shall prevent continued gas flow if spark ignition fails. Heating section shall be factory pressure and leak tested and shall bear AGA approval.

2.10 CONDENSATE DRAIN PAN:

- A. Condensate drain pan shall be stainless steel or double wall galvanized steel with bituminous corrosion resistant coating. Pans shall be insulated on bottom side to prevent condensation.
- B. Drain pan shall conform to ASHRAE Standard 62.

2.11 FILTERS:

- A. Units shall be equipped with 2 inch thick, MERV 7, 30 percent efficient, pleated media type filters.

2.12 MOTORIZED OUTSIDE AIR DAMPERS:

- A. Furnish motorized outdoor air dampers that provide minimum outside air or full economizer control as required by equipment schedule. Outdoor air dampers shall open to set position as indicated in the sequence of operations. The damper shall close to the full closed position as indicated in the sequence of operations.

2.13 CONTROLS:

- A. Unit shall be completely factory-wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Unit shall provide an external location for mounting a fused disconnect device.
- B. A centralized Microprocessor shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection.
- C. 24-volt control circuit shall include control transformer and contactor pressure lugs for power wiring. Units shall have single point power entry as standard.

2.14 WARRANTY:

- A. Provide a written warranty agreeing to replace components that fail in materials and workmanship within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.
- B. Warranty Period: Manufacturers standard, but not less than 5 years from date of Substantial Completion.

2.15 ACCEPTABLE MANUFACTURERS:

- A. Acceptable manufacturers shall include Trane, Carrier, and Daikin.

PART 3 - EXECUTION**3.1 INSTALLATION:**

- A. Install units level and plumb, maintaining manufacturer's recommended clearances.
- B. Install packaged equipment on concrete housekeeping pad. Housekeeping pad shall extend a minimum of 8 inches from the perimeter of the unit. Secure unit to pad with anchor bolts.

3.2 CONNECTIONS:

- A. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.
- B. Install condensate drain with trap and indirect connection to nearest roof drain or area drain.

- C. Connect ducts to packaged equipment with flexible duct connectors .

3.3 FIELD QUALITY CONTROL:

- A. Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. After installing rooftop air conditioners and after electrical circuitry has been energized, test units for compliance with requirements.
- C. Inspect for and remove shipping bolts, blocks, and tie-down straps.
- D. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Remove malfunctioning units, replace with new units, and retest as specified above.

3.4 DEMONSTRATION:

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Session shall be a minimum of four hours.

END OF SECTION 237413

SECTION 23 8153 - DUCTLESS SPLIT SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. The work required under this sections includes all work necessary for a complete installation of ductless split systems.

1.2 CODES AND STANDARDS:

- A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.
- B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
- C. The units shall be rated in accordance with Air-conditioning Refrigeration Institute's (ARI) Standard 210 and bear the ARI Certification label.

1.3 SUBMITTALS:

- A. Submittals shall include complete data on the following:
 - 1. Condensing Unit
 - a. Capacity
 - b. Dimensional Information
 - c. Electrical Requirements
 - 2. Evaporator Section
 - a. Capacity
 - b. Filter
 - c. Sound power level for each octave band

1.4 DELIVERY, STORAGE AND HANDLING:

- A. Unit shall be stored and handled according to the manufacturer's recommendations.
- B. The wireless controller shall be shipped inside the carton with the indoor unit and able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

1.5 WARRANTY:

- A. The units shall have a manufacturer's parts and defects warranty for a period one (1) year from date of installation. The compressor shall have a warranty of 6 years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. The cooling or heat pump systems shall be a ductless split system with Variable Speed Inverter Compressor technology. The system shall consist of an indoor section with wired, wall mounted controller and a horizontal discharge outdoor unit. System efficiency shall meet or exceed 13.0 SEER.

2.2 WALL MOUNTED INDOOR UNIT:

- A. Cabinet:
 - 1. The indoor unit cabinet shall be wall mounted by means of a factory supplied mounting plate, The cabinet shall be formed from high strength molded plastic with front panel access for

- filter.
2. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor.
 3. The unit in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.
- B. Fan: The evaporator fan shall be high performance, double inlet, forward curve, direct drive sirocco type. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall have multiple speeds.
- C. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower noise levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.
- D. Filter: Return air shall be filtered by means of an easily removable washable filter.
- E. Coil: The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.
- F. Electrical: The electrical power of the unit shall be as scheduled. The power to the indoor unit shall be supplied from the outdoor unit. A three (3) conductor AWG-14 wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.
- G. Control:
1. The control system shall consist of two (2) microprocessors, one on each indoor and outdoor unit. Field wiring shall run directly from the indoor unit interconnected by a single non-polar two-wire AWG-16 stranded cable to the wall mounted controller with no splices.
 2. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.
 3. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.
 4. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F). Temperature changes shall be by increments of 1°F with a range of 67°F to 87°F.
 5. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.
 6. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 1,500 feet.

7. The control voltage from the wired controller to the indoor unit shall be 12 volts, DC. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.
8. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.

2.3 OUTDOOR UNIT:

- A. General:
 1. The connected indoor unit must be of the same capacity as the outdoor unit. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.
 2. The outdoor unit shall be capable of operating at 0°F ambient temperature without additional low ambient controls. Provide wind baffle.
 3. The outdoor unit shall be able to operate with a maximum height difference of 100 feet indoor unit to outdoor unit.
 4. System shall have a maximum refrigerant tubing length of 100 feet between indoor and outdoor units without the need for line size changes, traps or additional oil.
 5. Units shall be pre-charged for a maximum of 70 feet of refrigerant tubing. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.
- B. Cabinet: The casing shall be constructed from galvanized steel plate, coated with a finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a munsell 3Y 7.8/1.1 finish. The fan grille shall be of ABS plastic.
- C. Fan: The fan motor shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.
- D. Coil: The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be control by a microprocessor controlled step motor.
- E. Compressor: The compressor shall be a DC rotary compressor with Variable Compressor Speed Inverter Technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain enough heat. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.
- F. Electrical: The electrical power of the unit shall be as scheduled. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Install unit in accordance with manufacturers instructions.
- B. Install full size condensate drain piping from unit to location shown on plan. Drain line shall be installed with a slope of not less than 1/8 inch per foot down in the direction of flow. Install condensing

units according to manufacturers written instructions.

- C. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- D. Install ground-mounted units on concrete housekeeping pad 4 inches larger than condensing unit on each side.
- E. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories. Provide refrigerant accessories shown on the drawings.
- F. Route control wiring in conduit.

3.2 TESTING:

- A. After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks and replace lost refrigerant oil. Use electronic leak detector to test for leakage.
- B. After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements. Record suction pressure.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units with new units and retest.

3.3 MISCELLANEOUS:

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Clean units to remove dirt and construction debris and repair damaged finishes.
- B. Insulate suction piping. Paint insulation.

3.4 DEMONSTRATION:

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain ductless split systems. Session shall be a minimum of four hours.

END OF SECTION 238153

DIVISION 26 SPECIFICATIONS



SECTION 260100 - GENERAL ITEMS**PART 1 - GENERAL****1.1 SCOPE:**

- A. The intent of these specifications and accompanying drawings is to describe and provide for all labor, equipment, and materials necessary for a complete installation of electrical wiring.
- B. The drawings and specifications shall be considered as complementary one to the other, so that materials and workmanship indicated, called for or implied by one and not the other shall be supplied and installed as though specifically called for by both. Omissions from the drawings and specifications or the mis-description of details of work which are evidently necessary to carry out the intent of the drawings and specifications, or which are customarily performed shall not relieve the Electrical Contractor from performing said work. In any case of conflicting or incorrect information, the matter shall be submitted to the Architect who shall make a deposition in writing. Any adjustment by the Contractor shall be at the Contractor's own risk and expense. These electrical drawings are diagrammatical only. Do not scale these drawings.
- C. For the purpose of these documents (Electrical Specs and drawings) the following definitions shall apply:
 - Exposed - Conduit or other equipment installed such that it is visible on finished walls, finished ceilings or structure.
 - Concealed - Conduit or other equipment installed such that it is not visible without removing building finishes.

1.2. WORK REQUIRED:

- A. Furnish labor and materials to complete electric work as shown on drawings or herein specified. Work shall consist of but shall not be limited to the following:
 - 1. Complete electric light and power system.
 - 2. Connection of all switchboards, panelboards, circuit breakers, power outlets, convenience outlets, switches, lighting fixtures, and/or any other equipment forming a part of the electrical system.
 - 3. Provide complete fire alarm system.
 - 4. Lighting control system.
 - 5. Complete emergency lighting and power system.
 - 6. Connection of electrical equipment mentioned in this section or noted on drawings, whether furnished by Electrical contractor or others.
 - 8. Installation of all starters. Except where specified otherwise starters will be furnished by Mechanical Contractor or Plumbing contractor or furnished integral with equipment.
 - 9. Installation and furnishing of disconnect and safety switches.
 - 10. Power wiring and connection of starters and motors, including control wiring where indicated on plans.
 - 11. Complete Structured Cabling System.
 - 12. Complete Audio-Visual System.
 - 13. Complete Security Camera (CCTV) System.

1.3. PROGRESS:

- A. Electrical Contractor shall coordinate his work so as to conform to progress of the work of other trades.

1.4. CODES, PERMITS, AND ORDINANCES:

- A. This contractor shall comply with all state laws and regulations applicable to electrical installations, and shall obtain all permits necessary for its installation paying all fees in connection there with.
- B. All electrical work and material shall conform to the following codes and regulations:
 - 1. The 2020 N.E.C. and amendments.
 - 2. Requirements of the state and local city code authorities.
 - 3. Requirements of the local utility companies.
 - 4. Requirements of the local telephone company.
 - 5. National Electrical Manufacturer's Association.
 - 6. Requirements of National Fire Protection Association Codes.
 - 7. Requirements of International Building Code.

1.5. PROTECTION OF EQUIPMENT AND STORAGE OF MATERIALS:

- A. The Electrical Contractor shall be responsible at all times for all work damaged by him in executing his contract, and any work damaged shall be replaced, and placed in proper working condition at no additional cost to Owner.
- B. The construction premises shall be kept clean and free of scrap materials at all times. The General Contractor shall designate the storage space at the site and/or in the building and the Electrical Contractor shall be responsible for the storage of his tools and materials.

1.6. GUARANTEE AND APPROVAL:

- A. The electrical installation shall be made by competent mechanics, under the supervision of a full-time foreman, all of whom shall be duly certified by local authorities. The entire installation shall be subject to the Architect's constant inspection final approval, and acceptance.
- B. Furnish the Architect with a written guarantee countersigned by the General Contractor, stating that if any workmanship or material executed under this section proves defective within one (1) year after final acceptance, such defects and all other work damaged thereby will be made good by him without charge to the Owner.

1.7. STANDARDS OF MATERIAL AND WORKMANSHIP:

- A. All materials and equipment shall be new and shall be listed as approved by the Underwriter's Laboratories, Inc. in every case where a standard has been established for the particular type of material in question. This requirement applies to all sections of Division 26 in these specifications.
- B. All work required under this section shall be first class in all respects with particular emphasis on neatness and workmanship. The Architect and/or Engineer will judge the quality of workmanship.
- C. The Electrical Contractor shall base his proposal on the materials specified herein and on the plans. Reference to a particular product by the manufacturer, trade name or catalog number establishes the quality standards of materials and equipment required for this installation and is not intended to exclude products equivalent in quality and similar in design. Materials recognized by the National Electrical Manufacturer's Association as equivalent to those specified will be accepted. The electrical contractor must obtain, ten (10) days prior to bid, written approval of any substitutions which he proposes to make. The Engineer reserves the right to decide the equality of proposed equivalents in lieu of those specified.

1.8. ALLOWANCES:

- A. Make allowance in bid for moving, prior to installation or during rough-in, any lighting fixture, wiring device, fusible disconnect switch, motor controller, power or lighting panelboard or equipment item (whether furnished by this Contractor or others) and requiring electrical connections a distance of 6'-0" or less from the locations shown on the drawings without additional cost to the Owner as a result of job conditions or Architect's request.
- B. Contractor shall coordinate specifically exact location of electrical equipment prior to installation to avoid conflict with other trades. Any conflicts shall be brought to the Architect's attention so that the conflict can be properly resolved.
- C. Electrical contractor shall include in their price to provide and install 10 extra exit lights. Exit lights shall be equal to the most expensive exit light model specified on the lighting fixture schedule shown on the plans. Location of exit lights to be determined during life safety inspection.
- D. Electrical contractor shall provide a \$55,000 allowance for the Fire Fighter Communication (BDA) system to be tested once the building is mostly built. If this money is not used, it is to be credited back to the owner via a deductive change order.

1.9. TESTING AND BALANCING:

- A. Make any tests, which may be required by the Inspection Agencies having jurisdiction thereof, the Owner or the Architect, in connection with the operation of the Electrical Systems to the buildings.
- B. Where a test is specified, submit the protocol for the test for review prior to performing the tests; and provide a report of the test results.
- C. Where testing to a NETA acceptance testing specification is specified the intent is for the Contractor to retain a NETA Accredited Company to perform the test and submit the report. The Contractor may elect to self-perform if they are a NETA Accredited Company. Submit certification of accreditation for the performing contractor

1.10. TRENCHING AND BACKFILLING:

- A. Do all excavation necessary for installation of work. Backfill trenches and excavations after work has been installed and inspected. Removing all surplus earth.
- B. Backfill within the building and under paved area shall meet compaction requirements established under other sections of these specifications and fill material shall be pit run gravel or similar granular material.

1.11. SHOP DRAWINGS AND SUBMITTAL DATA:

- A. The Contractor shall submit a list of items proposed for use. He shall also submit catalog data and shop drawings on proposed systems and their components, panelboards, safety switches, starters and contactors, transformers, lighting fixtures, floor boxes, time switches, and wiring devices and plates. Where substitutions alter the design or space requirements, the Contractor shall defray all items of cost for the revised design and construction including costs to all allied trades involved. Contractor shall review and approve shop drawings and data prior to submission to Architect. Data shall be submitted within thirty (30) days after the contract is awarded. Provide electronic copies of drawings unless hard copies are required by the general conditions. Each submittal data section shall be covered with an index sheet listing contractor, supplier, etc., and an index to the enclosed submittals.
- B. Each major section of submittals such as power equipment, lighting equipment, fire alarm, intercom, etc., shall be secured in a booklet or stapled with a covering index which lists the following information:
1. General contractor with phone number and project manager.
 2. Sub-contractor with phone number and project manager.
 3. Supplier of equipment with phone number and person responsible for this project.
 4. Index of each item covered in submittal and model number as proposed in the attached.
 5. Any deviation from contract documents shall be specifically noted on submittal cover index and boldly on specific submittal sheet.
 6. Any of the above information not included with submittals may result in the entire package being returned and not reviewed.
- C. Each section of submittal will be furnished complete. Incomplete sections will not be reviewed and will be returned.
- D. Contractor shall review approved shop drawings and submittal data in detail. Electrical plans are diagrammatical. Contractor shall adjust equipment locations and electrical connection requirements as indicated in approved shop drawings.
- E. Electrical contractor shall submit written verification that he has coordinated all electrical requirements for HVAC and plumbing equipment with mechanical and plumbing subcontractors. Written document shall indicate any difference between design requirements and actual verified requirements and shall recommend solutions to any conflicts found. See "EXAMPLE" form and blank form at end of this section. "EXAMPLE" shows type of information that is required.
NOTE: Electrical submittals will be returned if this document is not included.
- F. Electrical contractor shall submit written verification that he has coordinated all electrical requirements for elevator equipment with the general contractor. Written document shall indicate any difference between design requirements and actual verified requirements and shall recommend solutions to any conflicts found. Refer to "EXAMPLE" form at end of this section.
NOTE: Electrical submittals will be returned if this document is not included.
- G. Electrical contractor shall submit drawings, to scale (1/4" = 1'), showing layout of proposed equipment in electrical rooms or electrical spaces. Drawings shall show panelboards, switchboards, disconnect switches, transformers, HVAC units, plumbing equipment, etc. Drawings shall indicate actual dimensions of equipment to be used on this project. Proper clearances, in accordance with the National Electrical Code, must be maintained. The general contractor shall sign saying he has seen this drawing.
NOTE: Electrical submittals will be returned if this document is not included.
- H. Submittals shall be in electronic PDF format and emailed through the channels. Submittals shall be printed to PDF format from a computer. Scans will not be accepted. If the engineer deems the submittals unreadable, then they will be rejected and returned.

1.12. PROJECT CLOSE-OUT:

- A. Prior to issuance of certificate for final payment, submit to architect and obtain his approval of the following:
1. Record Drawings (As-Builts): Provide record drawings showing all revisions to contract documents including addenda and change orders.
 2. Written certification of any special systems including, but not limited to, fire alarm and intercom (3 copies).
 3. Equipment operating and maintenance manuals (3 copies).
 4. Equipment submittal data (3 copies).
 5. Equipment and system warranty dates and guarantee (3 copies).
 6. Recommended maintenance schedule for equipment and systems (3 copies).
 7. List of owner's personnel with signatures indicating who has received training and operating instructions for each electrical system or special equipment (3 copies).
 8. Test Results or start-up report for any equipment or special systems (3 copies).
 9. Provide an electronic copy of all documents to the Owner and Engineer.
 10. Coordinate other closeout requirements required by Division 1.

1.13. SPECIAL TRAINING:

- A. Contractor shall explain and demonstrate all systems to owner's representative. Contractor shall obtain signature of approved owner's representative on a document indicating that he is satisfied with explanation and demonstration of all electrical systems.
- B. After completion of work, contractor shall provide special training and operating instructions for each system. This training and instruction shall be as necessary for owner's representative to be familiar with system operation but shall not be more than eight (8) hours for any one system.
- C. Special training shall be provided for the following systems:
 1. General Electrical – Light fixtures and lamps, lighting controls, panelboards, transformers, etc.
 2. Fire Alarm System.
 3. Audio Visual System
- D. After training and instruction is complete and owner is satisfied, provide a document for each system stating owner has received special training and instruction and is completely satisfied with his understanding of system operation. Have owner's representative sign this document and submit with project close-out information.

1.14. ELECTRICAL SERVICE:

- A. New Service shall extend underground from utility company padmounted transformer to Main Switchboard.
- B. The service voltage is 277/480 volt, 3 phase, 4 wire 60 hertz with grounded solid neutral.
- C. The primary distribution system is owned and operated by the owner, Sand Mountain Electric Coop. Provide all material and labor as required to produce a complete installation of the electrical service meeting all requirements of the plans and specs.
- D. Service equipment shall be legibly marked in the field with the maximum available fault current. The field markings shall include the date the fault current calculation was performed and shall be of sufficient durability to withstand the environment involved. Contractor is responsible for calculation and proper markings and must comply with NEC 110.24. Field marking shall utilize the same method as panelboard nameplates or labels and shall be on outside cover of Nema 1 panels and on inside of Nema 3R panels.

1.15. HEATING AND AIR CONDITIONING:

- A. The Electrical Contractor shall furnish all branch circuit wiring to motors, exhaust fans, unit heaters, and air handling units as shown on the drawings to provide a complete system of wiring for power. Control equipment and control circuit wiring which is not shown on Electrical Plan will be by the Heating and Air Conditioning Contractor. Provide control conduits as shown on plan with pullwires where empty and with wire when indicated.
- B. Starters shall be furnished by Mechanical or Plumbing Contractor or shall be an integral part of equipment. Where loose starters are furnished, electrical contractor shall install and wire starters for proper operation even if not specifically shown on drawings. Starters in motor control centers shall be furnished and installed by electrical contractor.
- C. All wiring on exterior of building shall be in rigid galvanized conduit or liquid-tight flexible steel conduit and shall be completely waterproofed.
- D. Thermostat outlets shall be furnished and installed by Mechanical Contractor.
- E. Should the manufacturer's data of the equipment furnished on the job indicate circuit breaker protection meets their requirements then non-fused disconnect switches will be acceptable as per local codes and ordinances. If the manufacturer's data indicates that fuses are required, then the disconnect switches shall be fused type. Electrical Contractor must verify this with Mechanical Contractor.
- F. Electrical contractor shall coordinate exact electrical wiring requirements for HVAC and plumbing equipment with Mechanical and Plumbing subcontractors prior to rough-in being done.
- G. Electrical contractor shall submit (along with shop drawings) written verification that he has coordinated all electrical requirements for HVAC and plumbing equipment with mechanical and plumbing subcontractors. Written document shall indicate any difference between design requirements and actual verified requirements and shall recommend solutions to any conflicts found. See "EXAMPLE" form and blank form at end of this section. "EXAMPLE" shows type of information that is required.
NOTE: Electrical submittals will be returned if this document is not included.
- H. Electrical contractor shall coordinate exact layout of HVAC equipment in mechanical rooms, electrical rooms, storage rooms, etc. with mechanical contractor to avoid conflicts with electrical equipment. Contractor shall adjust electrical equipment locations slightly to achieve adequate space and proper clearance requirements. Severe conflicts shall be brought to Architect's attention for a resolution.
- I. Refer to detail on drawings for mounting of disconnect switch and specific wiring requirements at outdoor HVAC equipment.

1.16. EMPTY CONDUITS:

- A. Where conduits in which no wiring is installed are indicated on the drawings, a 200lb mule tape pullwire shall be installed. Leave 18 inch free ends at all outlets, boxes, cabinets and terminations.

1.17 NAMEPLATES (EQUIPMENT IDENTIFICATION):

- A. Provide appropriate nameplates on all disconnect switches, disconnect breakers, panelboards, switchboard, terminal cabinets, controllers, time switches, etc. even if furnished by other contractors under this contract.
- B. Nameplates shall be 4" high x 4" wide multicolored laminated phenolic with minimum 3/8" high engraved letters. Normal power equipment shall be identified by using a black faceplate with white core. Emergency power equipment shall be red faceplate with white core. Identification of flush mounted cabinets shall be on the inside of the device and surface mounted equipment shall be on the outside cover. Nameplates must comply with NEC 200.6 and 215.12.
- C. Equipment identification nameplate shall indicate the following:

Example (120/208 Volt System)

Equipment I.D. AbbreviationPanel B1LA
 Voltage, Phase, Wires120/208V, 3PH, 4W
 Power Source OriginationFed by MPL-400/3P
 Conductor ColorPhase A - Black
 Conductor ColorPhase B – Red
 Conductor ColorPhase C – Blue
 Conductor ColorNeutral - White

Example (277/480 Volt System)

Equipment I.D. AbbreviationPanel B1HA
 Voltage, Phase, Wires277/480V, 3PH, 4W
 Power Source OriginationFed by MPH-400/3P
 Conductor ColorPhase A - Brown
 Conductor ColorPhase B – Orange
 Conductor ColorPhase C – Yellow
 Conductor ColorNeutral - Gray

1.19 ATTIC STOCK:

- A. Contractor shall provide 10% of total LED fixtures of each top 4 quantity type for owner attic stock.
- B. Contractor shall provide 10% of total number of basic electrical, light switches, fire alarm and auxiliary devices.

PART 2 – PRODUCTS

Not applicable.

PART 3 – EXECUTION

Not applicable.

END OF SECTION 260100

(See Attachment A)

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SECTION 260100
ATTACHMENT "A"

Garner & Associates Engineering, PC

D. Morgan Garner, P.E. - Electrical
D. Stanley Borden, P.E. - Electrical

901 South Perry Street
Montgomery, AL 36104
TEL: 334-647-1596

COORDINATION OF ELECTRICAL REQUIREMENTS FOR HVAC AND PLUMBING EQUIPMENT

PROJECT: XYZ High School - Montgomery, AL

DATE: 1-10-11

EQUIP. MARK	DESIGN CHARACTERISTICS				SUBMITTED REQUIREMENTS				CHANGE REQ'D (Y/N)	RECOMMENDED SOLUTION		
	V/PH	HP/A/KW	CKT BKR	DISC SW	FEEDER SIZE	V/PH	HP/A/KW	CKT BKR			DISC SW	FEEDER SIZE
AH-1	208/3	2 HP	15/3P	30A3P	3#12 & 1#12(G)-1/2" c	208/3	3 HP	20/3P	30A3P	3#12 & 1#12(G)-1/2" c	Y	Change 15/3 CB to 20/3 CB
AH-2	208/3	5 HP	40/3P	60A3P	3#8 & 1#10(G)-3/4" c	208/3	5 HP	40/3P	60A3P	3#8 & 1#10(G)-3/4" c	N	
ACCU-7	208/3	45.3A	60/3P	60A3P	3#6 & 1#10(G)-3/4" c	208/3	43.7A	60/3P	60A3P	3#6 & 1#10(G)-3/4" c	N	
ACCU-9	208/3	15.2A	20/3P	30A3P	3#12 & 1#12(G)-1/2" c	208/3	18.1A	30/3P	30A3P	3#10 & 1#10(G)-3/4" c	Y	See Note 1 below.
CH-1	480/3	155A	200/3P	N/A	3#3/0 & 1 #6(G)-2" c	480/3	183A	250/3P	N/A	3#250M&1#4(G)-2 1/2" c	Y	See Note 2 below.

NOTES:

- ACCU-9 - Change 20/3P CB to 30/3P CB and change circuit to 3#10&1#10G-1/2" c.
- CH-1 - Change 200/3P CB to 250/3P CB and change circuit to 3#250 MCM&1#4G-2 1/2" c.

The above referenced contractors have coordinated all electrical requirements for the HVAC and plumbing equipment and agree to all changes. The mechanical and plumbing contractors acknowledge that they are responsible for any cost difference for the electrical contractor's changes.

James Doe
Electrical Contractor

Henry Smith
Mechanical Contractor

Joe Thomas
Plumbing Contractor

ABC Electric, Inc.
Company

Smith Heating & Air
Company

Joe's Plumbing Company
Company

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Garner & Associates Engineering, PC

D. Morgan Garner, P.E. - Electrical
 D. Stanley Borden, P.E. - Electrical

901 South Perry Street
 Montgomery, AL 36104
 TEL. 334-647-1596

COORDINATION OF ELECTRICAL REQUIREMENTS FOR HVAC AND PLUMBING EQUIPMENT

PROJECT: _____ DATE: _____

EQUIP. MARK	DESIGN CHARACTERISTICS				SUBMITTED REQUIREMENTS				CHANGE REQ'D (Y/N)	RECOMMENDED SOLUTION				
	V/PH	HP/A/KW	CKT BKR	DISC SW	FEEDER SIZE	V/PH	HP/A/KW	CKT BKR			DISC SW	FEEDER SIZE		

NOTES:

The above referenced contractors have coordinated all electrical requirements for the HVAC and plumbing equipment and agree to all changes. The mechanical and plumbing contractors acknowledge that they are responsible for any cost difference for the electrical contractor's changes.

Electrical Contractor _____ Mechanical Contractor _____ Plumbing Contractor _____
 Company _____ Company _____ Company _____

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.
- C. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for armored cable, Type AC with ground wire.
- D. VFC Cable:
 - 1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
 - 2. Type TC-ER with oversized crosslinked polyethylene insulation, and sunlight- and oil-resistant outer PVC jacket.
 - 3. Comply with UL requirements for cables in applications.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

- 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. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.

- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.
- I. Branch Circuits Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. Termination of service conductors at pad mounted transformer and at service equipment (where possible) shall be two hole, long barrel compression lugs (two compressions minimum), IlSCO, Burndy, or equal. Connections shall be made with full sized tinned or cadmium plated silicone bronze bolts and hardware.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification of Electrical Systems".
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07841 "Through-Penetration Firestop Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.
 - a. Generator, ATS.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

- c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- B. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
 - 4. Provide certifications as identified above.
- C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. 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 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad or Stainless steel, sectional type; 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. 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.

3.2 **EQUIPMENT GROUNDING**

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.
 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
 10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- G. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 **INSTALLATION**

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 2 Section "Underground Ducts and Utility Structures," and shall be at least 12 inches deep, with cover.
 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- G. System Grounding: Ground the neutral of the electrical distribution system on the supply side of the first switch or circuit breaker controlling the system at the service entrance in accordance with the NEC and as indicated on the drawings. Ground to cold water piping system at service entrance location. Refer to plumbing plans. Also, provide driven ground rod, ground to building steel, and ground to steel rebar in slab on grade.

3.4 **FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- 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 grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- E. Grounding system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Report measured ground resistances that exceed the following values:
 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 5. Substations and Pad-Mounted Equipment: 5 ohms.
 6. Manhole Grounds: 10 ohms.
- H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 1. Hangers and supports for electrical equipment and systems.
 2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 ACTION SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 1. Trapeze hangers. Include Product Data for components.
 2. Steel slotted channel systems. Include Product Data for components.
 3. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Atkore International.
 - g. Wesanco, Inc.
 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical 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 malleable iron.

- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. 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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type 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.

2.2 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 05500 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. 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.

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical 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: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: 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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 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 meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05500 "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 electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03300 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 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.
- B. Touchup: Comply with requirements in Section 09911 "Exterior Painting" Section 09912 "Interior Painting" and Section 09960 "High Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 1. Metal conduits, tubing, and fittings.
 2. Nonmetal conduits, tubing, and fittings.
 3. Metal wireways and auxiliary gutters.
 4. Nonmetal wireways and auxiliary gutters.
 5. Surface raceways.
 6. Boxes, enclosures, and cabinets.
 7. Handholes and boxes for exterior underground cabling.
- B. Related Requirements:
 1. Section 02584 "Underground Ducts and Utility Structures" for exterior ductbanks, manholes, and underground utility construction.

1.2 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit 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 conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. ARC: Comply with ANSI C80.5 and UL 6A.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch, minimum.
- F. EMT: Comply with ANSI C80.3 and UL 797.
- G. FMC: Comply with UL 1; zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew.
 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- J. 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, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ENT: Comply with NEMA TC 13 and UL 1653.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. LFNC: Comply with UL 1660.

- E. Continuous HDPE: Comply with UL 651B.
- F. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
- G. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- H. Fittings for LFNC: Comply with UL 514B.
- I. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- J. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 Type 3R unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
- D. Tele-Power Poles:
 - 1. Material: Aluminum with clear anodized finish.
 - 2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Metal Floor Boxes:
 - 1. Material: sheet metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
 - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

1. Listing and labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- M. Gangable boxes are allowed.
- N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Fiberglass.
 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- O. Cabinets:
 1. NEMA 250, Type 1 Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 1. Standard: Comply with SCTE 77.
 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC."
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.
 1. Standard: Comply with SCTE 77.
 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC."
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed Conduit: IMC.
 2. Concealed Conduit, Aboveground: EMT.
 3. Underground Conduit: RNC, Type EPC-40-PVC.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway 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. Raceway locations include the following:

- a. Loading dock.
- b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
- c. Mechanical rooms.
- d. Gymnasiums.
- 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
- 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
- 6. Damp or Wet Locations: GRC.
- 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways 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. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - 3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
 - 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 **INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Support conduit within 12 inches of enclosures to which attached.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from ENT to GRC before rising above floor.
- I. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- O. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.

2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
- Q. Install devices to seal raceway 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 raceways at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- R. Expansion-Joint Fittings:
 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.
 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 temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F 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 degree F of temperature change for PVC conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion 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.
- S. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- T. 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.
- U. 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 surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- V. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- W. Locate boxes so that cover or plate will not span different building finishes.
- X. 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.
- Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- Z. Set metal floor boxes level and flush with finished floor surface.
- AA. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

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 02300 "Earthwork" for pipe less than 6 inches in nominal diameter.
 2. Install backfill as specified in Section 02300 "Earthwork."
 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 of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 02300 "Earthwork."
 4. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches 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 from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Underground Warning Tape: Comply with requirements in Section 260553 "Electrical Identification."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07841 "Through-Penetration Firestop Systems."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and 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 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Direct-buried conduit, ducts, and duct accessories.
 - 2. Concrete-encased conduit, ducts, and duct accessories.
 - 3. Handholes and boxes.
 - 4. Manholes.

1.2 ACTION SUBMITTALS

- A. Product Data: For ducts and conduits, duct-bank materials, manholes, handholes, and boxes, and their accessories.
- B. Shop Drawings:
 - 1. Precast or Factory-Fabricated Underground Utility Structures:
 - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include reinforcement and joint details, frame and cover design, and manhole frame support rings.
 - 2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, elevations, accessory locations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes.

1.3 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles, locations of expansion fittings, and coordination with other utilities and underground structures on Drawings signed and sealed by a qualified professional engineer.
- B. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
- C. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- D. Source quality-control reports.
- E. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted by Owner, and then only after arranging to provide temporary electrical service.
- B. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

- A. Comply with ANSI C2.

2.2 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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

1. ARNCO Corp.
 2. Beck Manufacturing.
 3. Cantex, Inc.
 4. CertainTeed Corporation.
 5. Condux International, Inc.
 6. ElecSys, Inc.
 7. Electri-Flex Company.
 8. IPEX Inc.
 9. Lamson & Sessions; Carlon Electrical Products.
- B. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-80 and Type EPC-40, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.
- C. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers.
 2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi red concrete and labeled "ELECTRIC."

2.4 **PRECAST CONCRETE HANDHOLES AND BOXES**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Christy Concrete Products.
 2. Elmhurst-Chicago Stone Co.
 3. Oldcastle Precast Group.
 4. Rinker Group, Ltd.
 5. Riverton Concrete Products.
 6. Utility Concrete Products, LLC.
 7. Utility Vault Co.
 8. Wausau Tile Inc.
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 3. Cover Legend: Molded lettering, "ELECTRIC."
 4. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
 5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
 7. Windows: Precast, reinforced openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 9. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 **HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE**

- A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
1. Color: Green.
 2. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC."
 6. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

- B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers made of polymer concrete.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Carson Industries LLC.
 - b. Christy Concrete Products.
 - c. Nordic Fiberglass, Inc.
 - d. Quazite: Hubbell Power System, Inc.
- C. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be made of polymer concrete.
- D. Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Carson Industries LLC.
 - b. Nordic Fiberglass, Inc.
 - c. PenCell Plastics.
 - d. Quazite: Hubbell Power System, Inc.
- E. Comply with ASTM C 858.
- F. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.
- G. Windows: Precast reinforced openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
- H. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
- I. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.
- J. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables More than 600 V: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.
- D. Underground Ducts Crossing Paved Paths, Walks and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin structurally tested according to SCTE 77 with 3000-lbf vertical loading.
 - 5. Cover design load shall not exceed the design load of the handhole or box.
- B. Manholes: Precast concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

- B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- C. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.4 **DUCT INSTALLATION**

- A. Install ducts according to NEMA TCB 2.
- B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.
- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- E. Installation Adjacent to High-Temperature Steam Lines: Where duct banks are installed parallel to underground steam lines, perform calculations showing the duct bank will not be subject to environmental temperatures above 40 deg?C. Where environmental temperatures are calculated to rise above 40 deg?C, and anywhere the duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- F. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch.
 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- G. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall, without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- I. Pulling Cord: Install 100-lbf- test nylon cord in empty ducts.
- J. Concrete-Encased Ducts: Support ducts on duct separators.
 1. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
 2. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
 3. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 4. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 5. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
 6. Elbows: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 7. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 8. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

9. Concrete Cover: Install a minimum of 3 inches of concrete cover at top and bottom, and a minimum of 2 inches on each side of duct bank.
 10. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
- K. Direct-Buried Duct Banks:
1. Excavate trench bottom to provide firm and uniform support for duct bank. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
 2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 3. Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
 4. Depth: Install top of duct bank at least 36 inches below finished grade unless otherwise indicated.
 5. Set elevation of bottom of duct bank below frost line.
 6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
 7. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 8. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
 - a. Place minimum 3 inches of sand as a bed for duct bank. Place sand to a minimum of 6 inches above top level of duct bank.
- L. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.
- M. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Cast-in-Place Manhole Installation:
1. Finish interior surfaces with a smooth-troweled finish.
 2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
 3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.
- B. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891 unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevations:
1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
 2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.

3. Install handholes with bottom below frost line.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.
- D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.
- F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- H. Hardware: Install removable hardware, including pulling eyes, cable stanchions as required for installation and support of cables and conductors and as indicated.
- I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 6-inch- long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND 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.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.
- B. Related Requirements:
 - 1. Section 07841 "Through-Penetration Firestop Systems" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
 - 1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
 - a. Advance Products & Systems, Inc.

- b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
3. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 4. Pressure Plates: Stainless steel.
 5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 **SLEEVE-SEAL FITTINGS**

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
 - a. Presealed Systems.

2.4 **GROUT**

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 **SILICONE SEALANTS**

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 **SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS**

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07920 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. White letters on a black field for normal power systems.
 - 2. White letters on red field for emergency, life safety, systems.
 - 3. Red letters on white field for standby, non-emergency, systems.
 - 4. Legend: Indicate voltage, system and origin of power.
 - a. See detail on plans for clarification.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. White letters on a black field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- D. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 FLOOR MARKING TAPE

- A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.7 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
3. ARC - FLASH WARNING: "WARNING ARC - FLASH HAZARD".

2.8 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
 1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
- 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.

2.9 EQUIPMENT IDENTIFICATION LABELS

- A. 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.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.
- H. Where conduit runs are visible due to exposed ceilings, conduits shall have self-adhesive printed labels detailing the system and voltage of the conduit every 50'. Labels shall be grouped together with other conduits in similar locations.
- I. All branch feeder conduits entries on top of panels for electrical and mechanical equipment shall have printed self-adhesive labels applied within 1' above the equipment with the name of the feeder on it.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits shall be identified in color coded conduit using the following color scheme:
 1. 120/208V – No color
 2. 277/480V – Orange
 3. Fire Alarm – Red
 4. Data – Blue
 5. Security – Purple

6. Lighting Controls – Green
 7. Intercom – White
 8. Interior CCTV – Yellow
 9. Exterior CCTV – Black
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems and exposed conduit runs with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
1. Emergency Power
 2. Power
 3. Fire Alarm
 4. Lighting
 5. Data
 6. Lighting Controls
 7. Security
- C. Power-Circuit Conductor Identification, 600 V or Less: For all conductors.
1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for all services, feeders and branch-circuit conductors.
 - a. Color shall be factory applied continuous for the entire length of the conductor.
 - b. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray
 - a) Where multiple circuits are installed in the same conduit, the neutral conductors shall be gray with color stripe to match associated phase conductor.
 - 5) Ground: Green
 - c. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White
 - a) Where multiple circuits are installed in the same conduit, the neutral conductors shall be white with color stripe to match associated phase conductor.
 - 5) Ground: Green
- D. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.

- J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer load shedding.
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label Stenciled legend 4 inches high.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - 2. Color Scheme:
 - a. White letters on a black field for normal power systems.
 - b. White letters on red field for emergency, life safety, systems.
 - c. Red letters on white field for standby, non-emergency, systems.

END OF SECTION 260553

SECTION 260923 - LIGHTING CONTROL SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Distributed Digital Lighting Control System: System includes
 - 1. Digital Lighting and Plug Load Controls
 - 2. Relay Panels
 - 3. Emergency Lighting Control.

1.2 RELATED SECTIONS

- A. Section 27 05 39 - Surface Raceways for Communications Systems
- B. Section 26 50 00 - Lighting.
- C. Section 26 52 00 - Emergency Lighting.
- D. Section 25 55 00 - Integrated Automation Control of HVAC- Integrated Automation, Building integrator shall provide integration of the lighting control system with Building Automation Systems.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association.
- B. NEMA - National Electrical Manufacturers Association
- C. FCC emission standards
- D. UL - Underwriters Laboratories, Inc. Listings
- E. UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products Installed in Air-Handling Spaces.
- F. UL 20 - General Use Switches, Plug Load Controls
- G. UL 924 - Standard for Emergency Lighting and Power Equipment
- H. ULC - Underwriter Laboratories of Canada Listings

1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. Digital Lighting Management System shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories that suit the required lighting and electrical system parameters.
- B. System shall conform to requirements of NFPA 70.
- C. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.
- D. System shall be listed under UL sections 916 and/or 508.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Catalog sheets and specifications.
 - 2. Ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation instructions.
- C. Shop Drawings: Wiring diagrams a for the various components of the System specified including:
 - 1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
 - 2. Show location of all devices, including at minimum sensors, load controllers, and switches/dimmers for each area on reflected ceiling plans.
 - 3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
 - 4. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.
- D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- E. Closeout Submittals:
 - 1. Project Record Documents: Record actual installed locations and settings for lighting control devices.
 - 2. Operation and Maintenance Manual:
 - a. Include approved Shop Drawings and Product Data.
 - b. Include Sequence of Operation, identifying operation for each room or space.
 - c. Include manufacturer's maintenance information.

- d. Operation and Maintenance Data: Include detailed information on device programming and setup.
- e. Include startup and test reports.
- F. Title 24 Acceptance Testing Documentation: Submit Certification of Acceptance and associated documentation for lighting control acceptance testing performed in accordance with CAL TITLE 24 P6, as specified in Part 3 of this specification under "COMMISSIONING".

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.
- B. Installer Qualifications: Company certified by the manufacturer and specializing in installation of networked lighting control products with minimum three years documented experience.
- C. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

1.7 PRE-INSTALLATION MEETINGS

- A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by Contractor, Architect, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.
- B. Review installation procedures and coordination required with related Work and the following:
 - 1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
 - 2. Review the specifications for low voltage control wiring and termination.
 - 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 - 4. Discuss requirements for integration with other trades
- C. Inspect and make notes of job conditions prior to installation:
 - 1. Record minutes of the conference and provide copies to all parties present.
 - 2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
 - 3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Architect.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.9 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 32 to 104 degrees F (0 to 40 degrees C).
 - 2. Relative humidity: Maximum 90 percent, non-condensing.

1.10 WARRANTY

- A. Products Warranty: Manufacturer shall provide a 5-year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement.

1.11 MAINTENANCE AND OPERATIONAL SERVICES

- A. Remote Access and Enhanced Warranty for Networked Lighting Controls: Provide Manufacturer's Remote Access and Enhanced Warranty for Networked Lighting Controls as follows:
 - 1. Configure to allow the manufacturer remote access to the lighting control system. Configuration includes at a minimum: cellular modem, antenna for the modem, cellular service contract and any connections required to enable communication to the specified Network Lighting Control system.
 - 2. Remote Access program will automatically trigger a First Year Enhanced Warranty Agreement that will start once lighting control system startup is complete and accepted by the Owner. During this one-year period, the Owners authorized site contact can request the manufacturer to check the system for proper operation, and make any programmable changes desired. Manufacturer shall provide a phone number dedicated to customer calls concerning Remote Accessible systems, and a support organization capable of enabling cellular communication to the system for troubleshooting and making requested changes to the system. Any user attempting to request remote support on the system shall be fully verified by the Remote Operations Center (ROC) before providing remote support or making any changes to the system. Systems that allow the modem to be always accessible will not be acceptable. Access must be by a secured VPN connection to the private lighting control network that is completely isolated from the Owner's internal network. Remote access that requires a connection through the Owner's internal network is not acceptable.

3. Remote Access Program may be continued by the Owner after the first year. However, If the Owner does not continue the enhanced warranty the cellular contract will lapse, and all hardware components, while still remaining property of the manufacturer, will remain in situ so that they can be re-activated at a later time should the Owner desire.
4. Manufacturer's Remote Access capability shall provide at a minimum the following features:
 - a. Ability to provide initial system diagnostics through LMCS Software to detect fault conditions in hardware or connected devices.
 - b. Access to all devices via LMCS Software allowing for programmability of device features. This will include all scheduling of Time of Day Events and programming of individual device parameters to meet Sequence of Operation requirements.
 - c. Access to the LMSM Segment Manager browser-based interface (if included on project) to verify it is setup per project documentation, and all functional operations are working properly.
 - d. On demand access to manufacturer technical support via a Remote Operations Center (ROC) that will provide remote troubleshooting, diagnostics, and configuration/programming assistance.
 - e. Additional client training and tuning on the Lighting Control System after building occupancy can be performed while remotely connected to the site.
 - f. Remote Site Readiness Check (SRC) which allows the Remote Operations Center to perform a remote discovery of all devices connected to the lighting control network during installation. DLM Networked projects that have a RACCESS cellular modem and have successfully completed the Site Readiness Check (SRC) process will receive priority scheduling (a SRC is considered successful if 80% or more of the networked devices are found on the network during discovery). After the scheduled on site startup, all manufacturer provided startup work for a site with a successful SRC will be done remotely, or via later complimentary return trips.
- B. Technology-Enabled Service Contract: The manufacturer of the Lighting Control System shall provide a service contract for continued support of the system post installation that combines secure yet immediately accessible remote support with the backup assurance of onsite support when necessary. The coverage levels and features of the selected service contract would apply immediately upon completion of startup and supersede any enhanced remote support offered by the manufacturer during the first year after startup.
 1. Technology-enabled service contract requires a RACCESS (Remote Access) secure cellular connection that allows the manufacturer remote access to the lighting control system to provide remote troubleshooting, diagnostics, and configuration/programming assistance. Manufacturer shall ensure provision of a cellular service plan that keeps the modem active through the chosen Technology-Enabled Service Contract's duration.
 2. If the customer does not renew the Service Contract at the end of the contract term, the cellular service plan will lapse, and all hardware components will remain in situ so that they can be re-activated later should the customer desire.
 3. Technology-Enabled Service Contract Specifics
 - a. Provide a complete "Connect Plus" Service Contract that includes the following features:
 - 1) Priority access to manufacturer technical support via a Remote Operations Center
 - 2) A complete system backup of LMCS and Segment Manager software files semi-annually
 - 3) Semi-annual Device Health Checks to identify any devices that have been bypassed, disconnected, or not functioning with recommendations for resolution
 - 4) An annual onsite training session by a certified factory-trained technician
 - 5) Semi-annual system tuning visits to optimize the lighting configuration, fine tune the Sequence of Operations or make programming changes to the system
 - 6) A 3 day onsite response time for unscheduled emergency visits provided by factory-trained technicians
 - b. Provide a complete "Connect Prime" Service Contract that includes the following:
 - 1) 24/7 priority access to manufacturer technical support via a Remote Operations Center
 - 2) A complete system backup of LMCS and Segment Manager software files quarterly
 - 3) Quarterly Device Health Checks to identify any devices that have been bypassed, disconnected, or not functioning with recommendations for resolution
 - 4) Semi-annual onsite training sessions by a certified factory-trained technician
 - 5) Quarterly system tuning visits to optimize the lighting configuration, fine tune the Sequence of Operations or make programming changes to the system
 - 6) A next day onsite response time for unscheduled emergency visits provided by factory-trained technicians
 4. Length of Technology-Enabled Service Contract:
 - a. 5 Year
- C. Spare Parts:
 1. Provide 10 spares of each complete remote power pack lighting control package.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Acceptable Manufacturer:
1. Legrand: Wattstopper/Solarfective, which is located at: 2700 Zanker Rd. Suite 168; San Jose, CA 95134; Tel: 408-988-5331; Fax: 408-988-5373; Email:[request info \(jon.null@legrand.us\)](mailto:jon.null@legrand.us); Web:<https://www.legrand.us/wattstopper.aspx>
 2. Basis of design product: WattStopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:
 - a. Hubbell and Encellium
- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

- A. System General: Provide a WattStopper, Provide Digital Lighting Management System (DLM) complete with all necessary enclosures, wiring, and system components to ensure a complete and properly functioning system as indicated on the Drawings and specified herein. If a conflict is identified, between the Drawing and this Specification, contact the Architect for clarification prior to proceeding.
1. Space Control Requirements: Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality as indicated in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-ON switches.
 2. Task Lighting / Plug Loads: Provide automatic shut off of non essential plug loads and task lighting in spaces as required by the applicable energy code. Provide Automatic-ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
 3. Daylit Areas: Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:
 - a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
 - b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
 - c. Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
 - d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
 4. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.
- B. Equipment Required: Lighting Control and Automation system as defined under this section covers the following equipment.
1. Digital Lighting Management (DLM) local network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
 2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
 3. Digital Plug Load Controllers: Self-configuring, digitally addressable, single relay, plenum-rated application-specific controllers. Selected models include integral current monitoring capabilities.
 4. Digital Fixture Controllers: Self-configuring, digitally addressable one relay fixture-integrated controllers for on/off/0-10V dimming control.
 5. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
 6. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
 7. Handheld remotes for personal control: On/Off, dimming and scene remotes for control using infrared (IR) communications. Remote may be configured in the field to control selected loads or scenes without special tools.
 8. Digital Daylighting Sensors: Single-zone closed loop, multi-zone open loop and single-zone dual-loop

- daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.
9. Configuration Tools: Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.
 10. Digital Lighting Management (DLM) segment network: Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple DLM local networks for centralized control.
 11. Network Bridge: Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
 12. Wireless Network Bridge and Border Router: Provides Wireless Network Bridges that automatically create BACnet objects for all DLM devices on their local network (room) and communicate that information over a standalone wireless mesh 6LoWPAN network to a Border Router. The Border Router manages the formation and communication of the mesh network, and provides an ethernet network connection to upstream intelligent devices, such as a Segment Manager.
 13. Segment Manager: BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
 14. Programming and Configuration Software: Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
 15. Digital Lighting Management Relay Panel and Zone Controller: Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.
 16. Emergency Lighting Control Unit (ELCU): Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building
- C. Local Network LMRJ-Series: DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
1. Features of the DLM local network include:
 - a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 - b. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
 - c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
 2. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
 3. If manufacturer's pre-terminated Cat5e cables are not used for the installation each cable must be individually tested and observed by authorized service representative following installation.

2.3 DIGITAL LOAD CONTROLLERS (ROOM, PLUG LOAD AND FIXTURE CONTROLLERS)

- A. Digital Load Controllers: Digital controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting and plug load control requirements. Controllers are simple to install, and do not have dip switches/potentiometers, or require special configuration for standard Plug n' Go applications. Control units include the following features
1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
 3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device ID's from highest to lowest.
 4. Device Status LEDs to indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status

5. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
 - a. Turn on to 100 percent
 - b. Turn off
 - c. Turn on to last level
7. Each load be configurable to operate in the following sequences based on occupancy:
 - a. Auto-on/Auto-off (Follow on and off)
 - b. Manual-on/Auto-off (Follow off only)
8. Polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.
9. BACnet object information shall be available for the following objects:
 - a. Load status
 - b. Schedule state, normal or after-hours
 - c. Demand Response enable and disable
 - d. Room occupancy status
 - e. Total room lighting and plug loads watts
 - f. Electrical current
 - g. Total watts per controller
 - h. Total room watts/sq ft.
 - i. Force on/off all loads
10. UL 2043 plenum rated
11. Manual override and LED indication for each load
12. Zero cross circuitry for each load
13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
14. Dimming Room Controllers shall share the following features:
 - a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
 - b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
 - c. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - 1) Establish preset level for each load from 0-100 percent
 - 2) Set high and low trim for each load
 - 3) Initiate lamp burn in for each load of either 0, 12 or 100 hours
 - d. Override button for each load provides the following functions:
 - 1) Press and release for on/off control
 - 2) Press and hold for dimming control
 - e. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
 - f. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
 - g. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
 - h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
- B. On/Off Room Controllers shall include:
 1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load
 2. One or two relay configuration
 3. Simple 150 mA switching power supply (Only 4 100 series devices on a Cat 5e local network)
 4. Three RJ-45 DLM local network ports with integral strain relief and dust cover
 5. WattStopper product numbers: LMRC-101, LMRC-102
- C. On/Off/0-10V Dimming KO Mount Room Controllers shall include:
 1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 10A total load
 2. Optional real time current and voltage monitoring (with - M Monitoring option).
 3. One or two relays configurations
 4. Smart 150 mA switching power supply
 5. Two RJ-45 DLM local network ports. Provide molded strain relief ring
 6. One dimming output per relay
 - a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible

- ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting
7. Units capable of providing both Class 1 or Class 2 wiring for the 0-10V output
 8. WattStopper product numbers: LMRC-111, LMRC-111-M, LMRC-112, or LMRC-112-M.
- D. On/Off/0-10V Dimming Enhanced Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) capable or 347 VAC, 60 Hz. 120/277 volt models rated for 20A total load; 347 volt models rated for 15A total load
 2. Built in real time current monitoring
 3. One, two or three relays configurations
 4. Smart 250 mA switching power supply
 5. Four RJ-45 DLM local network ports. Provide integral strain relief
 6. One dimming output per relay
 - a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting (LMRC-110 series and 210 series).
 7. WattStopper product numbers: LMRC-211, LRM-212, LRM-213.
- E. On/Off/ Forward Phase Dimming Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) rated for 20A total load, with forward phase dimmed loads derating to 16A for some load types
 2. Built in real time current monitoring
 3. One or two relays configurations
 4. Smart 250 mA switching power supply
 5. Four RJ-45 DLM local network ports. Provide integral strain relief
 6. One dimming output per relay
 - a. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. (LMRC-220 series)
 7. WattStopper product numbers: LMRC-221, LMRC-222
- F. Plug Load Controllers shall include:
1. 120 VAC, 60 Hz rated for 20A total load. Controller carries application-specific UL 20 rating for receptacle control.
 2. One relay configuration with additional connection for unswitched load
 3. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
 4. Factory default operation is Auto-on/Auto-off, based on occupancy
 5. Real time current monitoring of both switched and un-switched load (LMPL-201 only)
 6. Switching power supply
 - a. Simple 150mA - Only 4 100 series devices on a Cat 5e local network (LMPL-101)
 - b. Smart 250mA (LMPL-201)
 7. RJ-45 DLM local network ports
 - a. Three RJ-45 ports (LMPL-101)
 - b. Four RJ-45 ports (LMPL-201)
 8. Provide a wireless transmitter that can be connected to any Cat 5e network of the lighting controls that will communicate the room's occupancy state to receptacles mounted in the area with integral relays. Binding of the transmitter to the receptacles shall be accomplished by pressing a test button on the transmitter, and then a test button on the receptacle.
 9. WattStopper product numbers:
 - a. Plug Load Controllers: LMPL-101, LMPL-201.
 - b. Wireless Transceiver and Receptacles: WRC-TX-LM, WRC-15-1/2, WRC-20-1/2
- G. Fixture Controllers shall include
1. A form factor and product ratings to allow various OEM fixture manufacturers to mount the device inside the ballast/driver cavity of standard-sized fluorescent or LED general lighting fixtures.
 2. One 3A 120/277V rated mechanically held relay.
 3. Programmable behavior on power up following the loss of normal power:
 - a. Turn on to 100 percent
 - b. Turn off
 - c. Turn on to last level
 4. Requirement for 7 mA of 24VDC operating power from the DLM local network.
 5. Fixture Controller does not require a connection to a neutral conductor to operate, and unlike other types of Load Controllers it does not contribute power to the DLM local network to drive accessory devices.
 6. Power to drive the LMFC Fixture Controller electronics can come from any Room or Plug Load Controller, LMPB-100 Power Booster and/or LMZC-301 Zone Controller (described later in the LMCP

- LIGHTING CONTROL PANELS specification section).
7. 0-10V dimming capability via a single 0-10 volt analog output from the device for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Fixture Controller.
 8. Connect to a single or dual RJ-45 adaptor with 24 inch leads. Single adaptor mounts in a 1/2 inch KO and dual adaptor in a 2.2 by 1.32 inch rectangular hole for connection to the DLM local network.
 9. Adaptor leads are insulated for use in a fixture cavity, and the lead length allows the OEM fixture manufacturer flexibility to position the Fixture Controller and the RJ45 jack in the best locations on each fixture.
 10. A complete set of dimming features described above in the paragraph detailing On/Off/Dimming Enhanced Room Controllers.
 - a. WattStopper product numbers: Fixture Controller: LMFC-011, DLM Cable Connector: LMFC-RJ-50-24 or LMFC-2RJ, Power Booster: LMPB-100.

2.4 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

- A. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity, 0-100 percent in 10 percent increments
 - b. Time delay, 1-30 minutes in 1 minute increments
 - c. Test mode, Five second time delay
 - d. Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 3. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - e. Ultrasonic and Passive Infrared
 - f. Ultrasonic or Passive Infrared
 - g. Ultrasonic only
 - h. Passive Infrared only
 - i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. One or two RJ-45 port(s) for connection to DLM local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 6. Device Status LEDs, which may be disabled for selected applications, including:
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 8. Manual override of controlled loads.
 9. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
 1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
- C. Units shall not have any dip switches or potentiometers for field settings
- D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
- E. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.5 DIGITAL WALL SWITCH OCCUPANCY SENSORS

- A. Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
 1. Digital calibration and pushbutton configuration for the following variables:

- a. Sensitivity: 0-100 percent in 10 percent increments
 - b. Time delay: 1-30 minutes in 1 minute increments
 - c. Test mode: Five second time delay
 - d. Detection technology: PIR, Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
2. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - 1) Ultrasonic and Passive Infrared
 - 2) Ultrasonic or Passive Infrared
 - 3) Ultrasonic only
 - 4) Passive Infrared only
 3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. Two RJ-45 ports for connection to DLM local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.
 6. Device Status LEDs including
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 7. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.
 8. Assignment of local buttons to specific loads within the room without wiring or special tools
 9. Manual override of controlled loads
 10. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
 4. Button state
 5. Switch lock control
 6. Switch lock status
- C. Units shall not have any dip switches or potentiometers for field settings.
- D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
- E. Two-button wall switch occupancy sensors, when connected to a single relay dimming room or fixture controller, shall operate in the following sequence as a factory default:
1. Left button
 - a. Press and release - Turn load on
 - b. Press and hold - Raise dimming load
 2. Right button
 - a. Press and release - Turn load off
 - b. Press and hold - Lower dimming load
- F. Low voltage momentary pushbuttons shall include the following features:
1. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 2. The following button attributes may be changed or selected using a wireless configuration tool:
 - a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 - b. Individual button function may be configured to Toggle, On only or Off only.
 - c. Individual scenes may be locked to prevent unauthorized change.
 - d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.

- e. Ramp rate may be adjusted for each dimmer switch.
- f. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
- g. WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.6 **DIGITAL WALL SWITCHES**

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
 - 1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - 3. Configuration LED on each switch that blinks to indicate data transmission.
 - 4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
 - 5. Programmable control functionality including:
 - a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
 - b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
 - 6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
 - 1. Button state
 - 2. Switch lock control
 - 3. Switch lock status
- C. Two RJ-45 ports for connection to DLM local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.
- E. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
 - 1. Individual button function may be configured to Toggle, On only or Off only.
 - 2. Individual scenes may be locked to prevent unauthorized change.
 - 3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - 4. Ramp rate may be adjusted for each dimmer switch.
 - 5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
 - 6. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.7 **DIGITAL WALL SWITCH AND TIMER FOR CORRELATED COLOR TEMPERATURE (CCT)**

- A. Digital CCT Preset Switch and CCT Timer Wall Switch for control of Correlated Color Temperature (CCT) in a room require fixtures with below listed CCT capable Logic Module with DLM Control Card - 1 per each independent lighting orientation (eg. direct and indirect), and circuit feed, up to a maximum 8 foot linear LED array or 2 individual down lights. Logic Module characteristics are determined by the specific module installed (Blanco 1, Blanco 2, Blanco 3, or Araya 5) and the LED array. Adjustment of CCT shall precisely trace the Black Body Curve across the LED array's tunable range to replicate natural daylight within the built environment. Only white LED's shall be used for maximum efficacy except for Araya 5. Lighting Fixtures, Lamps, and Ballasts are specified in Section 16500.
 - 1. Each Logic Module with a DLM Control Card to be individually addressable by the system. All other DLM hardware and software products will treat the combo Logic Module/DLM Control Card as a single DLM load and a single DLM device, with the capability of controlling them individual or as part of a group with other DLM load devices in the space, or over the room-to-room network.
 - 2. CCT functionality to be implemented as an additional channel of information for any DLM load device. DLM's standard system capabilities to apply without reduction - either a max of 24, 48, or 96 DLM devices on the local network based on the power device, and a max of 64 loads. Loads that are not CCT capable will ignore any CCT command, so that CCT loads can be added to any existing DLM network without problem to existing programming and devices.
 - 3. CCT and minimum CCT level determined by specific version of logic module used:
 - a. Blanco 1 - No CCT capability, but dimming to .1% minimum.
 - b. Blanco 2 - 2 Channel CCT and dimming to .1% minimum. CCT range from 3000 - 5000K unless

- specified differently in the fixture schedule.
- c. Blanco 3 - 3 Channel CCT and .1% minimum dimming level. CCT range from 2700 - 6500K.
 - d. Araya 5 - 5 Channel CCT and 1% minimum dimming level. CCT range from 1650 - 8000K.
4. CRI shall not be less than 90 (85 for Araya 5) throughout the entire CCT range.
 5. Color consistency of ± 2 MacAdam ellipses over the life of the source.
 6. Closed loop thermal and optical feedback to compensate for thermally induced output variation and lumen depreciation over time.
 7. Integrated driver and LED array assemblies to address inherent LED variability and complex non-linear relationships between system components.
 8. A unique, programmable color model for each color tuning light source enabled by in-line dynamic spectral capture of each LED and custom color model generation.
- B. Low voltage CCT Preset Switch and CCT Wall Switch Timer shall include the same hardware features specified in the proceeding paragraph Digital Wall Switches and be connected to the room's DLM Cat 5e local network cable.
- C. 5 Button CCT Preset Switch to control CCT capable loads via its 4 buttons and rocker.
1. Default Plug n' Go behavior will be that the Preset Switch will bind to all CCT capable loads in the room on connection. Individual loads can be added or removed via normal Push n' Learn programming either manually, via hand held commissioning tool, or LMCS software.
 2. The four preset buttons provide default settings of 100%, 75%, 50% and 25% of available CCT range. Buttons can be programmed to a user's preferred presets by specifying a specific Kelvin temperature, or DLM percentage of controlled fixtures' CCT range (0-100%). Pressing and holding preset button for 5 seconds to record new preset level to that button based on last changed fixture's current setting.
 3. CCT Present Switch shall also include a single rocker that provides full range control of all bound load's CCT level.
- D. CCT Timer Wall Switch to provide automatic time of day events to bound CCT loads in a space.
1. Once the time, date, and location are set, a default program provides a typical daylight cycle with CCT adjustments in the morning and evening to mimic the CCT cycle of sunrise through sunset.
 2. A single schedule of CCT events will apply to every day of the week, adjusting automatically for sunrise and sunset if astronomic events are programmed.
 3. User can choose between 6 astronomic based events or 8 standard time events. Astronomic events can use Sunrise and Sunset (with offsets) and Morning, Mid Day, and Evening event times. Each event to define a single CCT transition that includes a start time, finish time, and CCT level to be achieved at finish. Systems that require multiple messages to fixtures to achieve a single event transition shall not be allowed.
 4. Longitude and latitude input capability for accurate astronomic controls including seasonality adjustment based on geographic location.
 5. Main override button to be capable of any one of the following:
 - a. Control intensity of all assigned CCT loads On/Off, or
 - b. Ability to override CCT level and automatically resume schedule after timed override expires, or
 - c. Ability to override CCT level and manually resume schedule
 6. CCT transitions to occur inside the fixture's logic modules even when lights are off, so that when the fixtures go on to any dimming level they will do so at the proper CCT level for that time. Any time the lights are on, the Timer shall show the current Kelvin temperature for the lights.
 7. Scheduling and settings can be entered on-screen directly using the CCT Timer Wall Switch high resolution display and/or via LMCS software.
- E. WattStopper product numbers: LMSW-105-CCT, LMTS-101-CCT. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.8 **DLM HANDHELD USER INTERFACE REMOTES**

- A. Battery-operated handheld devices in 1, 2 and 5 button configurations for remote switching or dimming control. Remote controls shall include the following features:
1. Two-way infrared (IR) transceiver for line of sight communication with DLM local network within up to 30 feet.
 2. LED on each button confirms button press.
 3. Load buttons may be bound to any load on a load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
 4. Inactivity timeout to save battery life.
- B. Provide with a wall mount holster and mounting hardware for each remote.
- C. WattStopper part numbers: LMRH-101, LMRH-102, LMRH-105.

2.9 **DIGITAL DAYLIGHTING SENSORS**

- A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.

2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone
- B. Digital daylighting sensors shall include the following features:
 1. Sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.
 2. Sensor light level range shall be from 1-6,553 foot-candles (fc).
 3. Capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
 4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
 5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
 6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
 7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
 8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
 9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
 10. Configuration LED status light on device that blinks to indicate data transmission.
 11. Status LED indicates test mode, override mode and load binding.
 12. Recessed switch on device to turn controlled load(s) ON and OFF.
 13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
 - a. Light level
 - b. Day and night setpoints
 - c. Off time delay
 - d. On and off setpoints
 - e. Up to three zone setpoints
 - f. Operating mode - on/off, bi-level, tri-level or dimming
 14. One RJ-45 port for connection to DLM local network.
 15. A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62 inch thick (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62 to 1.25 inches thick (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.
 16. Any load or group of loads in the room can be assigned to a daylighting zone
 17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
 18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.
- C. Closed loop digital photosensors shall include the following additional features:
 1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
 2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
 3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.
 4. WattStopper Product Number: LMLS-400, LMLS-400-L.
- D. Open loop digital photosensors shall include the following additional features:
 1. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
 2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband

- between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.
 4. WattStopper Product Number: LMLS-500, LMLS-500-L.
- E. Dual loop digital photosensors shall include the following additional features:
1. Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this con
 2. Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.
 3. Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.
 4. Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.
 5. Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes.
 6. Device must include extendable mounting arm to properly position sensor within a skylight well.
 7. WattStopper product number LMLS-600

2.10 DIGITAL PARTITION CONTROLS

- A. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.
- B. Four-button low voltage pushbutton switch for manual control.
 1. Two-way infrared (IR) transceiver for use with configuration remote control.
 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 3. Configuration LED on each switch that blinks to indicate data transmission.
 4. Each button represents one wall; Green button LED indicates status.
 5. Two RJ-45 ports for connection to DLM local network.
 6. WattStopper part number: LMPS-104. Available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening.
- C. Coordinate contact closure interface for automatic control via input from limit switches on movable walls specified in Section 10 22 43 - Sliding Partitions .
 1. Operates on Class 2 power supplied by DLM local network.
 2. Includes 24VDC output and four input terminals for maintained third party contract closure inputs.
 3. Input max. sink/source current: 1-5mA
 4. Logic input signal voltage High: > 18VDC
 5. Logic input signal voltage Low: < 2VDC
 6. Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.
 7. Two RJ-45 ports for connection to DLM local network.
 8. WattStopper part number: LMIO-102

2.11 HANDHELD CONFIGURATION TOOLS

- A. Provide a wireless configuration tool to facilitate customization of DLM local networks using two-way infrared communications, and/or PC software that connects to each local network via a USB interface.
- B. Features and functionality of the wireless configuration tool shall include but not be limited to:
 1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify DLM devices by type and serial number.
 4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
 5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
 6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
 7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
 8. Verify status of building level network devices.
- C. WattStopper Product Numbers: Handheld LMCT-100

2.12 DLM SEGMENT NETWORK

- A. Provide a segment network using linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.
1. Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.
 2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.
 3. Segment network utilizes 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. Maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
 4. Network wire jacket is available in high visibility green, white, or black.
 5. Substitution of manufacturer-supplied cable is not permitted and may void the warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
 6. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
 7. Segment networks shall be capable of connecting to any of the following: BACnet-compliant BAS (provided by others) directly via MS/TP, or BACnet/IP via an NB-ROUTER or LMSM Unit. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable
- B. WattStopper Product Number: LM-MSTP, LM-MSTP-W, LM-MSTP-B, LM-MSTP-DB

2.13 NETWORK BRIDGE

- A. Network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. Network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.
1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
 2. Provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
 3. Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after hours schedule state for the room
 - b. Read the detection state of each occupancy sensor
 - c. Read the aggregate occupancy state of the room
 - d. Read/write the On/Off state of loads
 - e. Read/write the dimmed light level of loads
 - f. Read the button states of switches
 - g. Read total current in amps, and total power in watts through the load controller
 - h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
 - i. Activate a preset scene for the room
 - j. Read/write daylight sensor fade time and day and night setpoints
 - k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
 - l. Set daylight sensor operating mode
 - m. Read/write wall switch lock status
 - n. Read watts per square foot for the entire controlled room
 - o. Write maximum light level per load for demand response mode
 - p. Read/write activation of demand response mode for the room
 - q. Activate/restore demand response mode for the room
- B. WattStopper product numbers: LMBC-300

2.14 WIRELESS NETWORK BRIDGES AND BORDER ROUTER

- A. Wireless Network Bridges connect to a DLM local network (room) and use IEEE 802.15.4 6LoWPAN for communication between rooms and to a Border Router that oversees the formation and configuration of the wireless network. Each local network shall include a wireless network bridge that connects to the other DLM devices on the local network, and a group of Wireless Bridges shall connect to a Border Router.

- B. Features of the Wireless Network Bridges shall be as follows:
1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
 2. Wireless Bridges provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the Border Router via the wireless network. No commissioning shall be required for set up of the network bridge on the local network.
 3. Wireless Bridges shall incorporate dual internal omni-directional antennas with diversity to provide wide and robust communication, and so the antennas will be protected against accidental contact with other objects in the space.
 4. Two LEDs shall be included on the bridge to provide feedback about the local network (red) and wireless network (blue) health.
 5. Wireless Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after hours schedule state for the room
 - b. Read the detection state of each occupancy sensor
 - c. Read the aggregate occupancy state of the room
 - d. Read/write the On/Off state of loads
 - e. Read/write the dimmed light level of loads
 - f. Read the button states of switches
 - g. Read total current in amps, and total power in watts through the load controller
 - h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
 - i. Activate a preset scene for the room
 - j. Read/write daylight sensor fade time and day and night setpoints
 - k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
 - l. Set daylight sensor operating mode
 - m. Read/write wall switch lock status
 - n. Read watts per square foot for the entire controlled room
 - o. Write maximum light level per load for demand response mode
 - p. Read/write activation of demand response mode for the room
 - q. Activate/restore demand response mode for the room
- C. Features of the Wireless Border Router shall be:
1. The Wireless Border Router shall manage the formation and configuration of the 6LoWPAN wireless mesh network, and provide connectivity via wired 10/100 Ethernet to a local area network that may include a LMSM Segment Manager or Building BAS System.
 2. Border Router shall provide key information about the health of the mesh network in the form of signal quality, device status, network status, and other real-time network information such as energy monitoring.
 3. The LMBR-600 shall have dual internal omni-directional antennas with diversity to ensure reliable communication with Wireless Network Bridges, and provide a user interface for set up and configuration.
 4. Include an internal MicroSD card and a Real-time clock with supercap back-up. Border Router shall get power for operation via a 120V outlet (in non-plenum applications) and a dedicated DLM LMPB-100 Power Booster connected to a Cat 5e to DC barrel connector (for plenum applications).
- D. Communication between the Wireless Network Bridges and the Border Router
1. The communication between the Wireless Bridges and the Border Router shall be via a standalone wireless mesh network that does not require interface with any other wireless network in the space. The mesh network shall allow communication between all rooms as long as they are within 100' of another connected room.
 2. The Wireless Bridges shall communicate over a 6LoWPAN 2.4 GHz IEEE 802.15.4 network and use AES 128 bit Key Encryption for network security.
 3. In addition to IEEE IPV6, the Border Router shall have available Constrained Application Protocol (CoAP), Routing Protocol for Low Power Networks (RPL), and Stateless Multicast RPL Forwarding (SMRF).
 4. The wireless protocol shall allow BACnet communication to be transported transparently between the Network Bridge and any front end BAS devices such as the LMSM Segment Manager.
- E. WattStopper product numbers: Wireless Network Bridge LMBC-600, Wireless Border Router LMBR-600.

2.15 **LMCP LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER**

- A. Hardware: Provide LMCP lighting control panels in the locations and capacities as indicated on the Drawing and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. Interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. Interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. Panel interiors shall include the following features:
 - a. Removable, plug-in terminal blocks with connections for all low voltage terminations.
 - b. Individual terminal block, override pushbutton, and LED status light for each relay.
 - c. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
 - d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
 - e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
 - f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
 - g. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
 - h. Relay group status shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
 - a. Electrical:
 - 1) 30 amp ballast at 277V
 - 2) 20 amp ballast at 347V
 - 3) 20amp tungsten at 120V
 - 4) 30 amp resistive at 347V
 - 5) 1.5 HP motor at 120V
 - 6) 14,000 amp short circuit current rating (SCCR) at 347V
 - 7) Relays shall be specifically UL 20 listed for control of plug-loads
 - b. Mechanical:
 - 1) Replaceable, 1/2-inch KO mounting with removable Class 2 wire harness.
 - 2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
 - 3) Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
 - 4) Tested to 300,000 mechanical on/off cycles.
5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic bypass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.
8. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
 - a. Each panel shall include digital clock capability able to issue system wide automation commands to up to 11 other panels for a total of 12 networked lighting control panels. Clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
 - b. Clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
 - c. Clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting

- shut off requirements shall not be allowed.
- d. Clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
 - 1) Scheduled ON / OFF
 - 2) Manual ON / Scheduled OFF
 - 3) Astro ON / OFF (or Photo ON / OFF)
 - 4) Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
 - e. User interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)
 - f. Clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
 - g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
9. Lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.
 10. Lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet protocol.
 - a. Panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 - 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
 - b. Panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
 - c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
 - d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 64.
 - e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 - 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
 - f. Setup and commissioning of panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
 - 1) Binary output objects in the instance range of 1 - 64 (one per relay) for on/off control of relays.
 - 2) Binary value objects in the instance range of 1 - 99 (one per channel) for normal hours/after hours schedule control.
 - 3) Binary input objects in the instance range of 1 - 64 (one per relay) for reading true on/off state of the relays.
 - 4) Analog value objects in the instance range of 101 - 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
 - g. Description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
 - h. BO and BV 1 - 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (<http://www.bacnet.org/Addenda/Add-135-2010aa.pdf>)
 - i. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
 - j. Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.
 11. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where LMFC-011 Fixture Controllers or other

distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:

- a. Use the same intelligence board as the LMCP relay panel.
 - b. Shall not include relay driver boards or relays.
 - c. Have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.
 - d. Tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available DLM local networks provided by the LMZC.
 - e. All programming and networking (whether DLM Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays.
12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone Controller, Plug n' Go automatic configuration will establish a unique sequence of operation so that all LMFC-controlled fixtures will turn on to 50 percent output when any digital occupancy sensor detects motion.
13. WattStopper Product Number: Relay Panels: LMCP8, LMCP24 or LMCP48, Zone Controller: LMZC-301.
- B. User Interface: Each lighting control panel system shall be supplied with at least one handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. User interface shall have the following panel-specific functions as a minimum:
1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
 2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
 3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
 4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
 5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
 6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
 7. WattStopper Product Number: LMCT-100

2.16 **SEGMENT MANAGER**

- A. For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).
- B. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the Drawings.
- C. Operational features of the Segment Manager shall include the following:
 1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
 2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. The Segment Manager shall not require installation of any lighting control software on an end-user PC.
 3. Log in security capable of restricting some users to view-only or other limited operations.
 4. Segment Manager shall provide two main sets of interface screens - those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system, and provide a centralized scheduling interface. Capabilities using the Config Screens shall include:
 - a. Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.
 - b. Allow information for all discovered DLM devices to be imported into the Segment Manager via a single XML based site file from the WattStopper LMCS Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text

- descriptions of every DLM component and individual loads, and automatic creation of room location information and overall structure of DLM network. Info entered into LMCS should not have to be re-entered manually via keystrokes into the Segment Manager
- c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
 - d. Ability to view and modify DLM device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
 - e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control. Any of above items shall be capable of being moved into an "Export Table" that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator's request for info and the overall system performance.
5. Capabilities using the Segment Manager's Dashboard Screens shall include:
 - a. A dynamic "tile" based interface that allows easy viewing of each individual room's lighting and plug load power consumption, and lighting and plug load power density (power consumption information requires Enhanced DLM Room and Plug Load Controllers with integral current transducers such as LMRC-21x). Tiles will be automatically organized according to location so a single tile for the building summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles use three color coded energy target parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. Tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the segment manager, based on the information found during the device discovery and/or information included in a file imported in from LMCS (such as tagged descriptions for each room) without any custom programming.
 - b. Ability to set up schedules for DLM local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to automatically show scheduled events by day, week or month.
 - c. For fixtures that are accessible via the Segment Network, and have CCT capability as specified under paragraph Digital Wall Switch and Timer For Correlated Color Temperature, the Segment Manager will provide schedule functionality similar to the CCT Wall Timer, allowing all CCT fixtures across the entire facility to be scheduled together.
 - d. Ability to provide a simple time vs. power graph based on information stored in each Segment Manager's memory (typically two to three days' data).
 6. If shown on the Drawings, Segment Managers shall be integrated into a larger control network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Segment Manager interface software with dedicated communication and networking capability, able to pull information automatically from each individual Segment Manager in the network. By using a Supervisor, information for individual Segment Managers can be accessed and stored on the Supervisor's hard drive, eliminating the risk of data being overwritten after a few days because of Segment Manager memory limits.
 7. Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.
- D. Segment Manager v2.2 and later shall support multiple DLM rooms as follows:
 1. Support up to 120 network bridges and 750 digital in-room devices (LMSM-3E).
 2. Support up to 200 network bridges and 1,100 digital in room devices, connected via network routers and switches (LMSM-6E).
 - E. WattStopper Product Numbers: LMSM-3E, LMSM-6E, LM-SUPERVISOR, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16.

2.17 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

- A. PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing

- standard BACnet/IP communication.
- B. Additional parameters exposed through this method include but are not limited to:
1. Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
 2. Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.
 3. Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.
 4. Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
 5. Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
 6. Load control polarity reversal so that on events turn loads off and vice versa.
 7. Per-load DR (demand response) shed level in units of percent.
 8. Load output pulse mode in increments of 1second.
 9. Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.
- C. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
1. Device list report: All devices in a project listed by type.
 2. Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
 3. BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
 4. Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.
 5. Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.
 6. Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100 percent, 2 = all loads 75 percent, 3 = all loads 50 percent, 4 = all loads 25 percent, 5-16 = same as scene 1).
 7. Occupancy sensor report: Basic settings including time delay and sensitivities for all occupancy sensors.
- D. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:
1. Set, copy/paste an entire project site of sensor time delays.
 2. Set, copy/paste an entire project site of sensor sensitivity settings.
 3. Search based on room name and text labels.
 4. Filter by product type (i.e. LMRC-212) to allow parameter set by product.
 5. Filter by parameter value to search for product with specific configurations.
- E. Network-wide firmware upgrading remotely via the BACnet/IP network.
1. Mass firmware update of entire rooms.
 2. Mass firmware update of specifically selected rooms or areas.
 3. Mass firmware upgrade of specific products
- F. WattStopper Product Number: LMCS-100, LMCI-100

2.18 **EMERGENCY LIGHTING CONTROL DEVICES**

- A. Emergency Lighting Control Unit - A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
1. 120/277 volts, 50/60 Hz, 20 amp ballast rating
 2. Push to test button
 3. Auxiliary contact for remote test or fire alarm system interface
- B. WattStopper Product Numbers: ELCU-100, ELCU-200.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Do not begin installation until measurements have been verified and work areas have been properly prepared.
- B. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that required pre-installation meeting specified in Part 1 of this specification has been completed, recorded meeting minutes have been distributed and all outstanding issues noted have been resolved prior to the start of installation.

3.2 PRE-INSTALLATION MEETING

- A. A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
 - 1. Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
 - 2. Review the specifications for low voltage control wiring and termination.
 - 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 - 4. Discuss requirements for integration with other trades.

3.3 CONTRACTOR INSTALLATION AND SERVICES

- A. Contractor to install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.
- B. Contractor to install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors. If pre-terminated cable is not used for room/area wiring, the contractor is responsible for testing each field-terminated cable following installation, and shall supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty per DLM SEGMENT NETWORK section of specification. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.
- C. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.
- D. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
 - 1. Adjust time delay so that controlled area remains lighted while occupied.
- E. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
- F. Post start-up tuning – After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report to the Architect / Owner of post start-up activity.

3.3 FACTORY SERVICES

- A. Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.
- B. The electrical contractor shall provide both the manufacturer and the electrical engineer with three weeks written notice of the system start up and adjustment date.
- C. Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system. There should be at least two different training sessions.
- D. The manufacturer's rep is responsible for checking with the owner at least 3 months after occupancy to make any corrections to the lighting control system as required.
- E. Upon completion of all work and programming, the Contractor shall certify the system is complete and ready for verification. Manufacturer should include three (3) extra days of a technician's time to review the functionality settings of the lighting control hardware and demonstrate the functionality to the commissioned systems process manager

3.4 INSTALLATION

- A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.
- B. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.
 - 1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
 - 2. If fixtures have internal DLM Control Modules, ensure that they are also connected with Cat 5e cable.
 - 3. Install all room to room network devices using manufacturer-supplied LM-MSTP network wire or wireless devices. Network wire substitution is not permitted and may result in loss of product warranty.
 - 4. Low voltage wiring topology must comply with manufacturer's specifications.
 - 5. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.
- C. All devices, room controllers and lighting control panels, shall be connected together so that they can be managed and viewed from a central location.
- D. All line voltage connections shall be tagged to indicate circuit and switched legs.

- E. Test all devices to ensure proper communication.
- F. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.
- G. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
- H. Post start-up tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.
- I. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.
- J. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.
- K. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.
- L. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.
- M. Remote Access for Network Systems: Ensure Segment Manager enclosure is installed in a location with good to excellent cellular phone coverage based on building orientation and geographic location, and mount magnetic antenna for the modem. For cases where alternate mounting locations are not available and a stronger cellular signal is needed, the manufacturer shall offer additional antenna options to improve signal quality. Verify final mounting location with Engineer and Owner prior to proceeding with the Work.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Notify Architect and Manufacturer in writing a minimum of 3 weeks prior to system start-up and testing.
- B. Tests and Inspections: Manufacturer's service representative shall perform the following inspections and prepare reports.
 - 1. Verify Class I and II wiring connections are terminated properly by validating system performance.
 - 2. Set IP addresses and other network settings of system front end hardware per facilities IT instructions.
 - 3. Verify / complete task programming for all switches, dimmers, time clocks, and sensors.
 - 4. Verify that the control of each space complies with the Sequence of Operation.
 - 5. Correct any system issues and retest..
- C. Provide a report in table format with drawings, or using a software file that can be opened in the manufacturer's system software including each room or space that has lighting control installed. Indicate the following:
 - 1. Date of test or inspection.
 - 2. Loads per space, or Fixture Address identification.
 - 3. Quantity and Type of each device installed
 - 4. Reports providing each device's settings.

3.6 COMMISSIONING ASSISTANCE

- A. Title 24 Acceptance Testing Service; Include additional costs for Lighting Control Manufacturer to provide a technician for one additional day while the CLCATT performs lighting control acceptance testing in accordance with CAL TITLE 24 P6 including submission of required documentation.

3.7 DEMONSTRATION AND TRAINING

- A. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, starting of the lighting control system and Owner instruction includes:
 - 1. Confirmation of entire system operation and communication to each device.
 - 2. Confirmation of operation of individual relays, switches, and sensors.
 - 3. Confirmation of system Programming, photocell settings, override settings, etc.
 - 4. Provide training to cover installation, programming, operation, and troubleshooting of the lighting control system.

3.8 PRODUCT SUPPORT AND SERVICE

- A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

END OF SECTION 260923

SECTION 262413 – SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
 2. Transient voltage suppression devices.
 3. Disconnecting and overcurrent protective devices.
 4. Instrumentation.
 5. Control power.
 6. Accessory components and features.
 7. Identification.

1.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 2. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
 3. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 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. Comply with NEMA PB 2.
- C. Comply with NFPA 70.
- D. Comply with UL 891.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution, ABB
 3. Siemens Energy & Automation, Inc.
- C. Front-Connected, Front-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted.

2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.
- D. Nominal System Voltage: 480Y/277 V.
- E. Main-Bus Continuous: See schedule on drawings.
- F. Enclosure: Steel, NEMA 250, Type 1.
 1. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
 2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.
- G. Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
- H. Space-Heater Control: Thermostats to maintain temperature of each section.
- I. Space-Heater Power Source: 120-V external branch circuit.
- J. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- M. Pull Box on Top of Switchboard:
 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 2. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 3. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- N. Phase and Neutral Buses and Connections: Three phase, four wire unless otherwise indicated. Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
 1. Ground Bus: 1/4-by-2-inch-minimum size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors.
 2. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 3. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables.
- O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
 1. Fuses, rated at 200-kA interrupting capacity.
 2. LED indicator lights for power and protection status.
 3. Audible alarm, with silencing switch, to indicate when protection has failed.
 4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device.
 5. Transient-event counter set to totalize transient surges.
- B. Peak Single-Impulse Surge Current Rating: 160 kA per phase/320 kA per phase.
- C. Withstand Capabilities: 5000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
- D. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277-V, three-phase, four-wire circuits shall be as follows:
 1. Line to Neutral: 800 V for 480Y/277.
 2. Line to Ground: 800 V for 480Y/277.
 3. Neutral to Ground: 800 V for 480Y/277.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26.
 - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - i. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
 1. Fixed circuit-breaker mounting.
 2. Two-step, stored-energy closing.
 3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time time adjustments.
 - c. Ground-fault pickup level, time delay, and I^2t response.
 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 5. Remote trip indication and control.
 6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26.
 7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 8. Control Voltage: 120-V ac.
- C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Boltswitch, Inc.
 - b. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - c. Pringle Electrical Manufacturing Company, Inc.
 - d. Siemens Energy & Automation, Inc.
 2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
 - a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
 - b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
 3. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
 4. Service-Rated Switches: Labeled for use as service equipment.
 5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

- a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- 6. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.
- D. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
 - a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
 - b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
 - 3. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
 - 4. Service-Rated Switches: Labeled for use as service equipment.
 - 5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
 - a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 6. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.
- E. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- F. Fuses are specified in Section 262813 "Fuses."

2.4 **INSTRUMENTATION**

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
 - 1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 2. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 - 3. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
 - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.5 **CONTROL POWER**

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.
- C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.7 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Receive, inspect, handle, store and install switchboards and accessories according to NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 03300 "Cast-in-Place Concrete."
 - 1. 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.
 - 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 switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Install filler plates in unused spaces of panel-mounted sections.
- E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install spare-fuse cabinet.
- G. Comply with NECA 1.
- H. Comply with requirements for terminating feeder bus specified in Division 26.
- I. Comply with requirements for terminating cable trays specified in Division 26.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Electrical Identification."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Electrical Identification."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Electrical Identification."

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Switchboard will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

SECTION 262416 – PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include wiring diagrams for power, signal, and control wiring.
 - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26.
- B. Field quality-control reports.
- C. Panelboard schedules for installation in panelboards.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 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. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus Configured Terminators: Mechanical type.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series-connected short-circuit rating by an NRTL.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution: ABB
 3. Siemens Energy & Automation, Inc.
- C. Panelboards: NEMA PB 1, power and feeder distribution type.
- D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- E. Mains: Circuit breaker or Lugs only.
- F. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- G. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- H. Branch Overcurrent Protective Devices: Fused switches.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
- C. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- D. Mains: Circuit breaker or lugs only.
- E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- F. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
1. External Control-Power Source: 120-V branch circuit.
- G. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- H. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
- C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26.
 - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
 1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."

2.6 **ACCESSORY COMPONENTS AND FEATURES**

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Section Division 26.
- C. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Electrical Identification."
- B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Electrical Identification."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Electrical Identification."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262416

SECTION 262418 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2. Buck-boost transformers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Indicate dimensions and weights.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26.
- B. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Sector; Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Company, ABB
 - 3. Siemens Energy & Automation, Inc.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Division 26.
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Enclosure: Ventilated, NEMA 250, Type 3R.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- F. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- G. Taps for Transformers Smaller Than 3 kVA: None.
- H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

- I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- K. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Tested according to NEMA TP 2.
- L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
- M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
- N. Wall Brackets: Manufacturer's standard brackets.

2.4 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Finish Color: Gray.

2.5 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate. Nameplates are specified in Section 260553 "Electrical Identification."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - a. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - b. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 - c. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

3.3 ADJUSTING

- A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 262418

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Receptacles, receptacles with integral GFCI, and associated device plates.
 2. Weather-resistant receptacles.
 3. Snap switches and wall-box dimmers.
 4. Solid-state fan speed controls.
 5. Wall-switch and exterior occupancy sensors.
 6. Communications outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 3. Leviton Mfg. Company Inc. (Leviton).
 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.
C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.4 GFCI RECEPTACLES

- A. General Description:
1. Straight blade, feed-through type.

2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.

2.5 USB CHARGER RECEPTACLE

- A. General Description:
1. Straight blade, feed-through type.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the USB charger is working.
 4. Shall have two USB ports 3A, 5Vdc, Type A. 2.0.
- B. Duplex USB Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, provide a product equal to the following:
 - a. Hubbell; USB20X

2.6 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Single Pole:
 - 2) Cooper; AH1221.
 - 3) Hubbell; HBL1221.
 - 4) Leviton; 1221-2.
 - 5) Pass & Seymour; CSB20AC1.
 - 6) Two Pole:
 - 7) Cooper; AH1222.
 - 8) Hubbell; HBL1222.
 - 9) Leviton; 1222-2.
 - 10) Pass & Seymour; CSB20AC2.
 - 11) Three Way:
 - 12) Cooper; AH1223.
 - 13) Hubbell; HBL1223.
 - 14) Leviton; 1223-2.
 - 15) Pass & Seymour; CSB20AC3.
 - 16) Four Way:
 - 17) Cooper; AH1224.
 - 18) Hubbell; HBL1224.
 - 19) Leviton; 1224-2.
 - 20) Pass & Seymour; CSB20AC4.
- C. Pilot-Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; AH1221PL for 120 and 277 V.
 - b. Hubbell; HBL1201PL for 120 and 277 V.
 - c. Leviton; 1221-LH1.
 - d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."
- D. Key-Operated Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; AH1221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.7 DECORATOR-STYLE DEVICES

- A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 6252.
 - b. Hubbell; DR15.

- c. Leviton; 16252.
- d. Pass & Seymour; 26252.
- B. GFCI, Feed-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; VGF15.
 - b. Hubbell; GF15LA.
 - c. Leviton; 8599.
 - d. Pass & Seymour; 1594.
- C. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 7621 (single pole), 7623 (three way).
 - b. Hubbell; DS115 (single pole), DS315 (three way).
 - c. Leviton; 56291-2 (single pole), 5623-2 (three way).
 - d. Pass & Seymour; 2621 (single pole), 2623 (three way).
- D. Lighted Toggle Switches, Square Face, 120 V, 15 A: Comply with NEMA WD 1 and UL 20.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 7631 (single pole), 7633 (three way).
 - b. Hubbell; DS120IL (single pole), DS320 (three way).
 - c. Leviton; 5631-2 (single pole), 5633-2 (three way).
 - d. Pass & Seymour; 2625 (single pole), 2626 (three way).
 - 2. Description: With neon-lighted handle, illuminated when switch is "off."

2.8 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. TVSS Devices: Blue.
- B. Wall Plate Color: For plastic covers, match device color.
- C. All devices and plates, including but not limited to AV devices, shall be from the same manufacturer and will be in the off-white color range. Architect to select color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 – FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

- A. 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. Comply with NEMA FU 1 for cartridge fuses.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Bussmann, Inc.
 2. Edison Fuse, Inc.
 3. Ferraz Shawmut, Inc.
 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

- A. Service Entrance: Class L, fast acting.
- B. Feeders: Class L, fast acting.
- C. Motor Branch Circuits: Class RK1, time delay.
- D. Other Branch Circuits: Class RK1, time delay.
- E. Control Circuits: Class CC, fast acting.

3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Electrical Identification" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers 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."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.7 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution, ABB
 - 3. Siemens Energy & Automation, Inc.
- C. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate indicated fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- F. Type HD, Heavy Duty, Double Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- G. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Lugs: Suitable for number, size, and conductor material.
 5. Service-Rated Switches: Labeled for use as service equipment.

2.2 **NONFUSIBLE SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
- C. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- F. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- G. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Lugs: Suitable for number, size, and conductor material.

2.3 **RECEPTACLE SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
- C. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 600-V ac, 30, 60 or 100 A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate indicated fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: [240] [600]-V ac, [30] [60] [100] A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- E. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
- F. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

2.4 **SHUNT TRIP SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Cooper Bussmann, Inc.
 2. Ferraz Shawmut, Inc.
 3. Littelfuse, Inc.
- C. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

- D. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- E. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power source of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- F. Accessories:
 1. Oiltight key switch for key-to-test function.
 2. Oiltight ON pilot light.
 3. Isolated neutral lug.
 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 5. Form C alarm contacts that change state when switch is tripped.
 6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac coil voltage.
 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.5 **MOLDED-CASE CIRCUIT BREAKERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
- C. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- D. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I²t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Features and Accessories:
 1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 7. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.

2.6 **ENCLOSURES**

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 **INSTALLATION**

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

- B. Comply with mounting and anchoring requirements specified in Division 26.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification of Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262816

SECTION 263000 - SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1 GENERAL

1.1 SCOPE

- A. The contractor shall furnish short-circuit and protective device coordination studies which shall be prepared by the equipment manufacturer.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.5 and Informative Annex D.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
 - 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - 3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
 - 4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
 - 5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
 - 6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations
- B. American National Standards Institute (ANSI):
 - 1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
 - 2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
 - 3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 - 4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories
 - 5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents
- C. The National Fire Protection Association (NFPA)
 - 1. NFPA 70 - National Electrical Code, latest edition
 - 2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.3 SUBMITTALS FOR REVIEW/APPROVAL

- A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.4 SUBMITTALS FOR CONSTRUCTION

- A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies, where required, shall be provided on CD in PDF format.
- B. The report shall include the following sections:

1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
5. Multi-function relay setting file printouts including all ANSI protective relay functions and associated logic and control. Metering, communication, and control logic settings not associated with ANSI protective functions are not required.
6. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
7. Incident energy and flash protection boundary calculations
8. Comments and recommendations for system improvements, where needed
9. Executive Summary including source of information and assumptions made

1.5 **QUALIFICATIONS**

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical Engineer shall be a full-time employee of the Engineering Services Organization.

PART 2 PRODUCT

2.1 **STUDIES**

- A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. By using the equipment manufacturer, the study allows coordination of proper breakers, fuses, and current transformers. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the 480 Volt motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.5 and Informative Annex D.

2.2 **DATA COLLECTION**

- A. Contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Source combination may include present and future utility supplies, motors, and generators.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.
- D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.
- B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.
- C. Provide the following:
 - 1. Calculation methods and assumptions
 - 2. Selected base per unit quantities
 - 3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
 - 4. Source impedance data, including electric utility system and motor fault contribution characteristics
 - 5. Typical calculations
 - 6. Tabulations of calculated quantities
 - 7. Results, conclusions, and recommendations
- D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 - 1. Electric utility's supply termination point
 - 2. Incoming switchgear
 - 3. Unit substation primary and secondary terminals
 - 4. Low voltage switchgear
 - 5. Motor control centers
 - 6. Standby generators and automatic transfer switches
 - 7. Branch circuit panelboards
 - 8. Other significant locations throughout the system
- E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- F. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short circuit ratings
 - 2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses
 - 3. Adequacy of transformer windings to withstand short-circuit stresses
 - 4. Cable and busway sizes for ability to withstand short-circuit heating
 - 5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

2.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.
- B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
- D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the curve sheets, where applicable:
 - 1. Electric utility's protective device
 - 2. Medium voltage equipment relays
 - 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 - 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands

5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
 6. Conductor damage curves
 7. Ground fault protective devices, as applicable
 8. Pertinent motor starting characteristics and motor damage points
 9. Pertinent generator short-circuit decrement curve and generator damage point
 10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.
- G. Select each primary protective device required for a delta-wye connected transformer so that the characteristics or operating band is within the transformer parameters which includes a parameter equivalent to 58% of the ANSI withstand point to afford protection for secondary line-to-ground faults.
- H. Separate low voltage power circuit breakers from each other and the associated primary protective device by a 16% current margin for coordination and protection in the event of secondary line-to-line faults.
- I. Engineer shall provide settings file printouts for all multifunction relays supplied under this contract including all ANSI protective relay functions and associated logic and control. Metering, communication, and control logic settings not associated with ANSI protective functions are not required.

2.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2012, Informative Annex D.
- B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.
- C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- D. The Arc-Flash Hazard Analysis shall include all MV, 575v, & 480v locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.
- E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.
- H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.6 REPORT SECTIONS

- A. Input Data:
1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
 2. Short-circuit reactance of rotating machines with associated X/R ratios
 3. Cable type, construction, size, # per phase, length, impedance and conduit type
 4. Bus duct type, size, length, and impedance
 5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
 6. Reactor inductance and continuous ampere rating

7. Aerial line type, construction, conductor spacing, size, # per phase, and length
- B. Short-Circuit Data:
 1. Source fault impedance and generator contributions
 2. X to R ratios
 3. Asymmetry factors
 4. Motor contributions
 5. Short circuit kVA
 6. Symmetrical and asymmetrical fault currents
- C. Recommended Protective Device Settings:
 1. Phase and Ground Relays:
 - a. Current transformer ratio.
 - b. Current setting.
 - c. Time setting.
 - d. Instantaneous setting.
 - e. Specialty non-overcurrent device settings.
 - f. Recommendations on improved relaying systems, if applicable.
 2. Circuit Breakers:
 - a. Adjustable pickups and time delays (long time, short time, ground).
 - b. Adjustable time-current characteristic.
 - c. Adjustable instantaneous pickup.
 - d. Recommendations on improved trip systems, if applicable.
- D. Incident energy and arc flash boundary calculations.
 1. Arcing fault magnitude
 2. Device clearing time
 3. Duration of arc
 4. Arc flash boundary
 5. Working distance
 6. Incident energy
 7. Recommendations for arc flash energy reduction

PART 3 EXECUTION

3.1 FIELD ADJUSTMENT

- A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify Owner in writing of any required major equipment modifications.
- D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.2 ARC FLASH WARNING LABELS

- A. The vendor shall provide a 4 in. x 4 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The label shall have an orange header with the wording, "WARNING, SHOCK & ARC FLASH HAZARD", and shall include the following information:
 1. Location designation
 2. Nominal voltage
 3. Arc flash boundary

4. Incident energy
 5. Working distance
 6. Shock Boundaries
 7. Engineering report number, revision number and issue date
- C. Labels shall be machine printed, with no field markings
- D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
 2. For each motor control center, one arc flash label shall be provided
 3. For each low voltage switchboard, one arc flash label shall be provided
 4. For each switchgear, one flash label shall be provided
 5. For medium voltage switches one arc flash label shall be provided
- E. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.3 ARC FLASH TRAINING

- A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

END OF SECTION 263000

SECTION 265119 - LED INTERIOR LIGHTING

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. Interior solid-state luminaires that use LED technology.
 - 2. Exit Signs.
 - 3. Lighting fixture supports.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of luminaire.
- C. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- 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. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. Recessed Fixtures: Comply with NEMA LE 4.
- D. CRI of minimum 80. CCT of 3500 K.
- E. Rated lamp life of 50,000 hours.
- F. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- G. Internal driver:
 - 1. Minimum efficiency: 85% at full load.
 - 2. Minimum Operating Ambient Temperature: -20° C. (-4° F.).
 - 3. Input Voltage: 120 - 277V (±10%) at 60 Hz.
 - 4. Integral short circuit, open circuit, and overload protection.
 - 5. Power Factor: ≥ 0.95.
 - 6. Total Harmonic Distortion: ≤ 20%.
 - 7. Comply with FCC 47 CFR Part 15.
- H. LED Modules:
 - 1. Comply with IES LM-79 and LM-80 requirements.
 - 2. Minimum CRI 80 and color temperature 3500° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
 - 3. Minimum Rated Life: 50,000 hours per IES L70.
 - 4. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.
- I. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.2 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.

- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, [12 gage] <Insert size>.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
 - 5. Each support shall be identified different from ceiling supports per NEC.
- E. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- F. Ceiling-Grid-Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

- G. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

SECTION 265619 - LED EXTERIOR LIGHTING

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. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
 - 2. Luminaire supports.
 - 3. Luminaire-mounted photoelectric relays.
- B. Related Requirements:
 - 1. Section 260923 "Lighting Control System" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaire.
 - 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79 and IES LM-80.
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 - 6. Wiring diagrams for power, control, and signal wiring.
 - 7. Photoelectric relays.
 - 8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Certificates: For each type of the following:
 - 1. Luminaire.
 - 2. Photoelectric relay.
- C. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Source quality-control reports.
- E. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 QUALITY ASSURANCE

- A. Provide luminaires from a single manufacturer for each luminaire type.
- B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- C. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.9 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- 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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. UL Compliance: Comply with UL 1598 and listed for wet location.
- D. Lamp base complying with ANSI C81.61.
- E. Bulb shape complying with ANSI C79.1.
- F. CRI of 80. CCT of 4000 K.
- G. L70 lamp life minimum of 50,000 hours.
- H. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- I. Internal driver.
- J. Nominal Operating Voltage: 120/277 V ac as noted on plans.
- K. Lamp Rating: Lamp marked for outdoor use.
- L. Source Limitations: Obtain luminaires from single source from a single manufacturer.

2.2 LUMINAIRE TYPES

- A. Area and Site:
 1. Manufacturers: Subject to compliance with requirements, provide products as scheduled on the drawings.
 2. Luminaire Shape: As indicated on drawings.
 3. Mounting: Pole with stainless-steel rectangular arm, length in accordance with fixture in light fixture schedule.
 4. Luminaire-Mounting Height: As indicated on drawings. Verify locations and height with architectural elevations.
 5. Distribution: As indicated in light fixture schedule.
 6. Diffusers and Globes: Tempered Fresnel glass.
 7. Housings:
 - a. Extruded-aluminum housing and heat sink.
 - b. Clear anodized powder-coat finish.

2.3 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Epoxy-coated steel. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- D. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- G. Housings:
 - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 - 2. Provide filter/breather for enclosed luminaires.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

2.4 FINISHES

- A. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As indicated on the light fixture schedule. Verify color with architect, to be confirmed during submittals.

2.5 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Install lamps in each luminaire.
- C. Fasten luminaire to structural support.

- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Support luminaires without causing deflection of finished surface.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
- F. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.
- H. Coordinate layout and installation of luminaires with other construction.

- I. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
- J. Comply with requirements in "Low-Voltage Electrical Power Conductors and Cables" and "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

- A. Aim as indicated on Drawings.
- B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.
 - b. IES LM-50.
 - c. IES LM-52.
 - d. IES LM-64.
 - e. IES LM-72.
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265619

SECTION 266000 – ELECTRIC HAND DRYER

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. High Efficiency Heated Air Electric Hand Dryer.
- B. High Efficiency Surface Mounted ADA Compliant Electric Hand Dryer.

1.2 RELATED SECTIONS

- A. Section 061000 – Rough Country: Blocking in stud partitions for mounting hand dryers.
- B. Section 260519 – Low Voltage electrical Power Conductors and Cables: Electrical supply, conduit, wiring boxes, and wiring devices for hand dryers.

1.3 REFERENCES

- A. ICC/ANSI A117.1 – American National Standard for Accessible and Useable Buildings and Facilities; 2017.
- B. UL, LLC/UL Environment – Product Category Rules (PCR) for Hand Dryers, 2016.

1.4 SUBMITTALS

- A. Submit under provisions of Section 013300
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instruction and recommendations.
 - 2. Operating instruction and performance.
 - 3. Storage and handling requirements.
 - 4. Electrical wiring diagrams.
 - 5. Installation methods.
- C. Shop Drawings showing dimensions, method of attachment, and required supports.
- D. Warranty for review by Engineer.
- E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. A manufacturer Qualifications: Company specializing in manufacturing electric hand dryers with 10 years minimum experience.
- B. Source Limitations: Obtain all electrical hand dryers from a single source and from single manufacturer.
- C. Equipment certified by Underwriters Laboratory, Inc., with UL and ULC labels.
- D. Comply with ICC/ANSI A117.1.

1.6 WARRANTY

- A. Provide manufacturer's standard limited warranty for period specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Excel Dryer, Inc., which is located at: 357 Chestnut St. P. O. Box 365; East Longmeadow, MA 01028. ASD. Tel: 413-525-4531; Fax: 413-525-2853; Email: sales@exceldryer.com; Web Site: www.exceldryer.com.
- B. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 PERFORMANCE

- A. UL Product Category Rule (PCR) Testing:
 - 1. XLERATOR Hand Dryer
 - a. Dry Time: Not greater than eight seconds.
 - b. Energy per Use: Not greater than 3.7 W-h (13.32 J).
- B. Electrical Components: Listed and labeled per NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- C. Certification: Products certified by Underwriters Laboratory, Inc., with UL and ULC labels.

- D. Accessibility Requirements: Components with requirements of ADA/ABA and accessibility requirements of authorities having jurisdiction.
1. Comply with ICC/ANSI A117.1.

2.3 **ELECTRIC HAND DRYERS**

- A. High Efficiency Heated Air Hand Dryer: XLERATOR; Hand Dryer; EPD Certified, Rapid-drying, energy efficient, rapid drying, automatic sensor, adjustable speed and sound control, adjustable heat control, electric hand dryer; surface mounted or semi-recessed; entire dryer internally grounded. Made in the USA Certified. Warranty 5 year limited.
1. Model XL5B-SI
 - a. Cover: To be determine during submittals by architect, provide most expensive
 - b. Finish: To be determine during submittals by architect, provide most expensive
 2. Options:
 - a. HEPA Filtration System: Filters 99.97 percent of bacteria at 0.3 microns from the air stream.
 - b. Noise Reduction Nozzle: Reduces air deflection noise level by 9 dB and increases the dry time by 2-3 seconds.
 3. Mounting: (verify correct mounting with architect)
 - a. Surface Mounted.
 - b. Recessed: ADA compliant recess kit is fabricated of 22 GA 18-8 type 304 stainless steel with #4 satin finish with 16 GA 18-8 type 304 stainless steel dryer mounting plate. All welded construction. 16-3/8 inches (416 mm) wide by 26 inches (660 mm) high by 3-3/8 inches (86 mm) deep.
 4. Controls: Automatic, activated by infrared optical sensor located next to the air outlet. Dryer will operate as long as hands are under the air outlet and has a 35-second lockout feature if hands are not removed. Control includes adjustable sound and speed control mechanism, adjustable heat control with High, Medium, Low, and Off settings and a filter sensor which is activated should the filter become clogged. Sensor equipped with externally visible Red LED light that flashes error codes to assist in troubleshooting. Control assembly sealed for protection against moisture, lint, dust and vandalism.
 5. Air Intake: Inlet openings on bottom of cover.
 6. Air Outlet: Delivers focused air stream of 19,000 LFM at nozzle and 16,000 LFM at average hand position of 4 inches (102 mm) below air outlet.
 7. Pre-Filter: Extends the lifespan and improves reliability. Reduces lint, dust and other airborne debris from entering the internal motor chamber. Filter sensor is activated if filter becomes clogged.
 8. Nominal Size: 11-3/4 inches (298 mm) wide by 12-11/16 inches (322 mm) high by 6-11/16 inches (170 mm) deep.
 9. Weight:
 - a. 16 pounds (7.2 kg) stainless cover.
 10. Power Source:
 - a. 120 Volts, 11.3 – 12.2 Amps, 50/60 Hz, 1240 – 1450 Watts.
 11. Combination Motor and Blower: Series commutated, through-flow discharge, vacuum type; 5/8 HP, 20,000 RPM. Airflow rate: 19,000 linear feet per minute (97 meters per second) at air outlet, 16,000 linear feet per minute (81 meters per second) at average hand position of 4 inches (102 mm) below air outlet.
 12. Heater: Nichrome wire element, mounted inside blower housing to be vandal resistant. Heater Safeguard: Automatic resetting thermostat to open when airflow is resumed.
 13. Air Temperature: 135 degrees F (55 degrees C) measured at average hand position of 4 inches (102 mm) below air outlet. Air Heater Output: 970 watts.
 14. All metal parts coated according to Underwriters Laboratories, Inc. requirements.
 15. Mount at the following heights above floor surfaces.
 - a. Men's Toilets: 45 inches (1143 mm)
 - b. Women's Toilets: 43 inches (1092 mm).
 - c. Teenagers' Toilets: 41 inches (1041 mm)
 - d. Young Children's Toilets: 35 inches (889 mm)
 - e. Toilets for Persons with Physical Disabilities: 37 inches (940 mm)
 - f. Mount dryers at heights indicated on Drawings.
 - g. Verify all mounting heights with Architect prior to rough-in.
 16. Optional Accessories:
 - a. Brushed Stainless Steel Wall Guards.
 - b. XChanger Combo Kit: Recessed Model #'s 40575 (Includes #40502 & 40550) & 40576 (Includes #40502 & 40551) retrofit kit is fabricated of 18 GA 15-8 type 304 stainless steel with #4 satin finish. All welded construction. 17-1/4 inches (416 mm) high by 56 inches (660 mm) deep.

mm) wide by 1 inch 925 mm) deep.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Coordinate requirements for blocking to ensure adequate means for support and installation of hand dryers.
- D. Coordinate requirements for power supply, conduit, disconnect switches and wiring.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install dryers at specified heights. See architectural drawings.
- C. Install dryers securely to supporting substrate so that fixtures are level and aligned with each other. Use type and length of fastener as recommended by manufacturer for type of substrate.

3.4 PROTECTION

- A. Inspect installation to verify secure and proper mounting. Test each dryer to verify operation, control functions, and performance. Correct deficiencies.
- B. Protect installed dryers until completion of project.
- C. Replace damaged products before Substantial Completion.

END OF SECTION 266000

DIVISION 27 SPECIFICATIONS



SECTION 270500 - STRUCTURED CABLING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of General Requirements/Provisions shall be considered a part of this section and shall have the same force as if printed herein full. In addition, all information related to communications infrastructure that is documented in the architectural, structural, mechanical, and electrical drawings/documents shall be included as part of the communications documents.

1.2 QUALITY ASSURANCE

- A. Specifications, Standards and Codes: All work shall be in accordance with the following:
1. The current edition of the National Electrical Code (NFPA 70)
 2. American National Standards Institute (ANSI)
 3. National Electrical Manufacturers Association (NEMA)
 4. Telecommunications Industries Association (TIA)
 5. Electronic Industries Association (EIA)
 6. Institute of Electrical & Electronics Engineers (IEEE)
 7. Underwriters Laboratories (UL)
 8. American Standards Association (ASA)
 9. Federal Communications Commission (FCC)
 10. Occupational Safety and Health Administration (OSHA)
 11. American Society of Testing Material (ASTM)
 12. Americans with Disabilities Act (ADA)
 13. Local city and county ordinances governing electrical work
 14. In the event of conflicts, the more stringent provisions shall apply.

1.3 SCOPE

- A. The work to be done under this section of the specifications shall include furnishing labor, material and equipment required to provide a complete installation of the work indicated on the drawings or as specified herein.
- B. All material required to provide a fully operational system but not specifically mentioned or shown on the drawings, shall be furnished and installed without any additional charge.
- C. The drawings and specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the drawings and specifications, the more stringent shall be included, and the engineer shall be notified of the discrepancy.

1.4 WORK INCLUDED

The Communications Infrastructure installed and work performed under this Division of the Specifications shall include but are not limited to the following:

- A. Fiber Cabling Infrastructure.
- B. Data Cabling Infrastructure
- C. CCTV Cabling Infrastructure System
- D. Wireless Access System Cabling
- E. Communications raceways, cable tray, ladder rack, racks and equipment mounting backboards
- F. Grounding and Bonding
- G. Provide racks, patch panels, faceplates as required for a complete and certified structured cabling system.

1.5 DEFINITIONS

- A. Terms: The following definitions of terms supplement those of the General Requirements and are applicable to Division 27 - Communications:
- B. Provide: As used herein shall mean "furnish, install and test (if applicable) complete."
- C. Infrastructure: As used herein shall mean cable, conduit, raceway, cable tray or j-hooks with all required boxes, fittings, connectors, and accessories; completely installed.
- D. Work: As used herein shall be understood to mean the materials completely installed, including the labor involved.

1.6 DRAWINGS

- A. Drawings are diagrammatic and show the arrangement and location of pathways, outlets, support structures and equipment. The contractor shall carefully investigate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, the contractor shall advise the engineer in writing for approval before proceeding with such work.
- B. Materials, equipment or labor not specifically indicated but required to form a complete system shall be provided. Drawings and Specifications do not indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.
- C. The right is reserved to make reasonable changes in locations of equipment indicated on drawings prior to rough-in without increase in contract cost.
- D. The contractor shall not reduce the size or number of conduit runs indicated on the drawings without the written approval of the Engineer.
- E. Any work installed contrary to contract drawings shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.
- F. The location of equipment, support structures, outlets, and similar devices shown on the drawings are approximate only. Do not scale drawings. Obtain layout dimensions for equipment from Architectural plans unless indicated on communications plans.
- G. Verify the ceiling type, ceiling suspension systems, and clearance above ceilings prior to ordering cabling and associated hardware. Notify the engineer of any discrepancies.
- H. Review all architectural drawings for modular furniture layouts.

1.7 SUBMITTALS

- A. Submit for approval, manufacture specifications of all materials, equipment and systems to be furnished. Work shall not proceed without the Engineer's approval of the submitted items. Three (3) copies of the following shall be submitted:
 - 1. Submittal specification sheets for individual items for equipment assemblies that consist of more than one item or component shall be submitted. Each specification sheet shall be reviewed and sealed by contractors RCDD. Partial or incomplete submittals will not be considered, reviewed or stored, and such submittals will not be returned except at the request and expense of the contractor.
 - 2. Contractor shall generate shop drawings. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop drawings with record drawings on hard copy. Additionally, provide one electronic copy of shop drawings in both AutoCad format (.dwg file) and Visio format(.vsdx file). Failure to submit electronic file with drawings will be grounds for immediate rejection.
 - 3. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings. All Submittal drawings shall be prepared and sealed by the contractors RCDD for approval.
 - 4. Provide Certificate of RCDD personnel.
 - 5. Provide all inspection certificates.
- B. Any materials and equipment listed that are not in accordance with specification requirements may be rejected.
- C. The approval of material, equipment, systems and shop drawings is a general approval subject to the drawings, specifications and verification of all measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. The contractor shall carefully check and correct all shop drawings prior to submission for approval.

1.8 QUALITY ASSURANCE

- A. Equipment and materials required for installation under these Specifications shall be the current model and new (less than one [1] year from the date of manufacture), unused and without blemish or defect.
- B. Equipment shall bear labels attesting to Underwriters Laboratories, where subject to label service. Manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of three (3) years and be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.

1.9 CONTRACTOR QUALIFICATIONS

- A. The contractor shall have total responsibility for the coordination and installation of the work shown and described in the drawings and specifications. The contractor shall be a company specializing in the design, fabrication and installation of integrated communications systems.
- B. Communication systems specified shall be installed under the direction of a qualified Contractor. Qualification requirements shall include submittal by the contractor to the engineer of the following:
 - 1. List of five [5] previous projects of this scope, size and nature; including names and sizes of projects, description of work, time of completion and names of contact persons for reference.
 - 2. Certification of contractor's manufacturer-authorization to provide material, perform installation and provide a minimum 25 year manufacturer's warranty for work to be performed under this contract. This must be provided with submittals for approval.
- C. Contractor must have a Registered Communications Distribution Designer (RCDD) on staff. This individual must be a W-2 employee of data contractor. Various types RCDD contractors are not allowed for this project.
- D. Submit copy of contractor's RCDD Certificate and resume for verification and approval at time of submittal.
- E. All submittal documentation shall be prepared, sealed and signed by the contractor's RCDD for approval.
- F. Contractor must have an office regularly staffed on a daily basis with certified service and installation technicians within a 75 mile radius of the project site.

1.10 COORDINATION WITH OTHER TRADES

- A. The Contractor shall coordinate communications work with that of other sections as required to ensure that the entire communications work will be carried out in an orderly, complete and coordinated fashion.

1.11 PERMITS

- A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

1.12 WARRANTY

- A. The performance warranty will cover the components and labor associated with the repair or replacement of any failed link, within the warranty period (minimum 25 years), that is a valid warranty claim.
- B. The minimum 25-year performance warranty shall cover applications assurance, transmission performance and the system components of the cable and connectivity system.
- C. Extended warranties shall be provided on all component installations. Any and all warranties shall be provided at no additional cost.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Where equipment is identified by manufacturer and catalog number, it shall be as the base of requirements for quality and performance. Where manufacturers for equipment are identified by name, the Contractor may submit for approval, similar equipment of other manufacturers as substitution. The Engineer's decision as to whether the submitted equipment is acceptable shall be final and binding.
- B. All changes necessary to accommodate the substituted equipment shall be made at the contractor's expense, and shall be as approved by the Engineer. Detailed drawings indicating the required changes shall be submitted for approval at the time the substitution is requested.
- C. If substitutions are made in lieu of devices specified; form, dimension, design and profile shall be submitted to the Engineer for approval.
- D. Submit request for approval of substitute materials in writing to the Engineer at least ten (10) days prior to bid opening for review.

2.2 MATERIALS

- A. All materials used in this work shall be new and shall bear the inspection label of Underwriters' Laboratories Inc. or certification by other recognized laboratory.
- B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), and the American Society of Testing Materials (ASTM), are made a part of these Specifications and shall apply wherever applicable.
- C. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- D. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer or partner manufacturers that offer a certified solution.
- E. Components shall be compatible with each other and with the total assembly for the intended service.

PART 3 - EXECUTION**3.1 EXAMINATION OF CONDITIONS**

- A. Prior to the start of work, the Contractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.
- B. Install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.
- C. In the event of a discrepancy, immediately notify the engineer in writing.
- D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.2 PROTECTION OF SYSTEMS AND EQUIPMENT

- A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
- B. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.
- C. As determined by the engineer, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the contract documents.
- D. Damaged paint on any equipment or material shall be repainted to the same quality of paint, color, finish and workmanship as used by the manufacturer.

3.3 ACCESS TO EQUIPMENT

- A. Equipment shall be installed in a location and manner that will allow convenient access for maintenance and inspection.
- B. Working spaces shall be not less than specified in the National Electrical Code (NEC) for voltages specified.
- C. Where the engineer determines that the contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the engineer, at no additional cost to the Owner. "Conveniently accessible" is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.4 CLEANING

- A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of all packing material and debris caused by communications work.
- B. Remove dust and debris from interiors and exteriors of all communications equipment.

3.5 COMPLETION

- A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
- B. Results Expected: Systems shall be complete and operational and controls shall be set and calibrated. Testing, start-up and cleaning work shall be complete.
- C. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this specification shall be delivered to the Owner.

3.6 **FIELD QUALITY CONTROL**

- A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.
- D. Perform tests and inspections.
- C. Tests and Inspections:
 - (i) Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with ANSI/TIA-568.1-D.
 - (ii) Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - (iii) Retain first subparagraph below if verification of quality is to be performed before completing horizontal cabling. Otherwise, specify testing of the transmission performance of cabling system in Section 271500 "Communications Horizontal Cabling"
 - (iv) Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - 1. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568.1-D. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - (v) Optical Fiber Cable Tests:
 - 1. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568.3-D. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - 2. Link End-to-End Attenuation Tests:
 - a. Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
 - b. Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in ANSI/TIA-568.3-D.
- D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
 - (a) Remove and replace cabling where test results indicate that they do not comply with specified requirements.
 - (b) End-to-end cabling will be considered defective if it does not pass tests and inspections.
 - (c) Prepare test and inspection reports.

END OF SECTION 270500

SECTION 270510 - IDENTIFICATION FOR COMMUNICATION SYSTEMS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Section 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the equipment and execution requirements relating to Identification for Communications Systems.
- C. Equipment specifications, general considerations, and guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 – LABELING

2.1 LABELING REQUIREMENTS

- A. Labeling shall be done in accordance with the recommendations made in the ANSI/TIA-606-C document, manufacturer's recommendations and best industry practices.
- B. All spaces, pathways, outlets, cables, termination hardware, grounding system and equipment shall be labeled with machine-generated labels.
- C. All labels shall be clear with black text.
- D. All cables shall be labeled with machine generated, wrap around labels. Handwritten labels will not be accepted.
- E. A total of three (3) labels per horizontal cable are required at the following intervals: 6" from outlet; 18" from outlet' 12" from termination block/patch panel.
- F. Labeling scheme shall be alphanumeric. Verify labeling scheme requirements with Owner prior to installation.

2.2 COLOR SCHEME

- A. The following color scheme shall apply to all wiring, face plates, patch panels, etc for the entire system:
 - 1. Data – Blue
 - 2. VOIP/Intercom – White
 - 3. Wireless Access Points (WiFi) – Orange
 - 4. Lighting Controls - Green
 - 5. Interior CCTV – Yellow
 - 6. Exterior CCTV - Black
 - 7. Access Controls – Purple

END OF SECTION 270510

SECTION 270520 - COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Section 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Cable Management and Ladder Rack.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

- A. Provide product data from manufacturer's specifications for each item to be installed under this contract to the Engineer for review and approval.

1.3 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Horizontal Cable Management Manufacturer(s)
 - 1. Leviton
 - 2. Systimax (Uniprise Not Excepted)
 - 3. Siemon
 - 4. No Exceptions
- B. Approved Vertical Cable Management Manufacturer(s)
 - 1. Leviton
 - 2. Systimax (Uniprise Not Excepted)
 - 3. Siemon
 - 4. No Exceptions
- C. Approved Ladder Rack System Manufacturer(s)
 - 1. Chatsworth Products, Inc.
 - 2. Hoffman
 - 3. No Exceptions
- D. Approved Tie Wrap/Velcro Strap Manufacturer(s)
 - 1. Leviton
 - 2. Or Approved Equal

2.2 CABLE MANAGEMENT - HORIZONTAL

- A. Horizontal Cable Management
 - 1. The horizontal wire manager shall be compatible with 19-inch equipment racks, cabinets or wall mount brackets.
 - 2. The horizontal cable manager shall be double-sided to provide support/management for patch cords at the front of the panel and support/management of cables at the rear of the panel.
 - 3. The horizontal cable manager shall be equipped with removable front and covers
 - 4. The horizontal cable manager shall be 2 rack-units in height when matched with a 2 rack-unit patch panel or switch.
 - 5. The horizontal cable manager shall be 1 rack-unit in height when matched with a 1 rack-unit patch panel or switch.
 - 6. Horizontal cable managers shall be black.

2.3 CABLE MANAGEMENT - VERTICAL

- A. Vertical Cable Management
 - 1. The vertical cable manger shall be 80" high double-sided.

2. The vertical cable manager shall provide support/management for patch cords at the front of the rack and support/management of cables at the rear of the rack.
3. The vertical cable manager shall be a minimum width of 5".
4. Vertical cable manager color shall be black.

2.4 LADDER RACK

- A. Ladder Rack System
 1. See Drawings for ladder rack system details.
 2. The ladder rack system shall be securely mounted with hardware designed for use with ladder rack systems per manufactures recommendations.
 3. Ladder rack shall be 18" wide.
 4. End caps shall be installed on the exposed ends of the ladder racks and channel supports. Protective covers shall be installed on threaded rods that come in contact with cabling plant.
 5. Ladder Rack System color shall be black.

2.5 TIE WRAPS AND VELCRO STRAPS

- A. Tie Wraps and Velcro Straps
 1. Backbone cables shall be fastened to support structures with tie wraps/Velcro straps.
 2. Horizontal cables shall be fastened to support structures with Velcro straps.
 - a. Tie Wrap color shall be black.
 - b. Velcro Strap color shall be black.

2.6 D-RINGS

- A. D-rings
 1. D-rings shall be used on backboards to support cables, patch cords and cross-connect wire.
 2. D-rings shall be made of high-strength, fire-retardant material with rounded edges to prevent damage to cable and wire insulation.
 3. Provide D-rings of appropriate size and quantity for proper cable management and support as required.

PART 3 - EXECUTION

3.1 CABLE MANAGEMENT - HORIZONTAL

- A. Horizontal cable managers shall be installed below patch panels in a 1:1 ratio (one horizontal cable manager per patch panel) or as indicated on drawings.

3.2 CABLE MANAGEMENT - VERTICAL

- A. Vertical cable managers shall be installed on both sides of a single equipment rack. Where two (2) or more racks are positioned in a row, vertical cable managers shall be installed between each rack and each end of the row.

3.3 LADDER RACKS

- A. Ladder rack system shall be installed straight, level and perpendicular to walls and ceiling slabs.
- B. Ladder racks shall be supported at 4' intervals maximum.
- C. Provide all hardware, accessories, fasteners, anchors, threaded rods and support channels required to provide a complete ladder rack system.
- D. Provide ladder rack system at minimum on (2) adjacent walls in each communications room or as indicated on drawings.
- E. See Drawings for ladder rack system details.

3.4 TIE WRAPS AND VELCRO STRAPS

- A. Tie wraps/Velcro straps shall be installed around cables at intervals of 12" minimum.
- B. Tie wraps shall secure cables to ladder racks using an "X" pattern.
- C. Do not over-cinch cables.

3.5 D-RINGS

- A. D-rings shall be installed on 3/4" backboard, straight and level.

3.6 IDENTIFICATION

- A. Refer to Identification for Communications Systems for labeling details.

END OF SECTION 270520

SECTION 270525 - GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. This document describes the products and execution requirements relating to Grounding and Bonding for Communications Systems.
- B. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.02 SUBMITTALS

- A. Provide product data from manufacturer's specifications for each item to be installed under this contract to the Engineer for review and approval.

1.03 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The contractor will provide and install all of the required material whether specifically addressed in the specification or not.

PART 2 - PRODUCTS

2.01 APPROVED PRODUCTS

- A. Approved Grounding Lug Manufacturer(s)
 - 1. Harger
 - 2. Burndy
 - 3. Hoffman
 - 4. Or Approved Equal
- B. Approved Grounding Busbar Manufacturer(s)
 - 1. Chatsworth Products, Inc.
 - 2. Hoffman
 - 3. Harger
 - 4. Or Approved Equal

2.02 GROUNDING CONDUCTORS

- A. Grounding Conductor
 - 1. Construction shall be Type THHN copper conductors, insulated with heat and moisture resistant PVC over which a UL listed jacket is applied.
 - 2. Jacket color shall be green or black. Black jacketed cable shall be identified at

2.03 GROUNDING LUGS

- A. Grounding Lugs and Hardware
 - 1. Grounding lugs shall be 2-hole compression type irreversible. Stainless steel bolts and washers shall be used to install lugs to equipment and grounding bus bars.

2.04 GROUNDING BUSBARS

- A. Grounding Busbar
 - 1. The grounding busbar shall be made of 1/4" thick solid copper.
 - 2. The grounding busbar shall be installed with minimum clearance, 1" offsets and 1-1/2" insulators.
 - 3. The grounding busbar shall accommodate 2-hole compression lugs.
 - 4. The grounding busbar shall meet or exceed ANSI/TIA-607-C requirements.

PART 3 - EXECUTION

3.01 GROUNDING

- A. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all communications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying

- conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA-607-C. Telecommunications Bonding and Ground Standard.
- B. The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding busbar (TMGB). Each telecommunications room (TR) shall be provided with a telecommunications ground busbar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility. In the dispatch data room, there should be two separate ground bus bars, one for the owner equipment and one for 911 equipment.
 - C. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the MC/IC/TC shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression lugs.
 - D. All wires used for communications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with green tape. All cables and busbars shall be identified and labeled in accordance with the ANSI/TIA-606-C.

END OF SECTION 270525

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 26 shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Pathways for Communications Systems.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

- A. Provide product data from manufacturer's specifications for each item to be installed under this contract to the Engineer for review and approval.

1.3 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Innerduct Conduit Manufacturer(s)
 - 1. Carlon
 - 2. Endot Industries
 - 3. MaxCell
 - 4. Petroflex
 - 5. Eastern
 - 6. Or Approved Equal
- B. Approved Cable Tray System Manufacturer(s)
 - 1. Hoffman Quick Tray Pro Part #QTP4X12
 - 2. Legrand Cablofil Cable Tray Part #CF105300EZ
 - 3. Snake Tray Mega Snake Cable Tray Part #CM 801-4-12-10
 - 4. Or Approved Equal
- C. Approved Cable Hanger Manufacturer(s)
 - 1. Erico Products – Caddy HP Series
 - 2. Hoffman
 - 3. Or Approved Equal
- D. Approved Tie Wrap/Velcro Strap Manufacturer(s)
 - 1. Leviton
 - 2. Or Approved Equal
 - 3. ENT shall be a pliable, non-metallic raceway manufactured of the same PVC material used for rigid non-metallic conduit.
 - 4. Fittings and outlet boxes shall be designed for use with ENT and listed by Underwriters Laboratories.
- E. Innerduct Conduit Channel
 - 1. Innerduct shall be corrugated plastic equipped with pull-string or mule tape.
 - 2. See Drawings for innerduct conduit channel details.

2.2 COMMUNICATIONS OUTLET BOXES

- A. Outlet boxes and device covers shall be galvanized steel not less than 1/16" thick.
- B. The dimensions of the outlet box shall be 4" x 4" square with a minimum depth of 2-1/8".
- C. Outlet boxes shall be equipped with single gang device covers. Where installed in plaster, gypsum board, etc., covers shall be raised to compensate for the thickness of the wall finish.
- D. Where outlet boxes are to be empty for future use, blank cover plates shall be used.

2.3 CABLE TRAY

- A. Cable Tray System
 - 1. Cable tray shall be steel or aluminum construction 12" wide with 4" high side rails.
 - 2. Cable tray cross members shall be factory welded at 12" intervals maximum.
 - 3. Cable tray shall be equipped with one (1) or two (2) support rails that run the length of each segment.
 - 4. End caps shall be installed on the exposed ends of the cable tray, channel supports and bolts. Protective covers shall be installed on threaded rods that come in contact with cabling plant.
 - 5. Wall mount cable tray used in limited clearance areas shall be hook style and constructed of aluminum.
 - 6. Provide all cable tray hardware accessory assemblies required to properly install cable tray system per manufactures requirements.
 - 7. See Drawings for cable tray dimensions.

2.4 **CABLE HANGERS**

- A. J-Hooks
 - 1. J-hooks shall provide sufficient width to comply with required bend radii of high-performance cables. J-hook shall be cULus Listed.
 - 2. J-hooks shall have flared edges to prevent damage while installing cables.
 - 3. J-Hooks shall be at least 4".
 - 4. J-Hook Multi-tier supports shall be factory assembled units equal to B-Line BCH series hangers.
 - 5. J-hooks shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
 - 6. Hangers shall be configured as required to attach to the structure, wall mounted, ceiling mounted, suspended from all thread rod, or supported on strut attached to the structure. Anchors attached to sheetrock shall not be acceptable.
 - 7. Hangers shall be single or multiple tiered as required for the number of cables being supported.
 - 8. At Corridor crossings or other locations where wall mounting is impractical hangers shall be double sided, single tier J-Hooks suspended on all thread rods supported from the building structure or beam clamps.
 - 9. J-Hooks shall be spaced at a maximum of 36" on centers.

2.5 **TIE WRAPS AND VELCRO STRAPS**

- A. Tie Wraps and Velcro Straps
 - 1. Cables shall be fastened to support structures with tie wraps/Velcro straps.
 - 2. Tie wraps/Velcro straps installed in air handling spaces must be plenum rated.
 - a. Non-plenum Tie Wrap color shall be black.
 - b. Plenum Tie Wrap color shall be red.
 - c. Non-plenum Velcro strap color shall be black.
 - d. Plenum Velcro strap color shall be red.

PART 3 - EXECUTION

3.1 **CABLE TRAY SYSTEM**

- A. Install trays in accordance with recognized industry practices, to ensure that the cable tray equipment complies with requirements of the NEC.
- B. All open trays shall be installed a minimum of six (6) inches away from any light fixture.
- C. Provide external grounding strap at expansion joints, sleeves, crossover and other locations where tray continuity is interrupted.
- D. Support all pathways from building structure. Do not support pathways from ductwork, piping or equipment hangers.
- E. Install cable tray level and straight.
- F. Provide all hardware, accessories, fasteners, anchors, threaded rods and support channels required to provide a complete cable tray system.
- G. Cable trays shall not be used to house both low voltage and power cables unless cables are separated by a grounded physical barrier.
- H. Cable tray system shall be grounded in accordance with ANSI/TIA-607-B.
- I. All cable tray shall be installed with a single, center mounted hanger spaced as recommended by the manufacturer.

3.2 CABLE HANGERS

- A. Installation and configuration shall conform to the requirements of ANSI/TIA-568.1-D, ANSI/TIA-568.3-D, & ANSI/TIA-569-D, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.
- B. Install cables using techniques, practices, and methods that are consistent with Category 6 or higher requirements and that supports Category 6 or higher performance of completed and linked signal paths, end to end.
- C. Install cables without damaging conductors, shield, or jacket.
- D. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
- E. Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling means that will not damage media.
- F. Do not exceed load ratings specified by manufacturer.
- G. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
- H. To avoid electromagnetic interference (EMI), pathways shall provide minimum clearances of four feet from motors or transformers, one foot from conduit and cables used for electrical power distribution, and five inches from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables or conduits.
- I. Provide J-hooks in all Corridors on one side spaced a maximum of 36" on centers where cable tray is not shown.

3.3 TIE WRAPS AND VELCRO STRAPS

- A. Tie wraps/Velcro straps shall be installed around cables at intervals of 12" minimum.
- B. Tie wraps shall secure cables to cable trays using an "X" pattern.
- C. Do not over-cinch cables.

END OF SECTION 270528

SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND 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.

1.2 SUMMARY

- A. Section Includes:
1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 2. Sleeve-seal systems.
 3. Sleeve-seal fittings.
 4. Grout.
 5. Silicone sealants.
- B. Related Requirements:
1. Section 078413 "Through-Penetration Firestop Systems" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
1. Material: Galvanized sheet steel.
 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- G. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 3. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 4. Pressure Plates: Stainless steel.

5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 **SLEEVE-SEAL FITTINGS**

- H. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
 3. Presealed Systems.

2.4 **GROUT**

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.2 **SILICONE SEALANTS**

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 **SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS**

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- H. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Sleeve-seal fittings in this article are used above and below grade in concrete slabs and in concrete walls for a watertight seal around piping. These fittings do not require a sleeve. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

SECTION 271300 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Optical Fiber Backbone Cabling.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

- A. Provide product data from manufacturer's specifications for each item to be installed under this contact to the Engineer for review and approval.

1.3 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Optical Fiber Backbone Cable (Inside Plant) Manufacturer(s)
 - 1. Berk-Tek
 - 2. CommScope
 - 3. Siemon
 - 4. No Exceptions
- B. Approved Optical Fiber Backbone Cable (Outside Plant) Manufacturer(s)
 - 1. Berk-Tek
 - 2. CommScope
 - 3. Siemon
 - 4. No Exceptions
- C. Approved Optical Fiber Pigtail Manufacturer(s)
 - 1. Leviton
 - 2. CommScope
 - 3. Siemon
 - 4. No Exceptions
- D. Approved Splice Tray Manufacturer(s)
 - 1. Leviton
 - 2. CommScope
 - 3. Siemon
 - 4. No Exceptions

2.2 OPTICAL FIBER BACKBONE CABLE (INSIDE PLANT)

- A. Plenum - Indoor Distribution 50-micron OS2 Single-Mode Optical Fiber Non-Conductive (OFNP) Tight Buffered Cable
 - 1. Generic Characteristics
 - a. The indoor optical fiber cable shall be available with up to twelve 900-micron tight-buffered, 250-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
 - b. The indoor optical fiber cable shall meet or exceed the performance criteria found in ANSI/TIA-568.3-D.
 - c. The indoor optical fiber cable shall have sequential length markings printed on the cable jacket.
 - d. All Single-Mode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.
 - e. The loss of fiber shall not exceed 0.5 dB per kilometer @ 1550 nm and 0.5 dB per kilometer @ 1310 nm.

- B. Riser - Indoor 50-micron OM3 Multi-Mode Optical Fiber Non-Conductive (OFNR) Tight Buffered Cable
 - 1. Generic Characteristics
 - a. The indoor optical fiber cable shall be available with up to twelve 900-micron tight-buffered, 250-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
 - b. The indoor optical fiber cable shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
 - c. The indoor optical fiber cable shall have sequential length markings printed on the cable jacket.
 - d. All Multi-Mode fibers shall be pigtail spliced into a rack mounted optical fiber panel or wall-mounted enclosure.
 - e. The loss of fiber shall not exceed 1.0 dB per kilometer @ 1550 nm and 1.0 dB per kilometer @ 1310 nm.

2.3 **OPTICAL FIBER BACKBONE CABLE (OUTSIDE PLANT)**

- A. Indoor/Outdoor 50-micron OM3 Multi-Mode Optical Fiber Non-Conductive (OFNR) Loose Tube cable
 - 1. Generic Characteristics
 - a. The indoor/outdoor optical fiber cable with up to twelve 250-micron coated fibers placed in a color-coded sub-unit bundle with moisture-blocking gel.
 - b. The indoor/outdoor optical fiber cable shall meet or exceed the performance criteria found in ANSI/TIA-568.3-D.
 - c. The indoor/outdoor optical fiber cable shall have sequential length markings printed on the cable jacket.
 - d. All Multi-Mode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.
 - e. The loss of fiber shall not exceed 0.5 dB per kilometer @ 1550 nm and 0.5 dB per kilometer @ 1310 nm.

2.4 **OPTICAL FIBER CONNECTORS**

- A. Multi-Mode Fiber Connectivity
 - 1. The optical fiber pigtail assemblies shall be factory terminated LC for installation onto Multi-Mode 50-micron OM3 fiber.
 - 2. The optical fiber pigtail connectors shall meet or exceed the performance criteria found in ANSI/TIA-568.3-D.
 - 3. The optical fiber pigtail connectors shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
 - 4. All Multi-Mode fiber pigtail assemblies shall be installed by fusion splicing method only (No Exceptions).
 - 5. Pigtails shall be factory terminated to a color-coded 900-micron buffer tube 3 meters in length. All fiber enclosure shall be equipped with slack storage splice trays that shall be used for housing all pigtail-splicing.
 - 6. The fusion splice loss of each pigtail connector shall not exceed 0.05 dB.
 - 7. The optical fiber adapter module that occupies the faceplate shall be equipped with zirconia ceramic sleeve.
 - 8. Multi-Mode fiber connector boot color shall be aqua.

2.5 **FIBER OPTIC ENCLOSURE SPLICE TRAYS**

- A. Splice Tray
 - 1. Splice trays shall be capable of housing a maximum of 24 strands of fiber. No more than 24 stands of fiber shall be installed in each splice tray.
 - 2. All splice trays, seals and hardware shall be from the same manufacturer as the rack or wall mount fiber optic enclosure.
 - 3. Splice trays shall utilize heat-shrink seals.

PART 3 - EXECUTION

3.1 **BACKBONE CABLES (INSIDE PLANT)**

- A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568.1-D and/or ANSI/TIA-568.3-D, manufacturer's recommendations and best industry practices.
- B. Backbone cables shall be installed separately from horizontal distribution cables

- C. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- D. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits
- E. Exposed cables must be OFNP rated if installed in an air return plenum. Riser rated cables shall be installed in metallic conduit if installed in an air return plenum.
- F. Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- G. Leave 15' of slack on each end of fiber backbone cable.
- H. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
- I. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.
- J. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.
- K. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- L. Each optical fiber cable shall be individually attached to the respective enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- M. Each optical fiber cable shall be clearly labeled at the entrance to the enclosure. Cables labeled within the bundle shall not be acceptable.
- N. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
- O. A maximum of 24 strands of fiber shall be spliced in each tray
- P. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

3.2 BACKBONE CABLES (OUTSIDE PLANT)

- A. All OSP cables brought to the Entrance Facilities shall have 15 ft of slack coiled and secured to the wall in the proximity of the fiber enclosure.
- B. All cables shall be tagged and identified within each hand-hole/maintenance hole.
- C. Place initial cables in bottom conduits to facilitate easy subsequent cable placement.
- D. Place leader guard in the duct before placing cable to prevent damaging the cable sheath on the sharp edge of the duct.
- E. Ventilate maintenance where gas has been detected before entering the maintenance hole.
- F. To ensure that the optical fiber cable's qualities and characteristics are not degraded during installation, excessive pulling tensions and short bending radii will not be allowed. The maximum pulling tension is 600 lbs. The minimum bending radius for cable under tension is 20 times the outside diameter of the cable and for cable at rest is 10 times the outside diameter of the cable.
- G. A 600 lb. break-away swivel, along with a slip clutch capstan winch that shows the dynamometer (pulling tension) reading, shall be used at all times during pulling.
- H. Reels shall be continuously manned during cable installation.
- I. Cable coils shall have at least two points of support on the optical fiber racking system.
- J. When mounting the optical fiber slack coils, the minimum bend radius shall not be exceeded; this radius is equal to 10 times the outside diameter of the cable in a static application and 20 times the outside diameter in a dynamic application. At anytime during the entire handling process of the optical fiber cable, as much care as possible should be maintained and all the manufacturer's recommendations should be followed.

3.3 OPTICAL FIBER CONNECTIVITY / SPLICING

- A. Optical fiber optic pigtails shall be installed as per the requirements specified by the manufacturer's installation guidelines.
- B. All splicing shall be of the fusion type made under Light Injection and Detection Mode. The Contractor shall provide certified and experienced personnel for splicing.
- C. Contractor's tools and equipment shall be in excellent working order. Any worn or improperly working tools shall be discarded and not used on this project. All fusion splicers shall be calibrated and labeled according to the manufacturer's specifications. Contractor shall submit certification of calibration for the fusion splicers to the Engineer.

3.4 IDENTIFICATION

- A. Refer to Identification for Communications Systems for labeling details.

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Copper Horizontal Cabling.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

- A. Provide product data from manufacturer's specifications for each item to be installed under this contract to the Engineer for review and approval.

1.3 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Horizontal Copper Cable Manufacturer(s)
 - 1. Berk-Tek LANmark-10G2
 - 2. Systimax (Uniprise Not Excepted)
 - 3. Siemon
 - 4. No Exceptions

2.2 HORIZONTAL COPPER CABLE

- A. 10G Category 6A Balanced Twisted Pair Cable
 - 1. The horizontal balanced twisted pair cable shall meet or exceed the Category 6A transmission characteristics per issue of ANSI/TIA-568-C.2.
 - 2. Cable jacket shall be CMR or CMP rated (according to the space it occupies).
 - 3. All Category 6A cabling shall be equal to Berk-Tek LANmark-1000 Enhanced Category 6A cabling – Plenum Rated.
 - 4. Jacket color shall be:
 - a. Blue Category 6A cabling for Data.
 - 1. Berk-Tek Part #10130484
 - 2. Or Approved Equal
 - b. Green Category 6A cabling for Wireless Access Points.
 - 1. Berk-Tek Part #10137694
 - 2. Or Approved Equal
 - c. White Category 6A cabling for Intercom.
 - 1. Berk-Tek Part #10137384
 - 2. Or Approved Equal.
 - d. Yellow Category 6A cabling for Interior CCTV cameras.
 - 1. Berk-Tek Part #10137385
 - 2. Or Approved Equal.
 - e. Black Category 6A cabling for Exterior CCTV cameras.
 - 1. Berk-Tek Part #11089905
 - 2. Or Approved Equal.
 - f. Orange Category 6A cabling for Access Control Equipment.
 - 1. Berk-Tek Part #10137183
 - 2. Or Approved Equal.

2.3 HORIZONTAL AUDIO VISUAL CABLE

- A. Cable shall be installed in accordance with manufacture's recommendations and best industry practices.
 - 1. Cable jacket shall be CMR or CMP rated (according to the space it occupies).
 - 2. Cabling shall be installed from each projector location to wall outlet providing the following connections at each location: VGA, 3.5mm Audio, Left and Right Stereo Audio, Composite Video and HDMI.
- B. Approved Audio Visual Cable Manufacture.
 - 1. Quiktron Rapid Run Cabling
 - 2. Or Approved Equal
- C. Approved Audio Visual Runner Cable
 - 1. VGA, 3.5mm Audio, Stereo Audio and Composite Video Runner: Quiktron Part #2212-60013-050
 - 2. HDMI Runner: Quiktron Part #2212-41183-050

PART 3 - EXECUTION**3.1 HORIZONTAL CABLES**

- A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.
- B. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- C. Cable raceways shall not be filled greater than the ANSI/TIA-569-D maximum fill for the particular raceway type.
- D. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
- E. Riser rated cable shall be installed in metallic conduit when installed in a plenum space.
- F. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- G. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- H. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids, conduit, pipes, duct work or panels.
- I. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.
- J. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes or other control devices.
- K. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers from the building structure to support the cabling.
- L. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.
- M. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568-C.2 document, manufacturer's recommendations and best industry practices.
- N. Leave a minimum of 12" of slack for twisted pair cables at the outlet. Cables shall be coiled in the outlet box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
- O. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- P. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.2 IDENTIFICATION

- A. Refer to Identification for Communications Systems for labeling details.

END OF SECTION 271500

SECTION 272005 - COMMUNICATIONS PATCH PANELS AND FIBER OPTIC ENCLOSURES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Termination Blocks and Patch Panels.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

- A. Provide product data from manufacturer's specifications for each item to be installed under this contract to the Engineer for review and approval.

1.3 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Patch Panel Manufacturer(s)
 - 1. Leviton eXtreme 48 Port Category 6A
 - 2. Systimax (Uniprise Not Excepted)
 - 3. Siemon
 - 4. No Exceptions
- B. Approved Optical Fiber Enclosure Manufacturer(s)
 - 1. Leviton
 - 2. Systimax (Uniprise Not Excepted)
 - 3. Siemon
 - 4. No Exceptions
- C. Approved Termination Block Manufacturer(s)
 - 1. Leviton
 - 2. Systimax (Uniprise Not Excepted)
 - 3. Siemon
 - 4. No Exceptions
- D. Category 6A Patch Panel
 - 1. The Category 6A patch panel shall be compatible with 19" equipment racks, cabinets or wall mount brackets.
 - 2. The Category 6A patch panels shall be 24 or 48 port unloaded patch panels.
 - 3. The Category 6A patch panels shall be sized to accommodate one port for each cable installed plus 25% spare capacity for future growth. All ports shall be filled with a removable 8-position modular jack. No port shall be left empty or blank.
 - 4. The Category 6A patch panel shall be equipped with removable 8-position modular jacks color coded for each system and shall allow for termination of both T568A and T568B wiring schemes.
 - 5. The Category 6A patch panel shall be equipped with front labeling windows to facilitate port identification.
 - 6. The connector module shall meet or exceed the Category 6A performance criteria per ANSI/TIA-568.3-D.

2.2 OPTICAL FIBER PANELS/ENCLOSURES

- A. Rack Mount Optical Fiber Panel/Enclosure
 - 1. The rack mount optical fiber panel/enclosure shall be equipped with a sliding drawer to access fibers.

2. The rack mount optical fiber panel/enclosure shall be capable of terminating tight-buffered or loose tube optical fiber cable.
3. The rack mount optical fiber panel/enclosure shall provide for bend radius control throughout the panel as well as storage space for slack cabling.
4. The panel/enclosure shall meet or exceed the performance criteria per ANSI/TIA-568.3-D.
5. The rack mount optical fiber panel/enclosure shall be equipped with optical fiber adapter panels.
 - a. The optical fiber adapter panels shall accommodate either multimode or singlemode terminated optical fiber.
 - b. The optical fiber adapter panels shall be compatible with ST OS2 connectors.
 - c. Single-mode adaptors shall be blue or green in color and equipped with zirconia ceramic sleeves.

PART 3 - EXECUTION

3.1 PATCH PANELS

- A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568.1-D0 and/or ANSI/TIA-568.2-D, manufacturer's recommendations and best industry practice.
- B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- C. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- D. Cables shall be neatly bundled and dressed to their respective patch panel. Each patch panel shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- E. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.2 OPTICAL FIBER PANELS/ENCLOSURES

- A. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-C.0 and/or ANSI/TIA-568-C.1, manufacturer's recommendations, and best industry practices.
- B. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- C. Bend radius of the optic fiber cable in the panel/enclosure shall not exceed 10 times the outside diameter of the cable.
- D. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
- E. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
- F. A maximum of 24 strands of fiber shall be spliced in each tray
- G. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel. At least 15 feet of slack for each individual cable shall be provided.

3.03 IDENTIFICATION

- A. Refer to Identification for Communications Systems for labeling details.

END OF SECTION 272005

SECTION 272010 - COMMUNICATIONS RACKS AND ENCLOSURES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Cabinets, Racks and Enclosures.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

- A. Provide product data from manufacturer's specifications of each item to be installed under this contract to the Engineer for review and approval.

1.3 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Equipment Rack/Cabinet Manufacturer(s)
 - 1. Eaton RS Enclosure, Part Number: RSN4561B
 - 2. Chatsworth Products, Inc.
 - 3. Hoffman
 - 4. Pentair E4DRS19FM45U
 - 5. No Exceptions

2.2 EQUIPMENT RACKS/CABINETS

- A. Equipment Racks
 - 1. The equipment rack shall be constructed of high strength, lightweight aluminum.
 - 2. The vertical rails of the equipment rack shall be equipped with the EIA hole pattern.
 - 3. 2 Post rack shall be: 7'H x 19"W floor mounted. Vertical channels shall be drilled and taped. Only where noted.
 - 4. 4 Post rack shall be: 45U, 43.31in deep, 23.6in wide, BLK. Vertical channels shall have square punched mounting holes. Provide additional mounting hardware for equipment to owner upon completion of the installation. Rack shall have full doors on both sides with lockable hardware.
 - 5. Wall mounted racks shall be 42"H x 19"W, wall mounted with vertical channels drilled and taped and a hinged front. Only where noted.
 - 6. Rack color shall be black.
 - 7. Self Leveling.

2.3 POWER STRIPS: COMPLY WITH UL 1363.

- A. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Rack mounting.
- C. Six - [20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
- D. LED indicator lights for power and protection status.
- E. LED indicator lights for reverse polarity and open outlet ground.
- F. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
- G. Close-coupled, direct plug-in line cord.
- H. Rocker-type on-off switch, illuminated when in on position.
- I. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
- J. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330V.

- K. Must have network capabilities for monitoring.
- L. Manufacturers:
 - 1. Tripp-Lite – PDUMV30NET
 - 2. Eaton

2.4 RACK MOUNTED UPS

- A. Equal to Tripp-Lite #SU3000RTXL2U
- B. Provide UPS Network card equal to Tripp-Lite SNMPWEBCARD
- C. Provide all software required for remote monitoring.

PART 3 - EXECUTION

3.1 EQUIPMENT RACKS/CABINETS

- A. Equipment racks shall be securely attached to the concrete floor using minimum 3/8" hardware or as required by local codes.
- B. Equipment racks shall be installed as per the requirements specified by the manufacturer's installation guidelines.
- C. Equipment racks shall be placed with a minimum of 36-inch clearance from the walls from the front, rear and one side of the rack or as indicated on Drawings.
- D. All equipment racks shall be grounded to the telecommunications ground bus bar.
- E. Mounting screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.
- F. All data rooms shall have 4 post racks as shown on plans. Each data closet shall have a minimum of one 4 post rack accounted for even if not shown.
- G. Each rack shall have a minimum of 2 vertical plug strips mounted in the back of each rack.
- H. Each rack shall have a minimum of 1 rack mounted UPS to supply each vertical plug strip.

3.2 BACKBOARDS

- A. Backboards shall be 3/4" void free plywood. Size of backboard shall be 4' x 8' unless noted differently on Drawings. Backboards shall be painted with two (2) coats of gray fire-retardant paint on all sides and edges.

3.3 IDENTIFICATION

- A. Refer to Identification for Communications Systems for labeling details.

END OF SECTION 272010

SECTION 272015 - COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Faceplates and Connectors.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

- A. Provide product data from manufacturer's specifications for each item to be installed under this contract to the Engineer for review and approval.

1.3 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Copper Connectivity Manufacturer(s)
 - 1. Leviton
 - 2. Systimax (Uniprise Not Excepted)
 - 3. Siemon
 - 4. No Exceptions
- B. Approved Optical Fiber Connectivity Manufacturer(s)
 - 1. Leviton
 - 2. Systimax (Uniprise Not Excepted)
 - 3. Siemon
 - 4. No Exceptions
- C. Approved Faceplate Manufacturer(s)
 - 1. Leviton
 - 2. Systimax (Uniprise Not Excepted)
 - 3. Siemon
 - 4. No Exceptions
- D. Approved Surface Mount Box Manufacturer(s)
 - 1. Leviton
 - 2. Systimax (Uniprise Not Excepted)
 - 3. Siemon
 - 4. No Exceptions

2.2 AUDIO VISUAL APPROVED PRODUCTS

- A. Approved Faceplate Module Manufacture(s)
 - 1. Quiktron Rapid Run
 - 2. Or Approved Equal
- B. Approved Faceplate Modules
 - 1. VGA, 3.5mm Audio, Stereo Audio and Composite Video Module: Quiktron Part #2212-60022-001.
 - 2. HDMI Module: Quiktron Part #2212-42420-001
- C. Approved Projector Connection Leads
 - 1. Quiktron Rapid Run
 - 2. Or Approved Equal
- D. Approved Connection Leads
 - 1. VGA, 3.5mm Audio, Stereo Audio and Composite Video Lead: Quiktron Part #2212-60019-003.

2. HDMI Lead: Quiktron Part #2212-42410-003.

2.3 COPPER CONNECTIVITY

- A. Voice/Data Jacks
 1. Category 6A, 8-Position, 8-Contact (8P8C) Modular Jack
 - a. The connector module shall meet or exceed the Category 6A performance criteria per ANSI/TIA-568.2-D.
 - b. The eight-position connector module shall accommodate six-position modular plug modular cords without damage to either the cord or the module.
 - c. The connector module shall be designed for use at the work area (WA), communications room (TR) and/or equipment room (ER) without modification.
 - d. The connector module shall be available in both the T568A and T568B wiring configurations within the same module.
 - e. The connector module shall have an insulation displacement connection featuring insulation slicing of 22 to 24 AWG plastic-insulated solid copper conductors forming a gas-tight connection.
 - f. Jack/Icon colors shall be:
 1. Blue for Data
 2. White for all Intercom
 3. Green for Wireless Access Points
 4. Yellow for CCTV Interior Cameras
 5. Black for CCTV Exterior Cameras
 6. Orange for Access Controls

2.4 FACEPLATES

- A. Faceplates
 1. The faceplate housing the connector modules shall have no visible mounting screws.
 2. The faceplate housing the connector modules shall have a labeling capability using built-in labeling windows, to facilitate outlet identification and ease network management.
 3. The faceplate housing the connector modules shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network application needs.
 4. Each faceplate shall have a minimum of (4) ports per each outlet location. Each unpopulated port shall have a blank module installed that matches the color of the faceplate.
 5. Faceplates shall be stainless steel unless noted otherwise. All faceplates shall match electrical outlet covers. Verify color and size of each faceplate prior to ordering.

2.5 SURFACE MOUNT BOXES

- A. The surface mount box shall be sized to accommodate the quantity of outlets per each location as required.
- B. A surface mount box shall be provided at each of the following locations: Projector, Wireless Access Point, Camera and/or any outlet location serving a ceiling mounted device.
- C. Provide a minimum of 15ft of slack at each ceiling mounted outlet location. Slack loop shall be coiled up neatly and placed on a j-hook to support cable.
- D. Color shall be white unless otherwise noted. Verify exact color and location prior to mounting.

PART 3 - EXECUTION

3.1 COPPER CONNECTIVITY

- A. 8-position, 8-contact (8P8C) modular jacks shall be installed in accordance with manufacturer's recommendations and installation guides, and best industry practices.
- B. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- C. All outlet locations shall have color-coded 8P8C modular jacks installed. No cable shall be left unterminated.

3.2 FACEPLATES

- A. Blank inserts shall be installed where ports are not used.
- B. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.

- C. Faceplates shall be installed straight and level.
- D. Faceplates shall be installed at the same heights as electrical faceplates.

3.3 SURFACE MOUNT BOXES

- A. Blank inserts shall be installed where ports are not used.
- B. The same orientation and positioning of jacks and connectors shall be utilized through out the installation.
- C. Surface mount boxes shall be installed straight and level.
- D. Surface mount shall be installed at heights as electrical receptacles.

3.4 IDENTIFICATION

- A. Refer to Identification for Communications Systems for labeling details.

END OF SECTION 272015

SECTION 272020 - COMMUNICATIONS PATCH CORDS AND WORKSTATION CORDS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Communications Patch Cords.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 SUBMITTALS

- A. Provide product data from manufacturer's specifications for each item to be installed under this contract to the Engineer for review and approval.

1.3 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Copper Patch Cord Manufacturer(s)
 1. Leviton
 2. Systimax (Uniprise Not Excepted)
 3. Siemon
 4. No Exceptions
- B. Approved Fiber Patch Cord Manufacturer(s)
 1. Leviton
 2. Systimax (Uniprise Not Excepted)
 3. Siemon
 4. No Exceptions

2.2 COPPER PATCH CORDS

- A. Category 6 Patch Cords
 1. The Category 6A patch cord shall be 4-pair, with 24 AWG solid or stranded copper conductors and 8-position modular plug.
 2. The Category 6A modular cord cable shall be UL Listed as Type CMR and Plenum Rated.
 3. The Category 6A patch cord shall meet or exceed the requirements of ANSI/TIA-568.2-D.
 4. Lengths shall be 3', 5', 7' and/or 10' as required by the Owner.
 5. Provide one patch cord for every cable installed that will be utilized for patching between patch panel and switches. Verify length and color with Owner prior to ordering.
 6. Provide one patch cord for every cable installed at each work area outlet. Verify length and color with Owner prior to ordering.
 - a. The Category 6A patch cord color for Data shall be: Blue
 - b. The Category 6A patch cord color for VOIP shall be: White
 - c. The Category 6A patch cord color for Wireless Access Points shall be: Purple
 - d. The Category 6A patch cord color for CCTV Interior Cameras shall be: Yellow
 - e. The Category 6A patch cord color for CCTV Exterior Cameras shall be: Black
 - f. The Category 6A patch cord color for Access Controls shall be: Orange

2.3 FIBER PATCH CORDS

- A. Singlemode Fiber Patch Cords
 1. 8.3/125-micron singlemode fiber patch cord:
 - a. The 8.3/125-micron fiber used in the singlemode fiber patch cord shall have a maximum attenuation of 1.0 dB/km @ 1310 nm and 1.0 dB/km @ 1550 nm.

- b. The optical fiber cord connector shall have a maximum insertion loss of 0.5 dB and a reflectance of -30 dB.
- c. The 8.3/125-micron singlemode fiber patch cord shall meet or exceed the requirements of ANSI/TIA-568.3-D.
- d. The optical fiber cord connector shall be ST to LC duplex.
- e. The singlemode fiber patch cord assembly shall be dual zip jacketed yellow in color.
- f. Lengths shall be 1m, 2m, and/or 3m as required by the application. Verify length with Owner prior to ordering.

PART 3 - EXECUTION

3.1 COPPER PATCH CORDS

- A. Copper patch cords shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.2 FIBER PATCH CORDS

- A. Fiber patch cords shall be installed as per the requirements specified by the manufacturer's installation guidelines.

3.3 IDENTIFICATION

- A. Refer to Identification for Communications Systems for labeling details.

END OF SECTION 272020

DIVISION 28 SPECIFICATIONS



Section 282300 – VIDEO MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

- A. Division 14 - General Elevator Requirements
- B. Section 28 13 00 – Electronic Access Control System

1.2 DEFINITIONS

- A. ACS – Access Control System
- B. CSA – Client Software Application
- C. DGM – Dynamic Graphical Maps
- D. DVS – Digital Video Server
- E. ALPR – Automatic License Plate Recognition
- F. SDK – Software Development Kit
- G. GLM – Genetec Lifecycle Management
- H. SSM – Server Software Module
- I. UI – User Interface
- J. USP – Unified Security Platform
- K. USW – Unified Web Client
- L. VMS – Video Management System

1.3 QUALIFICATIONS

- A. The system programmer shall have attended manufacturer training and obtained certification in Genetec Security Center - Omnicast™ Technical Certification at time of bid.
- B. The system programmer shall have attended manufacturer training and obtained certification in Genetec Security Center - Enterprise Technical Certification.
- C. The system programmer shall be a Genetec certified partner with the following level of qualification:
 - 1. Unified Elite Reseller
- D. The system programmer shall submit proof of certifications.

PART 2 - PRODUCTS

2.1 VMS GENERAL REQUIREMENTS

- A. The VMS shall be based on a true open architecture that shall allow the use of non-proprietary workstation and server hardware, non-proprietary network infrastructure, and non-proprietary storage.
- B. The VMS shall offer a complete and scalable video surveillance solution that shall allow cameras to be added on a unit-by-unit basis.
- C. The VMS shall interface with analog-to-digital video encoders and IP cameras and with digital-to-analog video decoders, hereafter referred to as digital video servers (DVS). The VMS shall support DVS from various manufacturers.
- D. The VMS shall integrate DVS using the DVS native SDK or using the following industry standards to interface to the DVS:
 - 1. ONVIF
- E. All video streams supplied from analog cameras or IP cameras shall be digitally encoded in H.265, H.264, MPEG-4, MJPEG, MxPEG, Wavelet, or JPEG2000 compression formats and recorded simultaneously in real time.
- F. All audio streams supplied from IP video servers shall be digitally encoded in g711 (u-law), g721, g723, or AAC compression formats and recorded simultaneously in real time.
- G. Each camera's bit rate, frame rate, and resolution shall be set independently from other cameras in the system and altering these settings shall not affect the recording and display settings of other cameras.
- H. The VMS shall be able to use multiple CCTV keyboards to operate the entire set of cameras throughout the system, including brands of cameras from various manufacturers and including their PTZ functionalities (i.e. Pelco keyboard controls Panasonic dome or vice-versa).
- I. The VMS shall be able to retrieve and set the current position of PTZ cameras using XYZ coordinates.
- J. The VMS shall support PTZ camera protocols from multiple manufacturers, including analog and IP protocols.
- K. The VMS shall arbitrate the user conflict on PTZ usage based on user levels per camera.
- L. The VMS shall support the following list of CCTV keyboard:
 - 1. American Dynamics 2078 ASCII, and American Dynamics 2088 ASCII
 - 2. Bosch Autodome, Bosch Intuikey
 - 3. DVTel

4. GE ImpactNet
 5. Panasonic, Pelco ASCII, Pelco KBD-300, Pelco 9760, and Pelco P.
 6. Radionics
 7. Hanwha Techwin SSC-100, SPC-600, SPC-2010, SPC-6000, and SPC-7000.
 8. Videoalarm
 9. Sony RM-NS1000
 10. Panasonic WV-CU161C
 11. Panasonic WV-CU950 Ethernet keyboard
- M. The VMS shall support the following list of joysticks:
1. Axis 295
 2. Axis T8310, T8311, T8312, T8313 Video Surveillance Control Board
 3. Any USB joystick detected as a Windows Game Controller
- N. The VMS shall allow for the configuration of a time zone for each camera connected to a DVS. For playback review, users shall have the ability to search for video based on the following options:
1. Local time of the camera
 2. Local time of the SSM
 3. Local time of user's workstation
 4. GMT Time
 5. Other time zone
- O. Audio and Video storage configuration for the SSM shall either be:
1. Internal or external IDE/SATA/SAS organized or not in a RAID configuration.
 2. Internal or external SCSI/iSCSI/Fiber Channel organized or not in a RAID configuration.
 3. Within the overall storage system, it shall be possible to include disks located on:
 - a. External PCs on a LAN or WAN
 - b. Network Attached Servers (NAS) on a LAN or WAN
 - c. Storage Area Networks (SAN)
- P. The SSM shall not limit the actual storage capacity configured per server.
- Q. Manufacturer:
1. Genetec Security Center:
 - a. Omnicast Enterprise

2.02 CYBER SECURITY REQUIREMENTS

- A. The USP shall be an IP enabled solution. All communication between the SSM and CSA shall be based on standard TCP/IP protocol and shall use TLS encryption with digital certificates to secure the communication channel.
- B. The USP shall support user authentication with claims-based authentication using external providers. External providers shall include:
1. ADFS (Active Directory Federation Services)
- C. The USP shall limit the IP ports in use and shall provide the Administrator with the ability to configure these ports.
- D. The VMS shall support only secured media stream requests, unless explicitly configured otherwise. Secured media stream requests shall be secured with strong certificate-based authentication leveraging RTSPS (RTSP over TLS). Client authentication for media stream requests is claims-based and may use a limited lifetime security token.
- E. The VMS shall offer the ability to encrypt the media stream, including video, audio, and metadata with authenticated encryption. Media stream encryption shall be done at rest and in transit and be a certificate-based AES 128-bits encryption. The VMS shall:
1. Allow encryption to be set on a per camera basis for all or some of the cameras.
 2. Provide up to 20 different certificates for different groups of CSA or users who have been granted access to decrypted streams.
 3. Not decrease the recording performance by more than 50% when encryption is enabled.
 4. Use Secure RTP (SRTP) to encrypt the payload of a media stream in transit and allow multicast and unicast of the encrypted stream.
 5. Use a random encryption key and change periodically.
 6. Allow encrypted streams to be exported.
- F. The VMS shall support end to end encrypted streams with cameras supporting Secure RTP (SRTP) both in unicast and multicast from the camera.
- G. The USP shall support encryption for all communications with its databases.
- H. The USP shall provide in its main user interface a visual list showing the state of all configuration items relating to the cyber security hardening of the features of the system.
- I. The USP shall provide recommendations relating to the passwords used to access the hardware units in the system. The recommendation should display if the passwords used on the units are weak, average, strong, or very strong.

- J. The USP shall provide recommendations relating to the firmware of the hardware units enrolled in the system. Recommendations should display if the firmware is up to date, out of date, or if it has known security vulnerabilities.

2.03 FAILOVER AND STANDBY REQUIREMENTS

- A. The USP shall support native and off-the-shelf failover options.
- B. Failover Directory:
 - 1. The Standby Directory shall act as a replacement SSM on hot standby, ready to take over as the acting Directory in case the primary Directory fails. The failover shall occur in less than one minute. No action from the user shall be required.
 - 2. The USP shall support up to five (5) Directories on standby, lined up to take over as the acting Directory in a cascading fashion.
 - 3. The Standby Directory shall keep its configuration database synchronized with the primary Directory.
 - 4. The Standby Directory shall support disaster recovery scenarios where a server can be located in another geographic area (or building) and only take over if all other Directories become offline.
 - 5. The Standby Directory shall support synchronization of the configuration databases using a backup and restore mechanism. The synchronization period shall be configurable from 15 minutes to 1 week.
 - 6. The Standby Directory shall support real-time synchronization of the configuration databases using SQL Mirroring or SQL Always On.
- C. Standby Archiver. Refer to section 2.05 Standby Archiver for more information.
- D. Off-the-shelf standby/failover options (excluding the VMS Archiver) shall include:
 - 1. Windows Clustering
 - 2. NEC ExpressCluster X LAN

2.04 ARCHIVING

- A. The Archiver (role) shall use an event and timestamp database for the advanced search of audio/video archives. This database shall use Microsoft SQL.
- B. The Archiver shall protect archived audio/video files and the system database against network access and non-administrative user access.
- C. The Archiver shall digitally sign recorded video using 248-bit RSA public/private key cryptography.
- D. The Archiver shall offer a plug and play type hardware discovery service with the following functionalities:
 - 1. Automatically discover DVS units as they are attached to the network.
 - 2. Discover DVS units on different network segments, including the Internet, and across routers with or without network address translation (NAT) capabilities.
- E. The Archiver shall have the capacity to configure the key frame interval (I-frame) in seconds or number of frames.
- F. The Archiver shall provide a pre-alarm and post-alarm recording option that can be set between one second and 5 minutes on a per camera basis.
- G. The Archiver shall provide the functionality of storing of video and audio streams based on triggering events, such as:
 - 1. Digital motion detection
 - 2. Digital input activation
 - 3. Macros
 - 4. Through SDK application recording
- H. The Archiver shall perform video motion detection on each individual camera based on a grid of 1320 motion detection blocks. All of the video motion detection settings are configurable on schedule. A global sensitivity threshold is available to reduce motion detection sensitivity when the video signal is noisy or when a lot of false hits are incurred. Video motion detection itself can be set into four different modes:
 - 1. Full Screen: All 1320 blocks on screen are activated, and a general threshold for the overall motion in the entire image can be set, and when it is reached, it can trigger recording and a motion event or a custom event.
 - 2. Full Screen Unit: This is the same as the Full Screen but the motion detection takes place in the DVS.
 - 3. Detection Zone: Six overlapping zones can be defined in the 1320 blocks on screen with each of these zones having its own threshold, and, when that threshold is reached, each one of them can trigger recording and a motion event or a custom event. Each zone triggering its own event allows for the configuration of directional motion detection events and other complex motion detection logic.

4. Detection Zone Unit: This is the same as the Detection Zone, but the motion detection takes place in the DVS and only one zone is supported.
5. Disabled: No motion detection is performed on this camera.
- I. The Archiver shall be able to detect motion in video within 200 milliseconds and not only on key frames.
- J. The Archiver shall allow for multiple recording schedules to be assigned to a single camera. Each schedule shall be created with the following parameters:
 1. Recording mode:
 - a. Continuous
 - b. On Motion/Manual
 - c. Manual
 - d. Disabled
 2. Recurrence pattern:
 - a. Once on specific days
 - b. Specific days on a yearly basis
 - c. Specific days on a monthly basis
 - d. Specific days on a weekly basis
 - e. Daily
- K. Time coverage:
 - a. All day.
 - b. Specific time range(s).
 - c. Daytime or nighttime based on the times of sunrise and sunset that are automatically calculated from the time of year and a geographical location. Provision shall be given to offset the calculated sunrise or sunset time by plus or minus 3 hours.
- L. The Archiver shall allow each camera (video source) to be encoded multiple times in the same or different video formats (H.265, H.264, MPEG-4, MPEG-2, MJPEG, MxPEG, Wavelet, or JPEG2000), limited only by the capabilities of each DVS.
- M. Whenever multiple video streams are available from the same camera, users shall be free to use any one of them based on their assigned usage. The standard video stream usages are:
 1. Live
 2. Recording
 3. Remote
 4. Low resolution
 5. High resolution
- N. The Archiver shall allow the video quality to vary according to predefined schedules. Such schedules shall have the same configuration flexibility as the recording schedules mentioned earlier. The video quality shall be based on, but not limited to, the following parameters:
 1. Maximum bit rate
 2. Maximum frame rate
 3. Image quality
 4. Key frame interval
- O. The Archiver shall have the ability to dynamically boost the quality of the "recording stream" (see previous bullet) based on specific events:
 1. When recording is started manually by a user.
 2. When recording is triggered by a macro, an alarm or detected motion.
- P. The Archiver shall have the capacity to communicate with the DVS using 128 bits SSL encryption.
- Q. The Archiver shall have the capacity to communicate with the DVS using HTTPS secure protocol.
- R. The Archiver shall have the capacity to receive multicast UDP streams directly from the DVS.
- S. For network topologies that restrict the DVS from sending multicast UDP streams, the Archiver shall redirect audio/video streams to active viewing clients on the network using multicast UDP.
- T. The Archiver shall have the capacity to redirect audio/video streams to active viewing clients on the network using unicast UDP or TCP.
- U. The Archiver shall empower the administrator with a full range of disk management options:
 1. The Archiver shall allow the administrator to choose which disks to use for archiving and to set a maximum quota for each.
 2. The Archiver shall allow the administrator to spread the archiving of different cameras on different disk groups (groups of disks controlled by the same controller) so that archiving could be carried out in parallel on multiple disks.
 3. The Archiver shall have the capacity to move video archives to the Azure Cloud. The archives will be moved after a preset number of days.
- V. The Archiver shall offer the following options to clean up old archives, on a camera by camera basis:
 1. After a preset number of days.
 2. Deleting oldest archives first when disks run out of space.
 3. Stop archiving when disks are full.
- W. The Archiver shall allow important video sequences to be protected against normal disk cleanup routines.

- X. Users shall have the following options when protecting a video sequence:
 - 1. Until a specified date
 - 2. For a specified number of days
 - 3. Indefinitely (until the protection is explicitly removed)
- Y. The Archiver shall allow the administrator to put a cap on the percentage of storage space occupied by protected video.
- Z. The Archiver shall keep a log and compile statistics on disk space usage.
 - 1. The statistics shall be available by disk group or for the whole Archiver.
 - 2. The statistics shall show the percentage of protected video over the total used disk space.
- AA. The Archiver shall have the capacity to down-sample video streams for storage saving purposes. The down-sampling options available are the following:
 - 1. For H.264, MPEG-4, and H.265, streams the down-sampling options are: all key frames, 1 fps, 2 sec./frame, 5 sec./frame, 10 sec./frame, 15 sec./frame, 30 sec./frame, 60 sec./frame, 120 sec./frame.
 - 2. For MJPEG streams the down-sampling options are: 15 fps, 10 fps, 5 fps, 2 fps, 1 fps, 2 sec./frame, 5 sec./frame, 10 sec./frame, 15 sec./frame, 30 sec./frame, 60 sec./frame, 120 sec./frame.
- BB. The Archiver shall support DVS with edge recording capabilities and offer the following capacity:
 - 1. The ability to playback the video recorded on the DVS at different speeds.
 - 2. The ability to offload (video trickling) the video recorded on the DVS on schedule, on event, or manually to store it on the Archiver.
 - 3. It shall be possible to filter the video that is being offloaded using one or multiple of the following filters:
 - a. Time interval
 - b. Playback request
 - c. Video analytic events
 - d. Motion events
 - e. Bookmarks
 - f. Alarms
 - g. Input pin events
 - h. Unit offline events
- CC. The Archiver shall be provided with proven performance and scalability figures:
 - 1. The Archiver's performance shall be guaranteed during the rebuild of a disk from a raid 5 disk group. The rebuild process shall not affect the recording and playback capabilities.
 - 2. The recommended server specification from the Genetec Security Center Hardware Requirement shall allow Archiver to perform up to 300 cameras or 300Mbps throughput first limit reached.
 - 3. The high-performance archiver specification from the Genetec Security Center Hardware Requirement shall allow Archiver to perform:
 - a. Up to 500 cameras or 500Mbps throughput first limit reached with a 1Gbps NIC.
 - b. Up to 700 cameras or 1300Mbps throughput first limit reached with a 10Gbps NIC.
- DD. The Archiver shall provide the ability to encrypt the media stream coming from the DVS including the video, audio and metadata:
 - 1. Media encryption shall be optional and can be activated on a per DVS basis.
 - 2. Media encryption shall be performed with AES 128-bits.
 - 3. Media encryption shall encrypt all video, audio and metadata at rest and in transit. Once media encryption is turned on for a DVS all media stored or redirected by the Archiver shall be encrypted and shall require the private key to be decoded.
 - 4. It shall be possible to export the encrypted media into a non-encrypted ASF file.

2.05 AUXILIARY ARCHIVER

- A. The Auxiliary Archiver shall be used to produce redundant archives (video, events, or bookmarks) for any camera in the system, on a case by case basis.
- B. The Auxiliary Archiver shall have the ability to record a camera on a different schedule than the Archiver.
- C. The Auxiliary Archiver shall have the ability to archive any of the standard video streams for archiving. The standard video stream usages are: Live, Recording, Remote, Low Resolution, and High Resolution.
- D. The Auxiliary archiver shall have the capacity to move video archives to the Azure Cloud.

2.06 STANDBY ARCHIVER

- A. The Standby Archiver shall act as a replacement Archiver role on hot standby, ready to take over the functions of the primary Archiver role. The failover will occur in less than 1 minute. No action from the user will be required.
- B. The Standby Archiver assigned to an Archiver role entity shall automatically provide protection for all DVS connected to that Archiver role.
- C. The Standby Archiver shall protect the primary Archiver role against the following failures:
 - 1. Server failure (hardware or software).

2. Storage failure, such as Archiver Role detects that it cannot read or write to any of its allocated disks.
- D. It shall be possible for a single USP server to act as the standby server of multiple Archiver roles.
 1. Each Archiver role shall have priority value if multiple Archiver Roles fail at the same time on the same standby server.
- E. It shall be possible for any Archiver role in the system to be designated as another's standby and vice-versa.
- F. For each Archiver role it shall be possible to set up to 2 standby Archiver so that if the first failover Archiver fails the failover will automatically occur to a third server.
- G. The Standby Archiver shall have the ability to act as a Redundant Archiver.
- H. It shall be possible to set a different retention period for the Archiver and the Redundant Archiver.
- I. The Redundant Archiver shall maintain an exact copy of everything recorded by the default Archiver, i.e. audio/video archives, events, and bookmarks.
- J. Redundancy shall be configured on a camera by camera basis.
- K. The Redundant Archiver shall have to ability to use a multicast video stream from the DVS and shall not require an additional connection to any DVS.

2.07 **CLOUD ARCHIVING**

- A. The VMS shall support the automatic transfer of video recorded on the Archiver to the cloud, based on the age of the video.
- B. The Archiver shall encrypt recordings using AES-256 prior to transferring video to the cloud and maintain encryption keys local to the user's system.
- C. The VMS shall support TLS encryption between the on-premises Archiver and the cloud.
- D. The VMS shall allow users to search video stored in the cloud through the same functionality used when querying video that is stored locally.
- E. The VMS will maintain a local cache of video downloaded from the cloud, to playback recordings without requiring an additional transfer.

2.08 **VMS MEDIA STREAMING**

- A. The Media Router Role shall be responsible for routing video and audio streams across local and wide area networks from the source (for example DVS) to the destination (for example CSA).
- B. The Media Router Role shall support multiple transport protocols, such as unicast TCP, unicast UDP, and multicast UDP.
- C. The Media Router shall support IGMP (Internet Group Management Protocol) to establish multicast group memberships:
 1. IGMP v3, including SSM (Source-Specific Multicast) shall be supported.
- D. The Media Router Role using Redirector Agents shall be responsible for redirecting a stream from a source IP endpoint to a destination IP endpoint.
- E. The Redirector Agents shall be capable of converting a stream from and to any supported transport protocols:
 1. Multicast UDP to Unicast TCP
 2. Multicast UDP to Unicast UDP
 3. Unicast TCP to Multicast UDP
 4. Unicast UDP to Multicast UDP
- F. It shall be possible to limit the number of concurrent live and playback video redirections for each Redirector Agent in order to better control the bandwidth across multiple sites.
- G. It shall be possible to limit the bandwidth consumed by live and playback video from the CSA to better control the bandwidth across multiple sites. The SSM shall be able to prioritize video streaming to the CSA based on user level.
- H. It shall be possible to protect the Media Router Role against hardware or software unavailability by configuring another Media Router Role to act as a hot standby server.
- I. Multiple Redirector Agents shall be used on a large VMS installation to increase the service availability and to provide automatic load balancing.

2.09 **VMS VIDEO ARCHIVES TRANSFER CAPABILITIES**

- A. Archive transfer shall provide the ability to:
 1. Transfer video from a server to another server in the same system.
 2. Transfer video from a federated server to another server.
 3. Transfer video from camera storage to a server.
- B. It shall be possible to program video transfers either on a recurrent schedule, or to trigger them manually or upon connection.
- C. It shall be possible to filter the video of interest for a transfer. The video of interest shall be defined with the following filters:
 1. All archives when the camera was offline.
 2. Alarms.
 3. Playback request from the edge.

4. Video analytics events.
 5. Motion events.
 6. Bookmarks.
 7. Input triggers.
 8. Time range.
- D. It shall be possible to define the length of video before and after the event used as a filter to determine the video of interest.
- E. The USP shall offer an interface for displaying all video archive transfer requests. This interface shall display all the current, requested and scheduled video transfer requests. It shall be possible to edit, trigger, and cancel video archive transfers from this interface.

2.10 SECURITY VIDEO ANALYTICS

- A. The analytics shall be completely unified with the Video Management System.
- B. Configuration shall natively be performed in the configuration interface of the Video Management System.
- C. The analytics shall feature dedicated configuration possibilities for the following scenarios:
 1. Perimeter protection
 2. Area protection
 3. Direction control
 4. Object detection
 5. Stopped vehicle detection
 6. Tailgating Detection
- D. Each of the scenarios shall trigger events in the Video Management System, which correspond to their functionality.
- E. Additional to these scenarios, the analytics shall allow to configure custom intrusion detection and object detection scenarios as well as allow to import settings to allow maximum flexibility.
- F. The analytics license shall allow to configure any one of these scenarios per camera.
- G. The analytics shall allow at least two different detection variants:
 - a. Trigger an alarm if a motion pattern moves from zone A (source) through zone B into zone C (sink).
 - b. Trigger an alarm if a motion pattern moves anywhere inside a specified zone.
- H. The analytics shall support an unlimited number of detection areas.
- I. The analytics feature rain-filters to filter out disturbances.
- J. The analytics shall feature live configuration to immediately see the effects of parameter changes in the configuration interface without prior saving new configurations.
- K. The configuration of the analytics shall be possible on recorded video streams.
- L. The analytics shall offer the possibility to configure object movement paths.
- M. The analytics shall not employ tripwires or crosslines.
- N. Areas and the scenes perspective (near & far object size) shall be configured on-screen using a point-and-click interface.
- O. The analytics shall feature filters for movement speed, distance, and direction to detect events.
- P. The analytics shall feature options to separately show or hide areas, area names, and detection overlays.
- Q. The analytics shall be fully server-based, with no calculation on cameras necessary.
- R. The analytics shall operate with color, thermal, and infrared cameras.
- S. The accuracy of the analytics shall be evaluated and approved by the CPNI Video Analytics Assessment Programme and shall be listed in the CPNI Catalogue of Security Equipment (CSE).

2.11 CAMERA INTEGRITY MONITOR

- A. Description:
 1. Automatically checks camera feeds to detect if cameras have been tampered with.
 2. Can be used for near-real-time alerting of tampering events or as a maintenance tool.
 3. Reports can be run on detected tampering events.
- B. Details:
 1. It shall be completely unified with the Video Management System.
 2. It shall be possible to set the detection sensitivity per camera stream between low, medium, and high.
 3. It shall be possible to choose on which servers the analytics shall run.
 4. The camera stream used for analytics shall be configurable.
 5. It shall be possible to define how many cameras are being analyzed at the same time.
 6. To utilize minimum hardware resources, it shall be definable how often camera streams are analyzed.
 7. There shall be an overview over which cameras are configured to be analyzed.

2.12 PRIVACY PROTECTOR

- A. Description:

1. Automatically obscures all movement in surveillance videos in real-time.
 2. Live privacy masking of moving objects (such as people and vehicles).
 3. Completely unified with the video management system.
 4. Native configuration in the configuration interface of the video management system.
- B. Details:
1. Certified with a valid EuroPriSe certification seal.
 2. Indoor / outdoor modes using flexible background modeling:
 - a. Indoor: Learning model with up to 10 different illumination states – this allows to adapt to fast lighting changes such as lights switching on and off.
 - b. Outdoor: Foreground detection based on edge detection rather than color – this allows to adapt to heavily changing lighting conditions such as clouds temporarily blocking sunlight.
 3. Detects movements using an absolute difference image, calculated by subtracting the current frame from a calculated background model.
 4. Masks movements using blocks, thus obscuring the outline of an object or person.
 5. Three different scrambling methods: Pixelation, Colorize, and Transparency.
 6. Masking grids can be configured in a point-and-click interface.
 7. Past preview mode to see configuration changes in the configuration interface without necessity to save the configuration.
 8. Zones can be freely definable polygons with a point-and-click interface.
 9. Option to set analysis resolution to optimize performance.
 10. No calculation on the camera necessary, completely server-based.
 11. Option to define zones, which should always or never be pixelated.
 12. Option to choose input stream and output stream parameters, including resolutions, frame rate, and encoding.
 13. Utilizes server-side hardware acceleration to maximize the amount of cameras analyzed per server.

2.13 **PEOPLE COUNTER**

- A. Description:
1. Automatically counts people in a camera's field of view.
 2. Provides live dashboard widgets dedicated for people counting.
 3. Completely unified in the video management system.
 4. Native configuration in the configuration interface of the video management system.
- B. Details:
1. Based on deep-learning models trained on person detection to exclude non-human objects.
 2. Dedicated dashboard widgets for people counting with the following features:
 - a. Charts: visualization of counts in line- or bar-charts
 - b. Throughput: Show number of persons in given timeframe.
 - c. Occupancy: Show how many people are in an area (IN minus OUT)
 3. Counts adults and children.
 4. Counts persons in wheelchairs.
 5. Supports top-down camera views.
 6. Supports bi-directional counting.
 7. Supports tilted camera views.
 8. Option to show/hide overlays with detected persons and counting line.
 9. No GPU required to run.
 10. The occupancy widget support resetting the count at a defined timeOption to define zones, which should always or never be pixelated.
 11. Supports organizing cameras into areas and show these areas in widgets.
 12. Utilizes server-side hardware acceleration to maximize the number of cameras analyzed per server.
 13. Counts can be integrated to external systems using CSV exports and a .NET SDK

2.14 **GENERAL CLIENT SOFTWARE REQUIREMENTS**

- A. The Client Software Applications (CSA) shall provide the user interface for USP configuration and monitoring over any network and be accessible locally or from a remote connection.
- B. The CSA shall consist of the Configuration UI for system configuration and the Monitoring UI for monitoring. The CSA shall be Windows-based and provide an easy-to-use graphical user interface (UI).
- C. The CSA for monitoring shall support running in 64-bit mode.
- D. The Server Administrator shall be used to configure the server database(s). It shall be web-based and accessible locally on the SSM or across the network.
- E. The CSA shall seamlessly merge access control, license plate recognition (ALPR), and video functionalities within the same user application.

- F. The USP shall use the latest user interface (UI) development and programming technologies such as Microsoft WPF (Windows Presentation Foundation), the XAML markup language, and the .NET software framework.
- G. All applications shall provide an authentication mechanism, which verifies the validity of the user. As such, the administrator (who has all rights and privileges) can define specific access rights and privileges for each user in the system.
- H. Logging on to a CSA shall be done either through locally stored USP user accounts and passwords or using the operator's Windows credentials when Active Directory integration is enabled.
- I. When integrated with Microsoft's Active Directory, the CSA and USP shall authenticate users using their Windows credentials. As a result, the USP will benefit from Active Directory password authentication and strong security features.
- J. The CSA shall support multiple languages, including but not limited to the following: English, French, Arabic, Czech, Dutch, German, Hebrew, Hungarian, Italian, Japanese, Korean, Norwegian, Persian (Farsi), Polish, Portuguese (Brazilian), Simplified and Traditional Chinese, Russian, Spanish, Swedish, Thai, Turkish, and Vietnamese.
- K. To enhance usability and operator efficiency, the Configuration UI and Monitoring UI shall support many of the latest UI such as:
 - 1. A customizable Home Page that includes favorite and recently used tasks.
 - 2. Task-oriented approach for administrator/operator activities where each type of activity (surveillance, visitor management, individual reports, and more) is an operator task.
 - 3. Consolidated and consistent workflows for video, ALPR, and access control.
 - 4. Single click functionality for reporting and tracking. The Monitoring UI shall support both single-click reporting for access control, ALPR, and video, as well as single-click tracking of areas, cameras, doors, zones, cardholders, elevators, ALPR entities, and more. Single-click reporting or tracking shall create a new task with the selected entities to report on or track.
- L. Configuration UI and Monitoring UI Home Page and Tasks
 - 1. The Configuration UI and Monitoring UI shall be task-oriented.
 - 2. A task shall be user interface design patterns whose goal is to simplify the user interface by grouping related features from different systems, such as video and access, in the same display window. Features shall be grouped together in a task based on their shared ability to help the user perform a specific task.
 - 3. Tasks shall be accessible via the Home Page of either the Configuration or the Surveillance CSA.
 - 4. Newly created tasks shall be accessible via the Configuration UI or the Monitoring UI taskbar.
 - 5. Similar tasks shall be grouped into the following categories:
 - a. Operation: Access control management, LRP management, and more.
 - b. Investigation: Video bookmark/motion/archive reports, access control activity reports, visitor activity reports, alarm reports, ALPR activity reports, and more.
 - c. Maintenance: Access control and video configuration reports, troubleshooters, audit trails, health-related reports, and more.
 - 6. An operator shall be able to launch a specific task only if they have the appropriate privileges.
 - 7. The Home Page content shall be customizable through the use of privileges to hide tasks that an operator should not have access to and through a list of favorite and recently used tasks. In addition, editing a USP XML file to add new tasks on the fly shall also be possible.
- M. The Contractor shall provide up to 5 number of simultaneous Clients.

2.15 CONFIGURATION USER INTERFACE (UI)

- A. General:
 - 1. The Configuration UI application shall allow the administrator or users with appropriate privileges to change the system configuration. The Configuration UI shall provide decentralized configuration and administration of the USP system from anywhere on the IP network.
 - 2. The configuration of all embedded ACS, VMS, and ALPR systems shall be accessible via the Configuration UI.
 - 3. The Configuration UI shall have a home page with single-click access to various tasks.
 - 4. The Configuration UI shall include a variety of tools such as troubleshooting utilities, import tools, and a unit discover tool, amongst many more.
 - 5. The Configuration UI shall include a static reporting interface to:
 - a. View historical events based on entity activity. The user shall be able to perform such actions as printing a report and troubleshooting a specific access event from the reporting view.
 - b. View audit trails that show a history of user/administrator changes to an entity.
 - 6. Common entities such as users, schedules, alarms and many more, can be reused by all embedded systems (ACS, VMS, and ALPR).
- B. Video management system:
 - 1. The Configuration UI shall allow the administrator or users with appropriate privileges to change video configuration.

2. The Configuration UI shall provide the ability to change video quality, bandwidth, and frame rate parameters on a per camera (stream) basis for both live and recorded video.
3. The Configuration UI shall provide the ability to change video quality by a selection of predefined video quality template.
4. The Configuration UI shall provide the ability to configure brightness, contrast, and hue settings for each camera on the same DVS.
5. The Configuration UI shall provide the capability to enable audio recording on DVS units that support audio.
6. The Configuration UI shall provide the ability to change the audio parameters, serial port and I/O configuration of individual DVS units.
7. The Configuration UI shall provide the capability to rename all DVS units based on system topology and to add descriptive information to each DVS.
8. The Configuration UI shall provide the ability to set recording schedules and modes for each individual camera. The recording mode can be:
 - a. Continuous
 - b. On motion and Manual
 - c. Manual only
 - d. Disabled
9. The Configuration UI shall support the creation of schedules to which any of the following functional aspects can be attached:
 - a. Video quality (for each video stream per camera)
 - b. Recording (for each camera)
 - c. Motion detection (for each detection zone per camera)
 - d. Brightness, Contrast, and Hue (for each camera)
 - e. Camera sequence execution
10. The Configuration UI shall support the creation of unlimited recording schedules and the assigning of any camera to any schedule.
11. The Configuration UI shall detect and warn user of any conflict within assigned schedules.
12. The Configuration UI shall provide the capability to set a PTZ protocol to a specific DVS serial port and shall allow mixing domes of various manufacturers within a system.
13. User shall have the ability to configure a return to home function after a predefined time of inactivity for PTZ cameras. This period of inactivity time shall be configurable from 1 to 7200 seconds.

2.16 **VMS CLIENT USER INTERFACE (UI)**

- A. The Monitoring UI shall fulfill the role of a Unified Security Interface that is able to monitor video, ALPR, and access control events and alarms, as well as view live and recorded video.
- B. The Monitoring UI shall provide a graphical user interface to control and monitor the USP over any IP network. It shall allow administrators and operators with appropriate privileges to monitor their unified security platform, run reports, and manage alarms.
- C. To enhance usability and operator efficiency, the Monitoring UI shall support the following UI concepts:
 1. Dynamically adaptive interface that adjusts in real-time to what the operator is doing.
 2. A dynamic controls section loaded with entity-specific widgets (e.g. door and camera widgets).
 3. Use of transparent overlays that can display multiple types of data in a seamless fashion.
 4. Display tile menus and quick commands.
 5. Consolidated and consistent workflows.
 6. Tile menus and quick commands easily accessible within every display tile of the user workspace.
 7. Single click functionality for reporting and tracking. The Monitoring UI shall support both single-click reporting for access control, ALPR, and video, as well as single-click tracking of areas, cameras, doors, zones, cardholders, elevators, ALPR entities, and more. Single-click reporting or tracking shall create a new task with the selected entities to report on or to track.
- D. Monitoring UI Home Page and Tasks:
 1. Similar tasks shall be grouped into the following categories:
 - a. Operation: Access control/LRP/video surveillance, visitor management, mustering, access control and video alarm monitoring, and more.
 - b. Investigation: Video bookmark/motion/archive reports, access control activity reports, visitor activity reports, alarm reports, ALPR activity reports, and more.
 - c. Maintenance: Access control and video configuration reports, troubleshooters, audit trails, and more.
- E. Dynamically Adaptive UI, Controls section, and Widgets:
 1. The Monitoring UI shall dynamically adapt to what the operator is doing. This shall be accomplished through the concept of widgets that are grouped in the Monitoring UI Controls section.
 2. Widgets shall be mini-applications or mini-groupings in the Monitoring UI Controls section that let the operator perform common tasks and provide them with fast access to information and actions.

3. With a single click on an entity (for example door or camera) the specific widgets associated to that entity appear and other non-relevant widgets disappear dynamically (instantly). Widgets shall bring the operator information such as door status and camera stream information, as well as user actions, such as door unlock, PTZ controls, and more.
 4. Specific widgets include those for a door, camera, alarm, zone, display tile, video stream (statistics), PTZ camera, and more.
- F. Operator Workflows:
1. A workflow shall be a sequence of operations an operator or administrator shall execute to complete an activity. The "flow" relates to a clearly defined timeline or sequence for executing the activity.
 2. The Monitoring UI shall be equipped with consistent workflows for the ALPR, video, and access control systems that it unifies.
 3. Generating or printing a report, setting up or acknowledging an alarm, or creating an incident report shall follow the same process (workflow) whether the operator is working with video, ALPR, or access control, or with both video and access control.
- G. Each task within the Monitoring UI shall consist of one or more of the following items:
1. Event list.
 2. Logical tree: Doors, cameras, zones, ALPR units, and elevators shall be grouped under Areas in a hierarchical fashion.
 3. Entities list of all entities being tracked.
 4. Display tiles with various patterns (1 x 1, 2 x 2, and more).
 5. Display tile menu with various commands related to cameras, doors, PTZ, and tile controls.
 6. Controls section with widgets.
- H. The Monitoring UI shall support multiple event lists and display tile patterns, including:
1. Event/alarm list layout only
 2. Display tile layout only
 3. Display tile and alarm/event list combination
 4. ALPR map and alarm/event list combination
- I. User workspace customization
1. The user shall have full control over the user workspace through a variety of user-selectable customization options. Administrators shall also be able to limit what users and operators can modify in their workspace through privileges.
 2. Once customized, the user shall be able to save his or her workspace.
 3. The user workspace shall be accessible by a specific user from any client application on the network.
 4. Display tile patterns shall be customizable.
 5. Event or alarm lists shall span anywhere from a portion of the screen up to the entire screen and shall be resizable by the user. The length of event or alarm lists shall be user-defined. Scroll bars shall enable the user to navigate through lengthy lists of events and alarms.
 6. The Monitoring UI shall support multiple display tile patterns (for example one display tile (1x1 matrix), 16 tiles (8x8 matrix), and multiple additional variations).
 7. The Monitoring UI shall support as many monitors as the PC video adapters and Windows Operating System are capable of accepting.
 8. Additional customization options include: show/hide window panes, show/hide menus/toolbars, show/hide overlaid information on video, resize different window panes, and choice of tile display pattern on a per task basis.
- J. The Monitoring UI shall provide an interface to support the following tasks and activities common to access control, ALPR, and video:
1. Monitoring the events from a live security system (ACS and/or VMS and/or ALPR).
 2. Generating reports, including custom reports.
 3. Monitoring and acknowledging alarms.
 4. Creating and editing incidents and generating incident reports.
 5. Displaying dynamic graphical maps and floor plans as well as executing actions from dynamic graphical maps and floor plans.
 6. Management and execution of hot actions and macros.
- K. The Monitoring UI shall be able to monitor the activity of the following entities in real-time: areas, ALPR entities, doors, elevators, cameras, cardholders, cardholder groups, zones (input points), and more.
- L. The Monitoring UI shall include advanced video capabilities, including:
1. Advanced live video viewing functionality.
 2. Advanced archive playing and video playback functionality.
 3. Monitoring and management of video system events and alarms.
 4. Intercom or duplex audio.
 5. Generation of video reports.
 6. Control of PTZ cameras.
 7. Creating and monitoring archive transfer requests.

8. Display metadata overlaid on live or playback video.
- M. The Monitoring UI shall leverage the Graphical Processing Unit (GPU) for video decoding.
 1. The following GPU technologies shall be supported:
 - a. NVidia CUDA
 - b. Intel Quick Sync
 2. The Monitoring UI shall have the ability to decode video through the optimal simultaneous use of the GPU and Computer Processing Units (CPU).
- N. The live video viewing capabilities of the Monitoring UI shall include:
 1. The ability to display all cameras attached to the USP and all cameras attached to federated systems.
 2. Support for live video monitoring on each and every display tile within a task in the user's workspace.
 3. The USP shall support uninterrupted video streaming. The CSA shall keep existing video connections active in the event that an SSM (except Archiver) becomes unavailable.
 4. The ability to drag and drop a camera into a display tile for live viewing.
 5. The ability to drag and drop a camera into a display tile for live viewing on an analog monitor connected to an IP hardware decoder (converting an IP encoded stream into an analog video signal).
 6. The ability to drag and drop a camera from a map into a display tile for live viewing.
 7. Support for digital zoom on live camera video streams.
 8. The ability for audio communication with video units with audio input and output.
 9. The ability to control pan-tilt-zoom, iris, focus, and presets.
 10. The ability to bookmark important events for later retrieval on any archiving camera and to uniquely name each bookmark in order to facilitate future searches.
 11. The ability to start/stop recording on any camera in the system that is configured to allow manual recording by clicking on a single button.
 12. The ability to activate or de-activate viewing of all system events as they occur.
 13. The ability to switch to instant replay of the video for any archiving camera with the simple click of button.
 14. The ability to take snapshots of live video and be able to save or print the snapshots.
 15. The ability to view the same camera multiple times in different tiles.
- O. The video playback (archive playing) capabilities of the Monitoring UI shall include:
 1. Support for audio and video playback for any time span.
 2. Support for video playback on each and every display tile.
 3. The ability to instantly replay the video for any archiving camera with the simple click of a button.
 4. The ability to select between instant synch of all video streams in playback mode, allowing operators to view events from multiple angles or across several camera fields, or non-synchronous playback.
 5. The ability to simultaneously view the same camera in multiple tiles at different time intervals.
 6. The ability to control playback with:
 - a. Pause
 - b. Lock Speed
 - c. Forward and Reverse Playback at: 1x, 2x, 4x, 6x, 8x, 10x, 20x, 40x, 100x
 - d. Forward and Reverse Playback frame by frame
 - e. Slow Forward and Reverse Playback at: 1/8x, 1/4x, 1/3x, 1/2x
 - f. Loop playback between two time markers
 7. The ability to display a single timeline or one timeline for each selected video stream, which would allow the operator to navigate through the video sequence by simply clicking on any point in the timeline.
 8. The ability to display the level of motion at any point on a timeline.
 9. The ability to clearly display bookmarked events on the timeline(s).
 10. The ability to query archived video using various search criteria, including, but not limited to, time, date, camera, and area.
 11. The tool necessary for searching video and associated audio based on user-defined events or motion parameters.
 12. The ability to define an area of the video field in which to search for motion as well as define the amount of motion that will trigger search results. The Monitoring UI shall then retrieve all archived video streams that contain motion that meets the search parameters. There shall be a graphical timeline on which the time of each search hit shall be indicated.
 13. The ability to browse through a list of all bookmarks created on the system and select any bookmarked event for viewing.
 14. The ability to add bookmarks to previously archived video for easier searching and retrieval.
 15. Support for digital zoom on playback video streams.
 16. Still image export to PNG, JPEG, GIF, and BMP format with Date and Time stamp, and Camera Name on the image (snapshot).

17. Tools for exporting video and a self-contained video player on various media such as USB keys or CD/DVD-ROM. This video player shall be easy to use without training and shall still support reviewing video metadata, such as bookmark, or navigating the video with functions like panoramic camera view dewarping.
 18. Tools for exporting video sequences in standard video formats, such as ASF or MP4.
 19. The ability to encrypt exported video files.
 20. The ability for an operator to load previously exported video files from their computer or network.
 21. The ability for queries to be saved upon closing the CSA and reappear when the application is reopened.
 22. The ability to dynamically block, on demand, video stream dynamically to lower level users to prevent access, for a specific time, to live and recorded video.
 23. A tool building and exporting a set of videos into a single container. This tool shall allow the operator to build sequences of video to create a storyboard and allow the export of synchronous cameras.
 24. The ability to store the video export and still image export at a pre-defined storage location.
 25. An interface with the ability to list, search, and manipulate previously generated video exports.
 26. The ability to export sequences of video in open standards including ASF and MP4.
- P. The Monitoring UI shall provide an interface to support the following ALPR tasks and capabilities:
1. Monitoring and management of ALPR events and alarms.
 2. Viewing of license plate picture(s) and context images.
 3. Viewing of license plate data (e.g. license plate reads)
 4. Verification of ALPR data against live and recorded video.
- Q. Entity Monitoring:
1. The USP shall permit the user to select multiple entities to monitor from the Monitoring UI by adding the entities one by one to the tracking list.
 2. The Monitoring UI shall provide the option to filter which events shall be displayed in the display tile layout and/or event list layout.
 3. It shall be possible to lock a Monitoring UI display tile so that it only tracks the activity of a specific entity (e.g. specific door or camera).
 4. The user shall be able to drag and drop an event from an event list (or an alarm from an alarm list) onto a display tile to view a license plate read, cardholder picture ID, badge ID, or live/archived video, among other options.
 5. Event, alarm, monitoring/tracking, and report lists shall contain cardholder pictures where applicable.
 6. The user shall be permitted to start or pause the viewing of events within each display tile.
- R. Display Tile Packing and Unpacking:
1. The Monitoring UI shall support single-click unpacking and packing for ALPR hits, ALPR reads, areas, doors, zones, camera sequences, and alarms.
 2. The packing and unpacking of entities shall allow operators to quickly obtain additional information and camera views of a specific entity.
 3. The unpacking of an entity shall display associated entities. For example, unpacking a door with multiple associated cameras shall display all cameras associated with that door. Unpacking shall reconfigure the display tiles to be able to display all associated entities. For example, unpacking a door (or a zone or alarm) that is currently in a 1 x 1 tile configuration and that has 3 cameras tied to it will create a 1 x 3 display tile arrangement for viewing all associated entities.
 4. Packing will return the display to the original tile pattern.
- S. Visual Tracking:
1. The Monitoring UI shall support the ability to manually track a moving target with the single click of a button.
 2. The ability to switch from one camera view to an adjacent camera shall be done within a single display tile.
 3. Switching between camera streams shall be accomplished by simply clicking on a semi-transparent shape or overlay.
 4. Visual tracking shall be available with both live and recorded video.

2.17 **SERVER ADMINISTRATOR USER INTERFACE REQUIREMENTS**

- A. The Server Administrator shall be used to configure the SSM and the Directory Role (main configuration) and its database(s), to apply the license, and more.
- B. The Server Administrator shall be a web-based application. Through the Server Administrator, it shall be possible to access the SSM across the network or locally on the server.
- C. Access to the Server Administrator shall be protected via login name, password, and encrypted communications.
- D. The Server Administrator shall allow the administrator (user) to perform the following functions:
 1. Manage the system license.
 2. Configure the database(s) and database server for the Directory Role,

3. Activate/Deactivate the Directory Role.
4. Manually back up the Directory Role database(s) and/or restore the server database(s), as well as configure scheduled backups of the databases.
5. Define the client-to-server communications security settings.
6. Configure the network communications hardware, including connection addresses and ports.
7. Configure system SMTP settings (mail server and port).
8. Configure event and alarm history storage options.

2.18 **UNIFIED WEB CLIENT (UWC) GENERAL REQUIREMENTS**

- A. The USP shall support a unified web client (UWC) for access control and video.
- B. The UWC shall be a truly thin client with no download required other than an internet web browser or standard web browser plugins.
- C. The UWC shall be platform independent and run within Microsoft Edge, Internet Explorer, Firefox, Safari, and Google Chrome.
- D. Web pages for the web client shall be managed and pushed by the Web Server Role. Microsoft IIS or any other web hosting service shall not be required given that all the web pages shall be hosted by the Web Server Role.
- E. The UWC shall support display on tablet format.
- F. Video Stream shall be redirected to the Web Client with no stream transformation or re-encoding for all streams in H264.
- G. The Contractor shall provide up to 5 number of simultaneous Web Clients.
- H. Functionalities:
 1. Log in using name and password or Active Directory support shall be available.
 2. Ability for user to change their password.
 3. Encrypted communications for all transactions.
 4. Print reports and export to CSV file.
 5. Customer logo customization shall be available for multi-tenant and hosted services applications.
 6. Video:
 - a. Live and playback video at 320 x 240, 640 x 480 or 1280 x 1024 @ 15 fps
 - b. Video export
 - c. 1, 4, 6 or 9 tiles
 - d. Basic PTZ Controls (Pan/Tilt, Zoom, go to presets, start pattern)
 - e. Start / Stop recording
 - f. Sample web page for customers to see how to view video for their own development
 - g. Add bookmarks
 7. Alarms:
 - a. Alarm report
 8. Threat Level.

2.19 **SMARTPHONE AND TABLET APP GENERAL REQUIREMENTS**

- A. The USP shall support mobile apps for various off-the-shelf devices. The mobile apps shall communicate with the Mobile Server of the USP over any Wi-Fi or cellular network connection.
- B. Mobile apps shall communicate with the USP via a Mobile Server Role (MSR). All communication between the mobile apps and MSR shall be based on standard TCP/IP protocol and shall use the TLS encryption with digital certificates to secure the communication channel.
- C. Supported device manufacturers shall include (refer to Mobile App specifications for latest compatibility list):
 1. Apple devices running iOS 11.0 or later
 2. Android devices 6.0 or later
- D. It shall be possible to download the mobile apps from the Central application store (Apple iTunes App Store, Google Play).
- E. Functionalities:
 1. Core
 - a. Ability to logon/logoff to the USP using an authorized user profile of the system.
 - b. Ability to change the picture or the password of the user of the mobile app.
 - c. Ability to view the current Threat Level of the system.
 - d. Ability to change the current Threat Level of the system.
 - e. Ability to execute hot actions configured in the user profile.
 - f. Ability to view entities from the USP:
 - i. Cameras
 - ii. Doors
 - iii. ALPR cameras
 - iv. Web Tile Plugins
 - v. Layouts
 - vi. Camera Sequences

- vii. Macros
 - viii. Maps (geographical maps only)
 - ix. Ability to navigate the system hierarchical view of the entities and search entities in the system.
2. Video
 - a. Ability to view live and recorded video from the cameras of the USP. A maximum of four cameras shall be displayed.
 - b. Ability to display live and recorded video side-by-side for a specific camera.
 - c. Ability to perform digital zoom on cameras.
 - d. Ability to perform actions on cameras such as add a bookmark, control a PTZ, control the iris/focus function, save a snapshot, start/stop recording.
 - e. Ability to view camera layouts.
 - f. Ability to view camera sequences.
 - g. Ability to run a camera events report.
 - h. Ability to change the video quality on the cameras displayed on the mobile app.
 - i. Ability to use the camera of the smartphone and stream a live video feed to a video recorder in the system.
 3. Access Control
 - a. Ability to view the door state and door lock state.
 - b. Ability to perform actions on a door such as unlock the door, set the door in maintenance mode, override the door unlocking schedule.
 4. Automatic License Plate Recognition
 - a. Ability to view live events raised by an ALPR camera.
 - b. Ability to view the read image, context image, and all metadata captured by the ALPR camera.
 - c. Ability to run an ALPR event report.
 - d. Ability to add a license plate to a hotlist on the system.
 5. Alarm Management
 - a. Ability to receive push notifications to notify mobile operators that an alarm was received.
 - b. Ability to view all active alarms assigned to the mobile operator.
 - c. Ability to perform action on an alarm such as acknowledge, forward, or alternate-acknowledge an active alarm.
 - d. Ability to view entities attached to the alarm.
 6. Map
 - a. Ability to display a geographic map with USP entities geo-located on the map.
 - b. Ability to view any entity configured on the map.
 - c. Ability to search entities or location on the map.
- F. It shall be possible to send a message from the client user interface to a mobile operator.
- G. It shall be possible to send a live or playback video sequence from the client UI to a mobile operator.
- H. It shall be possible to view mobile operators who enabled location tracking on a map in the system. The location of the mobile operator should be updated in real time.

2.20 **HEALTH MONITOR**

- A. The USP shall monitor the health of the system, log health-related events, and calculate statistics.
- B. USP services, roles, agents, units, and client apps will trigger health events.
- C. The USP shall populate the Windows Event Log with health events related to USP roles, services, and client apps.
- D. A dedicated role, the Health Monitoring Role, shall perform the following actions:
 1. Monitor the health of the entire system and log events.
 2. Calculate statistics within a specified time frame (hours, days, months).
 3. Calculate availability for clients, servers and video/access/ALPR units.
- E. A Health Monitoring task and Health History reporting task shall be available for live and historical reporting.
- F. A Health Monitoring dashboard task shall be available in the client application user interface to provide a live display, such as pie charts and event lists, for quick visual assessment on the general health of the system.
- G. A web-based, centralized health dashboard shall be available to remotely view unit and role health events of the USP.
- H. Detailed system care statistics will be available through a web-based dashboard providing health metrics of USP entities and roles, including Uptime and mean-time-between-failures.
- I. All health events raised in the system can be used for automating the USP event/action management.
- J. Health events shall be accessible via the SDK (can be used to create SNMP traps).

2.21 SESSION INITIATION PROTOCOL (SIP) COMMUNICATION MANAGEMENT (CM)

- A. An operator of the USP shall be able to, within the USP Monitoring UI, initiate calls to and answer calls from other operator and edge voice devices such as intercoms, emergency call stations, information desks, softphones, or phone devices.
- B. The USP shall support CM between the USP client User Interface and SIP endpoint devices.
- C. SIP endpoints shall be able to register to the USP using a standard SIP protocol.
- D. The USP shall support CM between two SIP endpoint devices.
- E. The USP shall allow the configuration of SIP trunk connections to multiple SIP Servers supporting SIP Trunks.
- F. The CM shall support the management of calls to and from other SIP Servers connected though SIP Trunks.
- G. The USP shall support the configuration of paging zones for pre-recorded and live message announcements.
- H. The CM is a service of the USP and shall not require the addition of any third party software.
- I. The CM shall support the following video codecs:
 - 1. H.264
 - 2. H.263
 - 3. H.263+ (1998)
- J. The CM shall support the following audio codecs:
 - 1. PCMA (G.711 aLaw)
 - 2. PCMU (G.711 uLaw)
 - 3. G.722
 - 4. G.729
 - 5. iLBC
 - 6. GSM
 - 7. telephone event
 - 8. Speex (Narrowband)
 - 9. Speex (Wideband)
 - 10. Speex (Ultrawideband)
 - 11. L.16
 - 12. L.16-44-1
 - 13. G.728
 - 14. G.726-16
 - 15. G.726-24
 - 16. G.726-32
 - 17. G.723
 - 18. G.726-40
- K. The CM shall certify SIP devices from the following manufacturers:
 - 1. 2N Telekomunikace
 - 2. Algo
 - 3. Axis
 - 4. Baudisch
 - 5. Castel
 - 6. Cisco
 - 7. Code Blue
 - 8. Commend
 - 9. EMCOM
 - 10. Grandstream networks
 - 11. Jacques
 - 12. Mobotix
 - 13. Siedle
 - 14. TalkaPhone
 - 15. TOA Corporation
 - 16. Valcom
 - 17. Vingtor-Stentofon
 - 18. Zenitel
 - 19. Intelbras
- L. The CM shall allow bidirectional audio and video recording of call sessions. The USP shall offer the following recording capabilities:
 - 1. Automatic cleanup of call session files after a programmable number of days.
 - 2. Deactivation of call recording between operators.
 - 3. Deactivation of call recording with specific operators.
 - 4. Deactivation of call recording with specific voice devices.
 - 5. Selection of the storage path for call session recordings.

- M. The CM shall provide the capability to reach a physical location identified by its own extension number regardless of the user connected to the USP.
- N. The CM shall provide the flexibility for the administrator to define the network ports used to communicate between the USP servers and the following:
 - 1. USP Operator Client User Interfaces
 - 2. SIP devices
 - 3. SIP servers
- O. The CM shall provide the capability to create Ring Groups. A Ring Group is a group of call numbers grouped under a single call number. It shall be possible to set a Ring Group to simultaneously or sequentially call the members of the group. Dwell time for sequence mode shall be configurable.
- P. The CM shall allow the automatic routing of calls through the configuration of a collection of rules (Dial Plan). Dial Plans shall support the following capabilities:
 - 1. Match a phone number with regular expression.
 - 2. Route calls based on matching the phone numbers from which calls are made.
 - 3. Route calls based on matching the destination phone numbers to which calls are made.
 - 4. Change the phone extension from which calls are received.
 - 5. Change the phone extensions to which calls are sent.
 - 6. A combination of any of the above capabilities in a configured priority and based on a schedule.
- Q. Dial Plans shall be applicable to calls between SIP entities registered to the USP as well as to and from external SIP servers.
- R. The USP shall unify, within a simple user interface, the workflow between the associated security entities of a call session, including the call box, cameras, doors, intrusion zones and outputs.
- S. The USP shall support video and audio calls:
 - 1. Between USP Client User Interfaces
 - 2. To and from USP Client User Interfaces and SIP devices
 - 3. Between SIP devices
- T. The USP shall provide an advanced and friendly call management user interface that allows operators to:
 - 1. Connect standard USB headsets and webcams to USP Client User Interface workstations so that USP users can make voice and video calls through the USP Client User Interface.
 - 2. Display the video associated with the call and switch between multiple video sources.
 - 3. Receive incoming call notifications directly through a notification tray.
 - 4. Initiate, answer, forward, place on hold, or cancel calls from a dedicated call dialog box.
 - 5. Control cameras, doors, zones, and device outputs during a call.
 - 6. Create a customizable list of contacts, so that users can quickly call their contacts. Contact lists shall include other USP users, as well as SIP devices.
 - 7. Dial a phone number to make a call.
 - 8. Dial a DTMF sequence during a call.
 - 9. Monitor the availability status of a user and set its own availability status.
 - 10. Access a history log of calls that the operator both initiated and received. This log shall show the time of the call, duration, direction and the reason for its ending. It shall be possible to redial one of the entries in the log.
- U. The USP shall allow an operator to manage up to 10 calls simultaneously. The call queue shall show the status of each call: incoming, in call, or on hold. It shall be possible to hold and resume a call directly from the call queue.
- V. The USP shall offer a call window. It shall be possible within the call windows to:
 - 1. Switch between cameras associated with the call participant.
 - 2. Open and lock doors associated with the call participant.
 - 3. Arm and Disarm zones associated with the call participant.
 - 4. Trigger outputs associated with the call participant.
 - 5. Put on hold, resume, forward, and end a call.
 - 6. Mute the microphone.
 - 7. Hide the webcam video feed.
- W. The USP shall have a built-in address book. The address book shall be available in the call dialog box, in which users can view and manage their list of contacts. From the address book, users shall be able to do the following:
 - 1. Call a contact by simply double-clicking the contact name.
 - 2. See the availability status of their contacts (users and SIP Devices).
 - 3. Quickly display a contact's information, such as photo, name, and number.
 - 4. Filter their contacts by type (SIP Device or User).
 - 5. Create a list of favorites by adding and removing contacts.
 - 6. Search for and call numbers that appear in the contact list.
- X. The USP shall provide a graphical dial pad to allow the operator to make calls and dial DTMF tones during a call.

- Y. The USP shall provide the ability to send public announcements via a microphone or uploaded pre-recorded messages. The users shall be able to do the following:
 1. Create paging zones.
 2. Associate any SIP callable entity with a paging zone.
 3. Upload pre-recorded messages.
 4. Trigger a live or pre-recorded message.
- Z. The USP shall provide call reporting capabilities to allow for the investigation of the activities during specific call sessions. The report shall provide the capability to replay audio recordings and watch call sessions that have associated video. The Call report shall provide filters to query the call records by:
 1. Date and time
 2. Call session duration
 3. Involved users and call stations
 4. Call events and actions
 5. Actions taken by a user on doors, intrusion zones, and outputs during the call session
- AA. The USP shall give the capability to export a call session, including bidirectional audio, associated video, and log journal of the call session.
- BB. It shall be possible to place the voice devices as icons on a map that shall display the call status of the voice device with a color code. A right-click on the voice device map icon shall allow the user to:
 1. Answer or reject an incoming call.
 2. Initiate a call to the device.
 3. Put on hold and resume a call with the device.
- CC. It shall be possible for an operator to select and broadcast his or her availability status, with the possible statuses being Available, Away and Busy. This status will appear with a color code in the call dialog box of other operators.
- DD. The Contractor shall provide up to 0 number of SIP connections.
- EE. The Contractor shall provide up to 0 number of SIP trunks.
- FF. The Contractor shall provide a failover and bidirectional audio and video recording license for each SIP device.
- GG. The contractor shall provide up to XX number of SIP public address.

2.22 USP GENERAL REQUIREMENTS

- A. The Unified Security Platform (USP) shall be an enterprise class IP-enabled security and safety software solution.
- B. The USP shall support the seamless unification of IP access control system (ACS), IP video management system (VMS), and IP automatic license plate recognition system (ALPR) under a single platform. The USP user interface (UI) applications shall present a unified security interface for the management, configuration, monitoring, and reporting of embedded ACS, VMS, and ALPR systems and associated edge devices.
- C. Functionalities available with the USP shall include:
 1. Configuration of embedded systems, such as ACS, ALPR, and VMS systems.
 2. Live event monitoring.
 3. Live video monitoring and playback of archived video.
 4. Alarm management.
 5. Reporting, including creating custom report templates and incident reports.
 6. The Federation feature for global monitoring, reporting, and alarm management of multiple remote and independent ACS, VMS, and/or ALPR systems spread across multiple facilities and geographic areas.
 7. Global cardholder management across multiple facilities and geographic areas each with their own independent ACS system.
 8. Microsoft Active Directory integration for synchronizing USP user accounts and ACS cardholder accounts.
 9. Intrusion device and panel integration (live monitoring, reporting, and arming/disarming).
 10. SIP Intercom device integration for bi-directional communication.
 11. Integration with third party systems and databases via plug-ins (access control, video analytics, point of sale, and more).
 12. Dynamic graphical map viewing.
 13. Asset management system integration.
- D. The USP shall be deployed in one or more of the following types of installations:
 1. Unified access, ALPR, video platform, and any combination thereof.
 2. Standalone access control, ALPR, or video platform.
 3. Unified access and video platform that federates multiple remote ACS, VMS, ALPR.
 4. Standalone video platform that federates multiple independent remote VMS.
 5. Standalone access control that federates multiple independent remote ACS.
 6. Standalone access control that federates multiple independent remote ALPR.
- E. Licensing:

1. A single central license shall be applied centrally on the configuration server.
 2. There shall be no requirement to apply a license at every server computer or client workstation.
 3. Based on selected options, one or more embedded systems shall be enabled or disabled.
- F. Hardware and Software Requirements:
1. The USP and embedded systems (video, license plate recognition, and access control) shall be designed to run on a standard PC-based platform loaded with a Windows operating system. The preferred operating system shall be coordinated with the Owner following the manufacturer supported operating systems.
 2. The core client/server software shall be built in its entirety using the Microsoft .NET software framework and the C# (C-Sharp) programming language.
 3. The USP database server(s) shall be built on Microsoft's SQL Server. The preferred SQL version shall be coordinated with the Owner and compatible with the USP.
 4. The USP shall be compatible with virtual environments, including VMware and Microsoft Hyper-V.
 5. The USP shall use the latest user interface (UI) development and programming technologies such as Microsoft WPF (Windows Presentation Foundation), the XAML markup language, and .NET software framework.

2.23 USP ARCHITECTURE

- A. The USP shall be based on a client/server model. The USP shall consist of a standard Server Software Module (SSM) and Client Software Applications (CSA).
- B. The USP shall be an IP enabled solution. All communication between the SSM and CSA shall be based on standard TCP/IP protocol and shall use TLS encryption with digital certificates to secure the communication channel.
- C. The SSM shall be a Windows service that can be configured to start when the operating system is booted and run in the background. The SSM shall automatically launch at computer startup, regardless of whether or not a user is logged on the machine.
- D. Users shall be able to deploy the SSM on a single server or across several servers for a distributed architecture. The USP shall not be restricted in the number of SSM deployed.
- E. The USP shall support the concept of The Federation feature whereby multiple independent ACS, VMS, and ALPR installations can be merged into a single large virtual system for centralized monitoring, reporting, and alarm management.
- F. The USP shall protect against potential database server failure and continue to run through standard off-the-shelf solutions.
- G. The USP shall support up to one thousand instances of CSA connected at the same time. However, an unrestricted number of CSA can be installed at any time.
- H. The USP shall support an unrestricted number of logs and historical transactions (events and alarms) with the maximum allowed being limited by the amount of hard disk space available.
- I. The USP shall support uninterrupted video streaming. The CSA shall keep existing video connections active in the event that an SSM (except Archiver) becomes unavailable.
- J. Roles-Based Architecture:
 1. The USP shall consist of a role-based architecture, with each SSM hosting one or more roles.
 2. Each role shall execute a specific set of tasks related to either core system, automatic license plate recognition (ALPR), video (VMS), or access control (ACS) functionalities, among many others. Installation shall be streamlined through the ability of the USP to allow administrators to:
 - a. Deploy one or several SSM across the network prior to activating roles.
 - b. Activate and deactivate roles as needed on each and every SSM.
 - c. Centralize role configuration and management.
 - d. Support remote configuration.
 - e. Move roles over from one SSM to another.
 3. Each role, where needed, shall have its own database to store events and role-specific configuration information.
 4. Roles without databases, such as The Federation feature, Active Directory, and Global Cardholder Management, shall support near real-time standby without any third party failover software being required.
 5. Directory Role:
 - a. The Directory Role shall manage the central database that contains all the system information and component configuration of the USP.
 - b. The Directory Role shall authenticate users and give access to the USP based on predefined user access rights or privileges, and security partition settings.
 - c. The Directory Role shall support the configuration/management of the following components common to the ACS, ALPR, and VMS sub-systems:
 - i. Security Partitions, users and user groups
 - ii. Areas
 - iii. Zones, input/output (IO) linking rules, and custom output behavior
 - iv. Alarms. Schedules, and scheduled tasks

- v. Custom events
- vi. Macros or custom scripts
- d. The Directory Role shall support the configuration/management of the following components specific to VMS:
 - i. Video servers and their peripherals (e.g. audio, IOs, and serial ports)
 - ii. PTZ
 - iii. Camera sequences
 - iv. Recording and archiving schedules
- e. The Directory Role shall support the configuration/management of the following components specific to ACS:
 - i. Door controllers, and input and output (IO) modules
 - ii. Doors, Elevators, and Access rules
 - iii. Cardholders and cardholder groups, credentials, and badge templates
- f. The Directory Role shall support the configuration/management of the following components specific to ALPR:
 - i. ALPR units and cameras
 - ii. Hotlists, permit lists, and overtime rules
- 6. The Video Archiver Role shall be responsible for managing cameras and encoders under its control and archiving.
- 7. The Media Router Role shall be responsible for routing video and audio streams across local and wide area networks from the source (for example DVS) to the destination (for example CSA).
- 8. The Access Manager Role shall be responsible for synchronizing access control hardware units under its control, such as door controllers and I/O modules. This role shall also be responsible for validating and logging all access activities and events when the door controllers and I/O modules are online.
- 9. The Automatic License Plate Recognition (ALPR) Role shall be responsible for synchronizing fixed ALPR units (cameras) and mobile ALPR applications under its control. The ALPR Role shall also be responsible for logging all ALPR activities and events.
- 10. The Zone Manager Role shall be responsible for managing all software zones (collection of inputs) and logging associated zone events. Zones shall consist of inputs from both access control and video devices.
- 11. The Health Monitoring Role shall be responsible for monitoring and logging health events and warnings from the various client applications, roles, and services that are part of the USP. This role shall also be responsible for logging events within the Windows Event Log and for generating reports on health statistics and health history.
- 12. Optional Roles:
 - a. The Federation Role shall be responsible for creating a large virtual system consisting of hundreds or thousands of independent and remote ACS, VMS, and/or ALPR systems.
 - b. The Global Cardholder Synchronizer Role shall be responsible for synchronizing cardholder and credential data between the local site and a central site. Synchronization between remote sites shall also be supported.
 - c. The Active Directory Role shall be responsible for synchronizing user accounts and cardholder accounts with a Microsoft Active Directory server.
 - d. The Intrusion Manager Role shall be responsible for managing third party intrusion devices such as alarm panels and perimeter detection devices. This role shall also be responsible for logging all intrusion events in a database.
 - e. The Asset Manager Role shall be responsible for integrating and synchronizing with third party asset management systems and logging asset related events. This role shall also be responsible for supporting the execution of asset-related reports such as inventory reports and asset activity reports.
 - f. The Plug-in Manager Role shall be responsible for the communication between the USP and third party systems such as video analytics, access control, ALPR, video, and building management systems.
 - g. The Point of Sale (POS) Manager Role shall be responsible for integrating the USP with third party POS systems and for logging transactions.
 - h. The Web SDK Role shall be responsible for connecting the USP to any application or interface developed with the Web Service SDK. Applications developed with the Web Service SDK shall be platform independent and rely on the REST protocol for communications.
 - i. The Communication Management Role shall be responsible for registering the SIP communication endpoints and for managing the call routing.
 - j. The Web Server Role shall be responsible for managing incoming Web Client connection and hosting the web pages for the Web Client. The Web Server Role acts as a proxy for the client connections and can be installed in a DMZ for additional security.

- k. The Media Gateway Role shall be responsible for connecting any video stream to a third party system using standard RTSP protocol. This role shall provide access to live video.
- K. Server Monitoring Service (Watchdog):
 1. The USP shall include a Server Monitoring Service that continuously monitors the state of the Server Software Module (SSM) service.
 2. The Server Monitoring Service shall be a Windows service that automatically launches at system startup, regardless of whether or not a user is logged into his account.
 3. The Server Monitoring Service shall be installed on all PCs/servers running an SSM. In the event of a malfunction or failure, the Server Monitoring Service shall restart the failed service. As a last resort, the Server Monitoring Service shall reboot the PC/server should it be unable to restart the service.

2.24 USP ACCESS CONTROL, VIDEO, AND ALPR UNIFICATION

- A. The Monitoring UI shall present a true Unified Security Interface for live monitoring and reporting of the ACS, VMS, and ALPR. Advanced live video viewing and playback of archived video shall be available through the Monitoring UI.
- B. The Configuration UI shall present a true Unified Security Interface for the configuration and management of the ACS, VMS, and ALPR.
- C. The user shall be able to associate one or more video cameras to the following entity types: areas, doors, elevators, zones, alarms, intrusion panels, ALPR cameras, and more.
- D. It shall be possible to view video associated to access control events when viewing a report.
- E. It shall be possible to view video associated to intrusion panel events when viewing a report.
- F. It shall be possible to view video associated to ALPR events when viewing a report.
- G. The USP shall support the following Alarm Management functionality:
 1. Create and modify user-defined alarms. An unrestricted number of user-defined alarms shall be supported.
 2. Assign a time schedule or a coverage period to an alarm. An alarm shall be triggered only if it is a valid alarm for the current time period.
 3. Set the priority level of an alarm and its reactivation threshold.
 4. Define whether to display live or recorded video, still frames or a mix once the alarm is triggered.
 5. Provide the ability to display live and recorded video within the same video tile using picture-in-picture (PiP) mode.
 6. Provide the ability to group alarms by source and by type.
 7. Define the time period after which the alarm is automatically acknowledged.
 8. Define the recipients of an alarm. Alarm notifications shall be routed to one or more recipients. Recipients shall be assigned a priority level that prioritizes the order of reception of an alarm.
 9. Define the alarm broadcast mode. Alarm notifications shall be sent using either a sequential or an all-at-once broadcast mode.
 10. Define whether to display the source of the alarm, one or more entities, or an HTML page.
 11. Specify whether an incident report is mandatory during acknowledgment.
- H. The workflows to create, modify, add instructions and procedures, and acknowledge an alarm shall be consistent for access control, ALPR, and video alarms.
- I. Alarms shall be federated, allowing global alarm management across multiple independent USP, ACS, VMS, and ALPR systems.
- J. The USP shall also support alarm notification to an email address or any device using the SMTP protocol.
- K. The ability to create alarm-related instructions shall be supported through the display of one or more HTML pages following an alarm event. The HTML pages shall be user-defined and can be interlinked.
- L. Alarm unpacking and packing shall be supported where all the entities associated to an alarm can be display in the Monitoring UI with the single click of a button.
- M. The user shall have the ability to acknowledge alarms, create an incident upon alarm acknowledgement, and put an alarm to snooze.
- N. The user shall be able to spontaneously trigger alarms based on something they see in the system.
- O. An alarm shall be configured in such a way that it remains visible until the source condition has been acknowledged.
- P. The user shall be able to investigate an alarm without acknowledging it.

2.25 USP THREAT LEVELS

- A. The USP shall support Threat Levels to dynamically change the system behavior to respond to critical events.
- B. Threat Levels shall be activated and deactivated by the CSA operator with the right privilege.
- C. Threat Levels shall be set on an area or on the entire system.
- D. Threat Levels shall affect the system behavior by executing any action available in the USP such as: trigger output, start recording, block camera, override recording quality, arm zone, set a door in maintenance mode, and more.
- E. The following specific actions shall be available with Threat Level:

1. Set minimum security clearance to restrict or permit access to cardholders on specific areas on top of the restrictions imposed by the access rules.
 2. Set minimum user level to automatically log out user from the USP.
 3. Set reader mode to change how the doors are accessed (for example card and PIN, or card or PIN).
- F. A visible notification shall be displayed in all operator CSA when a Threat Level is activated.

2.26 USP REMOTE TASK

- A. The USP shall provide, through a Remote Task, capabilities to remotely monitor and control the content of other workstations running the CSA (Monitoring UI) that are part of the same system.
- B. The USP shall support video wall applications by connecting and controlling multiple workstations and monitors simultaneously.
- C. The Remote Task shall be a graphical interface showing a replication of the remote workstation running the CSA (Monitoring UI).
- D. The Remote Task shall allow the connection to other workstations using a low bandwidth mode to receive only snapshots of video viewed remotely.
- E. The Remote Task shall allow the connection to other workstations using a spy mode to remain invisible to the remotely connected workstation. The spy mode option should be available to the user with permission to access the feature.
- F. The functionality provided by the remote monitoring and control capability shall include:
 1. Remote monitoring and control of the monitoring and alarm monitoring tasks.
 2. Ability to remotely switch cameras, doors and zones into display tiles.
 3. Ability to remotely control live and playback video.
 4. Ability to remotely change the tile pattern.
 5. Ability to remotely create and delete tasks.
 6. Ability to remotely start/stop task cycling.
 7. Ability to remotely go into full screen mode.
 8. Ability to remotely save and reload the workspace.

2.27 USP ADVANCED TASK MANAGEMENT

- A. USP shall support an infrastructure for managing Monitoring UI tasks used for live monitoring, day to day activities, and reporting.
- B. Administrators shall be able to assign tasks and lock the operator's workspace. The user management of their workspace shall be limited by their assigned privileges.
- C. Operators shall be able save their tasks as either Public tasks or Private tasks and in a specific partition. Public tasks shall be available to all users. Private tasks shall only be available to the owner of the task.
- D. Operators shall be able to share their tasks by sending them to one or more online users. Recipients shall have the option to accept the sent task.
- E. Operators shall be able to duplicate a task.

2.28 USP REPORTING

- A. The USP shall support report generation (database reporting) for access control, ALPR, video, and intrusion.
- B. Each and every report in the system shall be a USP task, each associated with its own privilege. A user shall have access to a specific report task if they have the appropriate privilege.
- C. The workflows to create, modify, and run a report shall be consistent for access control, ALPR, and video reports.
- D. Reports shall be federated, allowing global consolidated reporting across multiple independent USP, ACS, VMS, and ALPR systems.
- E. Access control and ALPR reports shall support cardholder pictures and license plate pictures, respectively.
- F. The USP shall support the following types of reports:
 1. Alarm reports
 2. Video-specific reports (archive, bookmark, motion, and more)
 3. Configuration reports (cardholders, credentials, units, access rules, readers/inputs/outputs, and more)
 4. Activity reports (cardholder, cardholder group, visitor, credential, door, unit, area, zone, elevator, and more)
 5. ALPR-specific reports (mobile ALPR playback, hits, plate reads, reads/hits per day, reads/hits per ALPR zone, and more)
 6. Health activity and health statistics reports
 7. Other types of reports, including visitor reports, audit trail reports, incident reports, and time and attendance reports
- G. Generic Reports, Custom Reports, and Report Templates:

1. The user shall have the option of generating generic reports from an existing list, generating reports from a list of user-defined templates, or creating a new report or report template.
 2. The user shall be able to customize the predefined reports and save them as new report templates. There shall be no need for an external reporting tool to create custom reports and report templates. Customization options shall include setting filters, report lengths, and timeout period. The user shall also be able to set which columns shall be visible in a report. The sorting of reported data shall be available by clicking on the appropriate column and selecting a sort order (ascending or descending).
 3. All report templates shall be created within the Monitoring UI.
 4. These templates can be used to generate reports on a schedule in PDF or Excel formats.
 5. An unrestricted number of custom reports and templates shall be supported.
- H. A reporting task layout shall consist of panes with settings (report length, filters, go and reset commands, etc.), the actual report data in column format, and a pane with display tiles. The user shall be able to drag and drop individual records in a report onto one or more display tiles to view a cardholder's picture ID, playback a video sequence, or an ALPR event.
 - I. The USP shall support comprehensive data filtering for most reports based on entity type, event type, event timestamp, custom fields, and more.
 - J. The reporting task shall have the ability to display results through graphics such as line charts, bar charts, stacked bar charts, doughnut charts, and pie charts.
 - K. The user shall be able to click on an entity within an existing report to generate additional reports from the Monitoring UI.
 - L. The USP shall support the following actions on a report: print report, export report to a PDF/Microsoft Excel/CSV file, export the graphics chart in JPG/PNG, and automatically email a report based on a schedule and a list of one or more recipients.

2.29 USP DASHBOARDS

- A. The USP shall support the ability to create dashboards.
- B. Operators shall be allowed to view dashboards if they are granted the appropriate privilege. Modification to dashboards should also be allowed to users granted the appropriate privilege.
- C. Dashboards in the system shall be a USP task. A user shall have access to a specific dashboard task if they have the appropriate privilege.
- D. Dashboards shall be saved either in a private folder or a public folder.
- E. A dashboard shall consist of a canvas with various widgets displayed on the canvas. All widgets should offer the ability to specify location and size to the widget, a title to the widget, a background color to the widget, and the ability to refresh periodically the content of the widget.
- F. Dashboard widget types shall be:
 1. Image: provides the ability to display an image (JPG, PNG, GIF, BMP) on a dashboard.
 2. Text: provides the ability to display a text on a dashboard. The text style shall be configurable, so font, size, color, and alignment can be specified by the user.
 3. Tile: provides the ability to display any entity of the USP inside of a tile.
 4. Web page: provides the ability to display a URL on a dashboard.
 5. Entity Count: provides the ability to display the total number of a specific entity type in the USP.
 6. Reports: provides the ability to display the results of any saved reports in the system. The results shall be displayed either by showing the total number of results in the report, a set of top results from the report, or a visual graph from the data returned by the report.
- G. It shall be possible to extend to the widgets of a dashboard using the SDK. This will provide the ability to develop custom widgets to the system.
- H. The USP shall support the following actions on a dashboard: print dashboard, export dashboard to PNG file, and automatically email a report based on a schedule and a list of one or more recipients.

2.30 USP FEDERATION FEATURE: MONITORING OF REMOTE SYSTEMS

- A. The USP shall support the concept of a Federation feature for access control, video, and ALPR.
- B. The Federation feature shall allow multiple independent USP systems (Federated systems) to be unified into a larger virtual system (the Federation feature). This shall facilitate the global monitoring of multiple independent USP systems.
- C. The Federation feature shall support the unification of multiple independent video surveillance systems or VMS.
- D. Entities that shall be federated and monitored centrally from the Federation feature shall include: alarms, areas, cameras, cardholders and cardholder groups, credentials, doors, elevators, ALPR events, and zones (monitored inputs).
- E. The Federation feature shall support a cloud-based deployment, whereby the service and infrastructure will be updated automatically and provisioned by the service provider, without need for on-site hardware.
- F. The Federation feature shall support Global Alarm Management from the Monitoring UI for access control, video, and ALPR.

- G. The Federation feature shall support Global Report Generation from the Monitoring UI for access control, video, and ALPR.
- H. The Federation feature shall support dozens of operator actions on remote (federated) entities from the Monitoring UI (for example, generating a global report taking into account events from multiple independent sites or acknowledging remote alarms).

2.31 USP ZONE MANAGEMENT

- A. The USP shall support the configuration and management of zones for input point monitoring via the Zone Manager Role. A user shall be able to add, delete, or modify a zone if they have the appropriate privileges.
- B. A zone shall monitor the status of one or more inputs points. Zone monitoring or input point monitoring shall be possible through the use of a controller and one or more input modules. Inputs from video cameras or video encoders shall also be accessible via a zone.
- C. Depending on the hardware installed, supervised inputs shall be supported. Depending on the input module used, both 3-state and 4-state supervision shall be available.
- D. A schedule shall be defined for a zone, indicating when the zone will be monitored.
- E. Custom Events shall provide full flexibility in creating custom events tailored to a zone. Users shall be able to associate custom events to state changes in monitored inputs.
- F. The ACS shall support one or more cameras per zone. Video shall then be associated to zone state changes.
- G. Input/Output (IO) Linking:
 - 1. Zone management shall support Input/Output (IO) Linking. I/O Linking shall allow one or more inputs to trigger one or more outputs.
 - 2. IO Linking shall be available in offline mode when communication between the server and hardware is not available.
 - 3. Custom Output Behaviors shall provide full flexibility in creating a variety of complex output signal patterns: simple pulses, periodic pulses, variable duty-cycle pulses, and state changes.
 - 4. Through the "trigger an output" action, the ACS shall support the triggering of outputs with custom output behaviors.

2.32 USP USER AND USER GROUP SECURITY, PARTITIONS, AND PRIVILEGES MANAGEMENT

- A. The USP shall support the configuration and management of users and user groups. A user shall be able to add, delete, or modify a user or user group if they have the appropriate privileges.
- B. The USP shall support user authentication with claims-based authentication using external providers. External providers shall include:
 - 1. ADFS (Active Directory Federation Services)
- C. Common access rights and privileges shared by multiple users shall be defined as User Groups. Individual group members shall inherit the rights and privileges from their parent user groups. User group nesting shall be allowed.
- D. User privileges shall be extensive in the USP. All configurable entities for the USP, including access control, video, and ALPR shall have associated privileges.
- E. Specific entities, such as cardholders, cardholder groups, and credentials shall include a more granular set of privileges, such as the right to access custom fields and change the activation or profile status of an entity.
- F. Partitions:
 - 1. The USP shall limit what users can view in the configuration database via security partitions (database segments). The administrator, who has all rights and privileges, shall be allowed to segment a system into multiple security partitions.
 - 2. All entities that are part of the USP can be assigned to one or more partitions.
 - 3. A user who is given access to a specific partition shall only be able to view entities (components) within the partition to which they have been assigned. Access is given by assigning the user as an accepted user to view the entities that are members of a particular partition.
 - 4. A user or user group can be assigned administrator rights over the partition.
- G. It shall be possible to specify user and user group privileges on a per partition basis.
- H. Advanced logon options shall be available such as dual logon and more.
- I. It shall be possible to specify an inactive period for the Monitoring UI after which time the application shall automatically lock, while still preserving access to currently displayed camera feeds.
- J. It shall be possible to review user permissions and determine:
 - 1. For any entity in the system, which user group or user can view or modify it.
 - 2. For any user group or user in the system, what are its privileges.
 - 3. For any privilege in the system, which user group or user is allowed to perform the underlying action.

2.33 USP EVENT/ACTION MANAGEMENT

- A. The USP shall support the configuration and management of events for video and ALPR. A user shall be able to add, delete, or modify an action tied to an event if he has the appropriate privileges.

- B. The USP shall receive all incoming events from one or more ACS, VMS, and/or ALPR. The USP shall take the appropriate actions based on user-defined event/action relationships.
- C. The USP shall receive and log the following events:
 - 1. System-wide events
 - 2. Application events (clients and servers)
 - 3. Area, camera, door, elevator, and ALPR events (reads and hits)
 - 4. Unit events
 - 5. Zone events
 - 6. Alarm events
 - 7. ALPR events
 - 8. Health Monitoring events
- D. The USP shall allow the creation of custom events.
- E. The USP shall have the capability to execute an action in response to an access control, video, and ALPR event. The USP shall support the following list of actions, without being limited to:
 - 1. Add bookmark
 - 2. Arm intrusion detection area
 - 3. Arm zone
 - 4. Block and unblock video
 - 5. Bypass input
 - 6. Cancel postpone intrusion detection area arming
 - 7. Clear input bypass
 - 8. Clear task
 - 9. Display a camera on an analog monitor
 - 10. Display an entity in the CSA
 - 11. Email a report
 - 12. Email a snapshot
 - 13. Export report
 - 14. Forgives antipassback violation
 - 15. Go home
 - 16. Go to preset
 - 17. Import from file
 - 18. Override recording quality
 - 19. Override with event recording quality
 - 20. Override with manual recording quality
 - 21. Play a sound
 - 22. Postpone intrusion detection area arming
 - 23. Reboot unit
 - 24. Recording quality as standard configuration
 - 25. Rest area people count
 - 26. Reset parking zone inventory
 - 27. Run a macro
 - 28. Run a pattern
 - 29. Send a message
 - 30. Send a task
 - 31. Send an email
 - 32. Set parking zone occupancy
 - 33. Set reader mode
 - 34. Set the door maintenance mode
 - 35. Set threat level
 - 36. Start/Stop applying video protection
 - 37. Start/Stop recording
 - 38. Start/Stop transfer
 - 39. Synchronize role
 - 40. Temporary override elevator schedules
 - 41. Trigger intrusion alarm
 - 42. Trigger alarm
 - 43. Trigger output
 - 44. Trigger read
 - 45. Unlock door explicitly
- F. The USP shall allow a schedule to be associated with an action. The action shall be executed only if it is an appropriate action for the current time period.

2.34 USP SCHEDULES AND SCHEDULED TASKS

- A. Schedules

1. The USP shall support the configuration and management of complex schedules. A user shall be able to add, delete, or modify a schedule if they have the appropriate privileges.
 2. The USP shall provide full flexibility and granularity in creating a schedule. The user shall be able to define a schedule in 1-minute or 15-minute increments.
 3. Daily, weekly, ordinal, and specific schedules shall be supported.
- B. Scheduled Tasks
1. The USP shall support scheduled tasks for video, and ALPR.
 2. Scheduled tasks shall be executed on a user-defined schedule at a specific day and time. Recurring or periodic scheduled tasks shall also be supported.
 3. Scheduled tasks shall support all standard actions available within the USP, such as sending an email or emailing a report.

2.35 USP MACROS AND CUSTOM SCRIPTS

- A. The USP shall enable users to automate and extend the functionalities of the system through the use of macros or custom scripts for access control, video, and ALPR.
- B. Custom macros shall be created with the USP Software Development Kit (SDK).
- C. A macro shall be executed either automatically or manually.
- D. In the Monitoring UI, a macro shall be launched through hot actions.

2.36 USP DYNAMIC GRAPHICAL MAPS (DGM)

- A. The USP shall support mapping functionality for access control, video surveillance, intrusion detection, ALPR, and external applications.
- B. The USP shall provide a map centric interface with the ability to command and control all the USP capabilities from a full screen map interface.
- C. It shall be possible to span the map over all screens of the USP client station. In the scenario where the map is spanned over all the screens of the USP client station it shall be possible to navigate the map including pan and zoom, and the map's moves shall be synchronized between all screens. Spanning the map over multiple screens must provide the same command and control capabilities than in a single screen display.
- D. The DGM shall support the following file format and protocol for importing map background:
 1. PDF
 2. JPG
 3. PNG
 4. Web Tile Map Service (WTMS) and Web Map Service (WMS) defined by the Open Geospatial Consortium (OGC)
 5. BeNomad
 6. AutoCAD (DWG & DXF)
- E. The DGM shall provide the following online map providers for use as map background and provide the ability to manage their service license if they require one:
 1. Google Map, aerial, terrain (Licensed)
 2. Bing Map, aerial, satellite, hybrid (Licensed)
 3. ESRI ArcGIS (Licensed)
 4. OpenStreet Map aerial (Licensed)
 5. OVI hybrid
- F. It shall be possible to configure a mixed set of maps made of GIS, online providers, and private imported files and link them together.
- G. The DGM shall provide the ability to display all native entities of the USP including:
 1. Cameras, fix, and PTZ
 2. Doors
 3. Camera sequences
 4. Areas
 5. Intrusion areas
 6. Intrusion zones
 7. License Plate Recognition cameras
 8. Digital inputs
 9. Digital outputs
 10. Intercoms
 11. Alarms
 12. Macros
 13. Police Car Patrollers
- H. The DGM shall provide the ability to draw and display information over the map in the form of:
 1. Vectoral shapes: lines, rectangles, polygons, ellipse
 2. Pictures
 3. Text
- I. The DGM shall provide the ability to display any type of third party entities integrated through an SDK.

- J. The DGM shall provide the ability to display layer of information in Keyhole Markup Language (KML) format.
- K. The DGM shall provide the ability to the operator to manage layers of entities displayed over the map, being able to turn them on and off and changing the superposition order.
- L. The DGM shall provide the ability to import data layers from one or more ESRI ArcGIS servers.
- M. The DGM shall provide the operators with the ability to manage layers that are imported from ESRI ArcGIS. The operators shall be able to turn the layers on and off, as well as sort the layers.
- N. The DGM shall offer built-in map data backup and restore for both map background and layers of entities.
- O. The DGM shall offer failover capabilities.
- P. The DGM shall scale up to several thousands of entities on a single map and hundreds of maps.
- Q. The DGM shall provide a means to update a map background without affecting the map object configuration.
- R. The DGM shall offer a user-friendly graphical map designer to configure the maps.
- S. The DGM shall provide a user friendly and intuitive navigation that includes:
 - 1. The ability to create hierarchies of maps to facilitate navigation within and between various sites and buildings.
 - 2. The ability to define favorites for recurrent position recall.
 - 3. The possibility to create links between maps. The map links shall allow the link from one map to multiple maps representing the floors of a building. Navigating between floors of a building shall keep the zoom level of the map.
 - 4. A common user experience regarding navigation into the map for both GIS and private maps.
- T. It shall be possible to monitor the state of entities on the map. It shall be possible to customize the icons of any entities represented on the map.
- U. The DGM shall offer the ability to optionally set a graphical display notification of the motion detection.
- V. The DGM shall offer a smart selection tool to access the video. By clicking the location the user wants to see, the DGM will automatically select the cameras that can see this location and move the PTZ towards that location. This smart selection tool shall take obstacles into consideration and not display cameras that cannot see the location because of a wall.
- W. It shall be possible to select a location by drawing a zone of interest on the DGM, and to display all the entities that are part of that zone or interest at once.
- X. The user shall be able to select and display the content of multiple USP entities on the map in pop-up windows.
- Y. The user shall be able to move, resize, and pain the USP entity pop-up windows to the map.
- Z. It shall be possible to access live and playback video from the map.
- AA. It shall be possible to monitor all entity event notifications from the DGM. Users shall be able to turn notifications on and off per entity.
- BB. The DGM shall offer the ability to fully operate alarm monitoring. It shall be possible to:
 - 1. Center the map on entities related to the alarm.
 - 2. Visualize the Alarm notifications on the map and access the related videos from the map.
 - 3. Trigger and receive alarms.
 - 4. Act on the alarm from the DGM, including acknowledgements, forwarding, and investigation.
 - 5. Visualize that an alarm occurred in an underlying linked map.
- CC. The DGM shall provide the following search capabilities:
 - 1. Search and center by entity name.
 - 2. From the Display of an entity in the USP, locate the entity on the map and offer the ability to select another one close-by.
- DD. Any update of map content by an administrator shall be immediately and dynamically pushed to all DGM users.
- EE. The DGM shall support the use of GIS maps, private maps, or a combination of both for the map background.
- FF. The DGM shall be compatible with any GIS compliant maps with the OGC and supporting WMTS and WMS. This includes, but is not limited to, ESRI maps. The DGM shall allow the selection of the appropriate GIS layers.
- GG. The DGM shall provide an intuitive built-in map designer for entity positioning on the map using drag and drop. Any configuration shall be graphic.
- HH. It shall be possible to edit and configure multiple map objects at once.
- II. All map design modifications shall be logged in an audit trail.
- JJ. Various actions shall be available within maps for execution through simple and intuitive double-click, right-click, or drag-and-drop functionality. Examples of actions available through maps shall include unlocking a door and acknowledging an alarm.

KK. Through the following functionalities, the DGM shall allow the management of USP alarms from the map:

1. Locate on the map entities related to the alarm.
2. Display entities of the alarm with a specific icon, color, transparency level, and blinking rate.
3. List, select, and locate alarms.
4. Auto center the map on the highest priority alarm.
5. Handle the alarm from the map, including acknowledgement, forwarding, and investigation.
6. All map containers, such as hotspots or map links, shall reflect the alarm status of the contained entities.

LL. It shall be possible to add advanced functionality to map objects using the SDK. Any functionality available through the USP SDK shall be available within maps.

MM. The DGM shall offer lasso tools for:

1. Displaying entities at one location through a single action.
2. Triggering an action on all entities at one location in a single click.
3. Editing multiple entities at one location simultaneously.

NN. The DGM shall allow the display of USP entities selected from the map on a remote monitor (video wall).

OO. The DGM shall provide the ability to search within the map by entity name.

PP. The DGM shall allow the use of KML overlay map information for both GIS and private maps. Moveable objects shall be supported using the KML.

QQ. The Contractor shall provide licenses for each entity that is required to be shown on the graphical maps.

2.37 USP DIGITAL EVIDENCE MANAGEMENT SYSTEM (DEMS)

- A. The USP shall support the ability to electronically share video exports with third parties.
- B. The USP shall allow recipients to natively review exported video from a web browser, without the need to install software or browser plugins.
- C. Video exported from the UPS will include the original file and timestamp information, as well as the system, workstation, and camera source metadata that can be viewed from the DEMS.
- D. The USP shall support the ability to create a case within the DEMS, and assign associated incident details, when exporting video.

2.38 USP AUDIT AND USER ACTIVITY TRAILS (LOGS)

- A. The USP shall support the generation of audit trails. Audit trails shall consist of logs of operator/administrator additions, deletions, and modifications.
- B. Audit trails shall be generated as reports. They shall be able to track changes made within specific time periods. Querying on specific users, changes, affected entities, and time periods shall also be possible.
- C. For entity configuration changes, the audit trail report shall include detailed information of the value before and after the changes.
- D. The USP shall support the generation of user activity trails. User activity trails shall consist of logs of operator activity on the USP such as login, camera viewed, ALPR event viewed, badge printing, video export, and more.
- E. The ACS shall support the following actions on an audit and activity trail report: print report and export report to a PDF/ Microsoft Excel/CSV file.

2.39 USP INCIDENT REPORTS

- A. Incident reports shall allow the security operator to create reports on incidents that occurred during a shift. Both video-related and access control-related incident reports shall be supported.
- B. The operator shall be able to create standalone incident reports or incident reports tied to alarms.
- C. The operator shall be able to link multiple video sequences to an incident, access them in an incident report, and change the date or time of the sequences later on.
- D. It shall be possible to create a list of Incident categories, tag a category to an incident, and filter the search with the category as a parameter.
- E. Incident reports shall allow the creation of a custom form on which to input information on an incident.
- F. Incident reports shall allow entities, events, and alarms to be added to support at the report's conclusions.

2.40 USP THIRD PARTY INTEGRATION

- A. Microsoft Active Directory Integration
 1. The USP shall support a direct connection to one or multiple Microsoft Active Directory server via the Active Directory Role(s). Active Directory integration shall enable the synchronization of information from the Active Directory server to the USP.
 2. Active Directory integration shall permit the central management of the USP users, user groups, cardholders, and cardholder groups.

3. The USP shall be able to connect to and synchronize data from multiple Active Directory servers (up to 10).
 4. The USP shall support synchronizing Active Directory Universal Groups as well as security groups belonging to other domains within the same forest.
 5. The USP shall support Microsoft Active Directory encryption using LDAP SSL.
 6. When enabled, Active Directory shall manage user logon to the USP client applications through the user's Windows credentials. Logging on to the USP shall utilize native Active Directory password management and authentication features.
 7. It shall be possible to synchronize the following USP entities and their information from Active Directory with the USP:
 - a. Users (username, first and last names, email address, and more)
 - b. User groups (user group name, description, and group email address)
 - c. Active Directory attributes to USP custom fields
 8. When enabled, the addition, removal, or suspension of a user's Windows account in Active Directory shall result in the creation, deletion, or disabling of the equivalent user account in the USP.
 9. Supported synchronization methods for additions, modification, and deletions of synchronized entities shall include on first logon (users only), manual synchronization, and scheduled synchronization.
 10. The USP shall support user connections across independent organizations by connecting to an external ADFS (Active Directory Federation Services) service using claims-based authentication.
- B. Intrusion Detection Integration:
1. The USP shall integrate with third party intrusion panels and devices via an Intrusion SDK. The Intrusion Manager Role shall manage communications with the intrusion panels. Communications with intrusion devices shall be over serial communications and/or an IP network.
 2. Integration with intrusion panels shall be possible outside the release cycle of the USP. It shall be possible to add new integrations at any point in time.
 3. Functionality available via the integration of intrusion devices with the USP shall include the following (where supported by the intrusion panel):
 - a. Arm and disarm intrusion devices (manually, on schedule, or following a USP event).
 - b. Activate or trigger intrusion device outputs.
 - c. View intrusion events and alarms.
 - d. Monitor the status, including arming status, of the intrusion devices.
 - e. Video verification of intrusion events and alarms with video panels.
 - f. Create USP zones using intrusion device inputs.
 4. Currently supported intrusion panels include:
 - a. Bosch G Series panels
 - b. DSC Power Series panels
 - c. DMP XR Series panels
 - d. Honeywell Galaxy Dimension and Flex panels
 - e. Vanderbilt SPC
 - f. UTC Advisor Master and Advanced
- C. Third Party Access Control Systems:
1. The USP shall integrate with third party access control software via the SDK. Communications with access control software shall be over an IP network, and should not support administrative tasks such as cardholder management.
 2. Integration with access control software shall be possible outside the release cycle of the USP. It shall be possible to add new integrations at any point in time.
 3. Functionality available via the integration of access control software with the USP shall include the following (where supported by the access control solution):
 - a. Synchronize access control entities and receive associated events and states within the USP, including:
 - i. Cardholders and access rights
 - ii. Visitors
 - iii. Readers and doors
 - iv. Alarms
 - v. Inputs and outputs
 - b. Monitor access control events.
 - c. Monitor and Acknowledge access control alarms.
 - d. Trigger actions and outputs in the access control software using hot actions and event-to-actions.
 - e. Lock and unlock doors in the access control software.
 - f. Video verification of access control events and alarms.

- g. Configure event-to-actions using the access control events and alarms.
- h. Generate Security Center reports using from the in the access control data.
- i. View and monitor states of door entities in the USP maps.
- 4. Currently supported access control manufacturers include:
 - a. Tyco Softwarehouse CCURE
 - b. UTC Lenel Onguard
 - c. Amag Symmetry
 - d. Siemens Sipass
 - e. AssaAbloy ARX
- D. Third Party Destination Dispatch Systems:
 - 1. The USP shall integrate with third part destination dispatch (elevator control) software via the SDK. Communications with the destination dispatch software shall be over an IP network.
 - 2. Integration with destination dispatch software shall be possible outside the release cycle of the USP. It shall be possible to add new integrations at any point in time.
 - 3. Functionality available via the integration of destination dispatch software with the USP shall include the following (where supported by the destination dispatch solution):
 - a. Destination dispatch entity creation and reception of associated events and states within the USP, including:
 - i. Floors and landings
 - ii. Elevator cars (front/rear doors) and kiosks
 - iii. Cardholders and credentials (if applicable)
 - b. Monitor destination dispatch events.
 - c. Trigger manual dispatch actions.
 - d. Video verification of destination dispatch events.
 - e. Configure event-to-actions using the destination dispatch events.
 - f. Generate Security Center reports using the destination dispatch data.
 - g. Support multiple readers
 - i. Kiosk internal readers
 - ii. USP readers
 - h. Kiosk advanced modes and passenger types.
 - 4. Currently supported destination dispatch manufacturers include:
 - a. Otis Compass
 - b. Thyssenkrupp Schindler
- E. Asset Management Integration:
 - 1. The USP shall integrate with third party asset management systems via the Asset Management Role.
 - 2. Communications with asset management solutions shall be over an IP network (via software communications).
 - 3. Functionality available via the integration of asset management systems with the USP shall include the following (where supported by the asset management systems):
 - a. Synchronize asset management system assets with USP asset entities.
 - b. Live monitoring of asset-related activity events, health events, and activity (asset online, asset offline, asset moves, or low battery).
 - c. Synchronization of asset management alarms with Security Center alarms.
 - d. Viewing video tied to asset-related activity and alerts within monitoring and reporting tasks.
 - e. Acknowledging alarms in Security Center which acknowledges alerts in the asset management system and vice versa.
 - f. Real-time tracking of asset locations on a per area basis.
 - g. Asset Management Inventory reporting task that details the current location (area) of an asset.
 - h. Asset Activity reporting task that provides a historical review of asset-related events and activity.
 - 4. Currently supported asset management systems include:
 - a. RF Code Asset Manager
 - b. Deister Key management
 - c. Morsewatchmans
 - d. TRAKA
- F. Additional Third-Party Integrations:
 - 1. The USP shall support multiple approaches to integrating third party systems. These shall include: Software Development Kits (SDKs), REST-based Web Service SDKs, RTSP Service SDKs, and more.
 - 2. The USP architecture shall support the addition of new connectors to integrate to third party system integration, such as:
 - a. Video analytics
 - b. Third party video systems

- c. Third party access control systems
- d. ALPR integrations with pay stations, permit vendors, pay-by-phone vendors, and ticketing vendors
- e. Point-of-sale (POS) systems
- f. Building management systems
- g. Access Control ecosystem (such as ID scanner, card synchronization, Guardtour)
- h. Transaction monitoring (POS, Barcode scanning, ATM)
- i. Data protocols (modbus, BacNet, OPC, SNMP)
- j. Videowall
- k. Human resource management systems (HRMS)

2.41 USP SOFTWARE DEVELOPMENT KIT (SDK)

- A. A USP SDK shall be available to support custom development for the platform.
- B. The SDK shall include functionalities specific to the embedded automatic license plate recognition (ALPR), access control (ACS), and video (VMS) systems.
- C. Integration with external applications and databases shall be possible with the SDK.
- D. The SDK shall enable end-users to develop new functionality (user interface, standalone applications or services) to link the USP to third party business systems and applications, such as Badging Systems, Human Resources Management Systems (HRMS), and Enterprise Resource Planning (ERP) systems.
- E. The SDK shall be based on the .NET framework.
- F. The SDK shall support dynamic or transactional updates to the USP configuration. It shall also support change notification of USP entity configuration.
- G. The SDK shall provide an extensive list of programming functions to view and/or configure core entities such as: users and user groups, alarms, custom events, and schedules, and more.
- H. The SDK shall provide an extensive list of programming functions to view and configure ACS, VMS, and ALPR.
- I. The SDK shall provide an extensive list of programming functions to view and configure most ACS entities such as: cardholders, cardholder groups, visitors, credentials, access rules (modify only), and custom fields.
- J. The SDK shall be able to receive real time events from the following USP entities: users and user groups, areas, zones, cameras, video units, doors, door controllers (units), elevators, cardholders, cardholder groups, and credentials.
- K. The SDK shall be able to query the history of events for areas, cameras, zones, alarms, cardholders, credentials, visitors, doors, query license plate read events, license plate hit events, generate a license plate hits report, generate a license plate reads report.
- L. The SDK shall support the following alarm functions: view alarms in real time, acknowledge alarms, change priority, and change recipient.

PART 3 - EXECUTION

3.01 WARRANTY

- A. The product shall perform in all material respects in accordance with the accompanying user manual, and the media on which the Software Product resides will be free from defects in materials and workmanship under normal use. Software defects are covered through Service Releases and Cumulative Updates which are available for a period of 1 year from the date of the software purchase.
- B. Extended warranty, up to 5 years, shall be available through the purchase of the Genetec Advantage support service which includes the following additional services over the standard warranty:
 - 1. Access to phone support and online chat for technical assistance
 - 2. Online case management
 - 3. Online system availability monitor
 - 4. Access to Major and Minor Release Upgrades
 - 5. 24/7 pager support and dedicated support specialist

3.02 DEPLOYMENT SERVICES AND SYSTEM COMMISSIONING

- A. General Requirements:
 - 1. The contractor shall engage the services of the USP vendor to assist in the management of the deployment of the USP at the end-user site on projects that involve:
 - a. Multiple contractors or subcontractors that will be responsible for deploying the USP at multiple client sites in different geographical regions.
 - b. Complex enterprise installations involving advanced functionality (for example The Federation feature, failover, plugins) and/or multiple systems (for example access control, video, ALPR) and/or third-party integrations.
 - c. Extensive use of customized solutions/plugins developed by the vendor that will be integrated into the USP.

2. The USP vendor services shall include Deployment Management and System Configuration and Commissioning.
- B. Deployment Management Service:
1. The Deployment Management service from the vendor shall include a Project Manager acting as the single point of contact for all communications between the contractor and the vendor organization and who will be responsible for:
 - a. Conducting a Risk Assessment of the impact of potential risk factors on the operation of the vendor's USP.
 - b. Providing a project plan for the deployment of the vendor's USP.
 - c. Managing the development and deployment of the custom solution components that will be integrated into the vendor's USP (if applicable).
 - d. Providing a scope of work detailing the services to be provided by the vendor to assist in the deployment of the vendor's USP.
 - e. Coordinating and scheduling the vendor field services with the contractor to assist with the deployment of the vendor's USP.
 - f. Providing regular project status updates to the contractor regarding the development of custom solutions (if applicable) and the deployment of the vendor's USP.
- C. Solution Architect Service:
1. The Solution Architect service from the vendor shall include a Solutions Architect Engineer acting as a single technical point of contact throughout the deployment of the USP, and who will be responsible for:
 - a. Assisting the contractor/subcontractor with the design and architecture of the vendor's USP.
 - b. Conducting technical consultation activities that may include fit/gap analysis, system design reviews, device compatibility assessments, functional and technical design reviews as well as performance reviews of the vendor's USP.
 - c. Conducting a system assessment and ensuring best practices of the vendor's USP are followed.
 - d. Providing upgrade and migration strategy for the vendor's USP where applicable.
 - e. Providing documentation regarding the system architecture, system design, hardware specifications and compatibility requirements, camera bandwidth calculations, and best practices as they relate to the vendor's USP.
- D. System Configuration and Commissioning Service:
1. The System Configuration and Commissioning service from the vendor shall include a Field Engineer who will be responsible for:
 - a. Assisting the contractor's or subcontractor's onsite/remote technicians with the configuration and commissioning of the vendor's USP at the client site.
 - b. Conducting a test of the USP following the deployment of the system using real-world operator scenarios to ensure optimal system performance.
 - c. Providing the contractor with a Service Report detailing the tasks completed during the deployment of the USP at the client site, as well as any recommendations for improving the performance of the USP that must be implemented by the contractor.
 - d. Providing a knowledge transfer of the vendor's USP to the contractor following the deployment of the USP at the client site.

3.03 MANUFACTURER END USER OPERATOR TRAINING

- A. The contractor shall engage the services of the USP vendor to assist in the end user training of the USP at the end-user site.

End of Section 282300

SECTION 282315 - VIDEO CONTENT ANALYTICS PLATFORM

PART 1 - GENERAL

1.1. SUMMARY

- A. Section specifies requirements for provision of all equipment, materials, labor, documentation and services necessary to furnish and install a VIDEO CONTENT ANALYTICS PLATFORM.
- B. System equipment and installation shall comply with all provisions and requirements of this specification as well as all applicable national, state and local codes and standards.
- C. All Servers, Licenses, Hardware and Software to fully integrate the VIDEO CONTENT ANALYTICS PLATFORM with the UNIFIED SECURITY PLATFORM shall be provided by the contractor. Every camera shall have a matching VIDEO CONTENT ANALYTICS PLATFORM LICENSE and associated server. Upon completion of this project the Door Access Control, Video Surveillance, License Plate ID, and Video Content Analytics Platform shall function as a completely UNIFIED SECURITY PLATFORM.
- D. The VIDEO CONTENT ANALYTICS PLATFORM and the UNIFIED SECURITY PLATFORM shall be provided and installed by the same security contractor. This security contractor must be factory trained and hold full training certifications from BOTH manufacturers along with being in good standing with BOTH manufacturers. Provide letters on company letter head to that end with bid and project submittal.
 - 1) Video Content Analytics Platform shall be Commissioned and Tested by a representative of the Hardware and Software Manufacturer.

1.2. REFERENCES

- A. *Abbreviations and Acronyms:*
 1. AD: Active Directory by Microsoft.
 2. AES: Advanced Encryption Standard.
 3. API: Application Programming Interface.
 4. BI: Business Intelligence.
 5. CODEC: Coder/Decoder.
 6. DB: Database.
 7. DNN: Deep Neural Network.
 8. FAR: False Acceptance Rate.
 9. FRR: False Rejection Rate.
 10. FPS (or fps): Frames Per Second.
 11. HLS: HTTP Live Streaming.
 12. REST: Representational State Transfer.
 13. ROI: Region of Interest
 14. SAML: Security Assertion Markup Language.
 15. SSO: Single-Sign-On.
 16. VMS: Video Management System.
- B. *Definitions:*
 1. *Appliance:* Computer with special hardware and/or software built to serve a specific need or function, delivered pre-configured to provide a turn-key solution for a particular application.
 2. *Appearance Similarity:* Video search capability to instantly locate people, vehicles, and other objects of interest with the same identified classes and attributes.
 3. *Application Programming Interface:* Documented interface or communication protocol between a software client and a system server intended to simplify the building of client software.
 4. *Case:* (a) An incident being investigated. (b) System feature enabling the searching, identification, and management of video evidence relating to a case investigation, including relevant search results, objects of interest and summaries of case findings – including exporting of reports and dynamic collaboration on case evidence with other users.
 5. *Close-Up Clip:* PTZ-like close-up view of an object (person, vehicle, animal) that follows the object as it moves throughout the camera's field of view, used to examine an object's appearance and behavior to determine whether or not it is of interest.
 6. *Facial Match Accuracy:* Video face image matching involves a trade-off between two factors: *false acceptance rate* and *false rejection rate*, both of which are defined below. A lower *false acceptance rate* generally means that the *false rejection rate* will be higher, and vice versa. Since no face matching can be 100% due to camera location, video image resolution, lighting, and quality differences between the video image and the image to be matched. The FAR working point must be adjusted so that the balance between false matches and failure failures to match are acceptable from security operations and risk mitigation perspectives. There is an inherent tradeoff between FAR and FRR. If one lowers the matching threshold, there will be more matches – with the possibility of more false matches and a higher FAR. Facial match accuracy is usually quoted as a

value of one of the rates (e.g. FRR) at a fixed value of the other (e.g. FAR) – and thus can be compared between different facial recognition engines.

7. **False Acceptance Rate:** Also called false match rate or false positives. In video face recognition matching, the false acceptance rate (FAR) is the measure of how likely it is that the system falsely matched an individual in the video with specific facial image uploaded, selected from video, or contained in a watchlist. A FAR rate of 1% means, for example, that out of 1,000 people walking in the protected area and being checked against the watchlist, 10 will be falsely identified as being on the watchlist when they are not. See Facial Match Accuracy above for an explanation about how FAR relates to FRR.
8. **False Rejection Rate:** Also called false negatives. In video face recognition matching the false rejection rate (FRR) is the measure of how likely it is that the system failed to match an individual in the video with their image. An FRR rate of 5% means, for example, a 95% chance that a suspect from the watchlist will be detected when he or she appears in the video, and a 5% chance that a suspect will not be detected. See Facial Match Accuracy above about how FRR relates to FAR.
9. **Filters:** Video search capability utilizing combinations of object attributes and search precision settings to optimize search results based on search purpose and desired search outcome. Filters speed up time-to-target and make the investigation time better utilized.
10. **Histogram:** Graphical display of numerical data using bars of different heights, where each bar represents a range of numbers out of the total set of numbers to be represented. For example, to graphically depict the speeds of two- and four-wheel vehicles whose speeds range between 1 and 40 MPH, instead of having a bar for each speed (40 different bars), a histogram could use just 8 bars for the following speed ranges: 1 – 5, 6 – 10, 11 – 15, 16 – 20, 21 – 25, 26 – 30, 31 – 35, and 36 – 40. To simplify refinement of smart video searches, histograms from one or more synopsis video clips can present, for example, selections of object size or speed ranges based upon groupings of sizes, speeds and dwell times that have been identified in the video being searched.
11. **HTTP Live Streaming:** Widely supported, high-quality, and robust media streaming protocol for delivering visual and audio media to viewers over the internet in a manner that maximizes streaming video quality. It allows video content streamers to deliver streams in a way that each viewer can receive the best quality stream for the quality of their internet connection at any given moment. It is the definitive de facto standard for live streaming content.
12. **Identity:** A collection of identifiable information, such as face images or feature vectors, with attributes and metadata known to be of the same individual.
13. **Object:** Video content analysis term for an item detected as being in the foreground of a scene as opposed to being part of the background. Typically, objects are identified according to class such as person, animal or vehicle and attribute such as color, size and speed.
14. **Object Attribute:** Quality or feature regarded as a characteristic or inherent part of someone or something. In video content analysis, an attribute is a characteristic that helps differentiate instances of items in the same class, such as how people in a video image can be differentiated by size, clothing, hair color and whether or not they are wearing a hat or backpack, or carrying a bag. For other objects – such as vehicles – vehicle type, color, size, and speed can be important differentiators.
15. **Object Class:** Group of objects of the same type. In video content analysis, objects are grouped into classes most relevant to the purpose of video observation.
16. **Password Hash:** A secure way to achieve password verification without storing a password. Instead, the password is transformed into data that cannot be converted back into the original password. In contrast to encryption, hashing is a one-way mechanism. The data that is hashed cannot be practically "unhashed". When a user enters a password to log in, the newly entered password is hashed and compared against the stored password hash. If the hashes match, login is successful.
17. **Proximity:** Video analytic capability to instantly detect objects that are below or above a specified proximity (distance) for a specified duration of time.
18. **Representational State Transfer:** A software architectural style (abbreviated as REST) that defines a set of constraints to be used for creating Web services. Web services that conform to the REST architectural style, called RESTful Web services, provide interoperability between computer systems on the Internet or other IP-based network.
19. **Security Assertion Markup Language:** Open standard for exchanging authentication and authorization data between parties, used to implement Single Sign-On.
20. **Single Sign-On (SSO):** Software system's capability enabling end-users to log in just once and access all needed applications without having to log in separately to each one.
21. **System Commissioning:** The process of assuring that all systems and components of a technology deployment project are designed, installed, tested, operated, and maintained according to the requirements of the owner and operator.
22. **Time to Target:** Time required for a video search to return requested search results for person or object that is the search target.

23. *VIDEO SYNOPSIS*: Patented video software technology that creates condensed video summaries of recorded video clips by extracting foreground objects from the video and superimposing them over the background of the original scene either simultaneously or in rapid succession, quickly presenting objects that have appeared at different times within the video. The result is a dramatically shorter video segment (called a "synopsis") that fully preserves the viewer's ability to analyze scene activity, enabling the review of hours of video in minutes and sometimes seconds.
 24. *VIDEO SYNOPSIS Density*: Density control setting used to control the maximum number of objects shown concurrently during video synopsis playback. Typically, increasing density shortens the run time of a synopsis; decreasing density lengthens it.
 25. *Visual Layers*: Visual elements overlaid on a video image to visually depict video analytics results within camera fields of view such as heat maps for activity, dwell time, changes to scene background; and path lines for object travel.
- C. *Trademarks: Trademarks used in this document:*
1. Apple, Inc.: Apple®.
 2. BriefCam Ltd.: BriefCam®, VIDEO SYNOPSIS®.
 3. Genetec Inc.: GENETEC™.
 4. Google LLC: Google®.
 5. Microsoft Corporation: Microsoft®, Active Directory®.
 6. Milestone Systems A/S: XProtect®.

1.1. **SUBMITTALS**

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. *Product Data*: Provide manufacturer's data sheets and installation manuals to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- C. *Shop Drawings*: Provide logical block diagram of interface to video management system and other interfaced systems or devices.
- D. *Operating Manuals*: Provide all relevant manufacturer operating manuals and user guides.

1.2. **CLOSEOUT SUBMITTALS**

- A. *Maintenance Contracts*:
 1. Submit contractor's maintenance service agreement for Owner's review that includes cost and services for a one-year period.
- B. *Warranty Documentation*:
 1. Submit manufacturer's standard warranty.

1.3. **REFERENCES AND CODE REQUIREMENTS**

- A. Device shall be installed in accordance with all applicable national, state, provincial, regional and local codes and standards. All equipment shall be U.L. listed or meet U.L. requirements for its intended use.

1.4. **COMPLETION**

- A. Complete system commissioning by target date established by Owner.

1.5. **QUALITY ASSURANCE**

- A. *Qualifications*:
 1. *Manufacturer shall*:
 - a. Regularly and presently produce, as the manufacturer's principal products, the Video Content Analytics Platform specified for this project.
 - b. Have at least 10 years of experience in video content analytics.
 - c. Provide the following professional services upon request of Contractor or Owner:
 - 1) Deployment and commissioning support services.
 - 2) Installer and end-user training services.
 - 3) Custom software enhancement.
 2. *Contractors/Installers*: Contractor or security sub-contractors shall comply with the following requirements.
 - a. Be licensed to perform security installations in the state in which the work is to be performed.
 - b. Have a minimum of five years' experience installing and servicing systems of similar scope and complexity.
 - c. Provide four current client references for systems of similar scope and complexity which became operational in the past three years.

- 1) At least three references shall utilize the same system components, in similar configurations as proposed.
- 2) References shall include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project. Owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the reference's level of satisfaction with the system.
- d. Utilize only factory-authorized technicians to install, program, and service Video Content Analytics Platform.
- e. Provide copies of system manufacturer certification for all technicians.
- f. Ensure technicians have a minimum of five continuous years of technical experience in electronic security systems installation including video management systems.
- g. Provide evidence that installing service company is an authorized dealer in good standing for the product's manufacturer, and that company meets manufacturer's technical certification requirements.

1.6. **DELIVERY, STORAGE, AND HANDLING**

- A. *Equipment*: Deliver equipment undamaged to specified location in manufacturer's packaging, complete with installation instructions, with the exception of software and firmware files provided by download from manufacturer's website.
- B. *Equipment Storage*: Store equipment in manufacturer's original sealed containers. Maintain storage temperature between 35 and 110 degrees Fahrenheit and not more than 80 percent relative humidity, non-condensing.
- C. *Software and Firmware Files*: Verify authenticity of software and firmware files, store securely in a protected device, and verify integrity of files prior to installing.

1.7. **WARRANTY AND SUPPORT**

- A. *Product Support Services*:
 1. *Support Structure*: Provide two levels of support:
 - a. *First Level Support*: Reseller to provide trained support personnel to supported end-users,
 - b. *Second Level Support*: Manufacturer to provide online knowledge base, online ticketing platform, and technical support through email, telephone and/or remote connectivity software, with Service Level Agreement response as follows:
 - 1) *Fatal or Sever Error*: Where no useful work can be done with the BriefCam platform, the initial response shall be made within half of a business day with ongoing assistance during working hours until the issue is resolved.
 - 2) *Degraded System Operations*: Where errors are causing issues with minor functions, the initial response shall be made within one business day and a resolution will be provided within 10 business days either in the form of a work-around solution or a software correction that will be included in the next software update.
 - 3) *Minor Impact Issues*: Where documentation or a feature request is required, the initial response shall be made within one business day and a resolution will be provided within 10 business days either in the form of an answer or a software correction that will be included in the next software update.
 2. *Computer Software*: Offer active annual maintenance contract includes software updates, upgrades and enhancements, software patches and bug fixes
 3. *Computer Hardware*: Hardware manufacturer's warranty program shall apply.
- B. *Maintenance and Service*:
 1. *General Requirements*:
 - a. Contractor shall warrant from final acceptance date agreed by Owner that all equipment and labor provided for system installation will, during warranty periods and under normal use and service, be free from defects and faulty workmanship or be replaced at no additional charge.
 - b. Warranty period shall be minimum period of one year from final acceptance date or match manufacturer's term of support service, whichever is greater.
 2. *Description of Work*:
 - a. Deployment of Video Content Analytics Platform includes software installation and integration with Owner's new or existing video management system.
 3. *Personnel*:
 - a. Service personnel shall be certified in maintenance and repair of selected type of equipment and integrations, and qualified to accomplish all work promptly and satisfactorily.
 4. *Schedule of Work*:
 - a. Work shall be performed during regular working hours, Monday through Friday, excluding federal holidays.

5. **Emergency Service:**
 - a. Owner shall initiate service calls whenever system is not functioning properly.
 - b. Provide Owner with an emergency service center telephone number. Emergency service center shall be staffed 24 hours a day, 365 days a year. Owner shall have sole authority for determining catastrophic and non-catastrophic system failures within parameters stated in General Project Requirements.
 - c. Catastrophic system failures are defined as any system failure that Owner determines will place a project facility at unacceptable security risk.
 - d. For catastrophic system failures, Contractor shall provide same-day 4-hour service response, with a defect correction time not to exceed 24 hours from notification.
 - e. For non-catastrophic failures, provide service response within 2 business days, with a defect correction time not to exceed 96 hours from notification.
6. **Operation:**
 - a. Scheduled or requested adjustments and repair shall include verification of corrected system operation as demonstrated by documented performance verification testing.

1.8. **DISTRIBUTION**

- A. System shall be offered commercially through authorized resellers who will install and commission system on customer premises and integrate system operations with existing video management system and other systems as specified by Owner.

PART 2 - PRODUCTS

2.1. **MANUFACTURER**

- A. BriefCam Ltd, 275 Grove Street, Suite 2-400, Newton, MA 02466.
 1. *Telephone:* (603) 527-4187.
 2. *Website:* www.BriefCam.com
- B. *Substitution Limitations:* No Substitutions.
- C. *Product Brand Name:* BriefCam.
- D. *Product Version:* v5.6.2

2.2. **VIDEO CONTENT ANALYTICS PLATFORM**

- A. *Description:* Deep-learning-enabled video stream and file analysis software platform for:
 1. Detection, classification and recognition across people and object classes, attributes, behaviors and faces.
 2. Extremely rapid video search and review using condensed video summaries.
 3. Case-based video evidence collection, management and sharing.
 4. Alerting based on smart real-time video stream content analysis.
 5. Quantitative statistical visual analysis to derive actionable insights for data-driven safety, security, and operational decision making.

2.3. **DESIGN / PERFORMANCE CRITERIA**

- A. *Deep Learning:* Utilize computer vision and deep learning technology to achieve high speed, highly accurate video content analysis that facilitates highly accurate metadata-based searching.
 1. *In-Depth Classification.* Provide two-tier classification scheme using deep learning as described below and depicted in List 1 below.
 - a. *Classify:* classify objects into top-level class (Person, 2 Wheeled, Vehicles, and Animals) to enable filtering objects class, which has an accuracy of over 96% (plus or minus 10%).
 - b. *Sub-Classify:* Further classified objects into a subclass (Man, Woman, Child, Car, Pickup, Van, Bus, Truck, Airplane, Train, Boat, Bicycle and Motorcycle) to enable filtering objects by a subclass, with an average accuracy of 86% (plus or minus 10%).

List 1. Two-Tiered Object Classification

- People
 - Man
 - Woman
 - Child
- Two-Wheeled Vehicles
 - Bicycle
 - Motorcycle
- Other Vehicles

- Car
 - Pickup
 - Van
 - Truck
 - Bus
 - Train
 - Airplane
 - Boat
 - Animals
2. *Movement Analysis*: Perform movement analysis to generate speed and direction metadata that can be used as search parameters and can be depicted visually using heat maps and paths.
 3. *Size Analysis*: Perform size analysis to generate size metadata that can be used as a search parameter.
 4. *Color Analysis*: Perform color analysis to generate color metadata that can be used as search parameters for the colors: brown, red, orange, yellow, green, lime, cyan, purple, pink, white, gray and black.
- B. *Object Classification Resolution*: Achieve classification accuracy described above for object images having at least minimum resolution specified in Table 1 below.

Table 1. Object Classification Image Resolution Minimum Requirements

Minimum Large Edge (pixels)	Minimum Small Edge (pixels)	Relevant Classes
32	12	High-level classes: Person, 2-Wheel Vehicle, Other Vehicles, Animals.
64	32	Man, Woman Boy, Girl and all Person attribute classes.
40	20	Car, Pickup, Van, Bus, Truck, Airplane, Train, Boat.
32	16	Bicycle, Motorcycle.

- C. *Accelerated Parallel Processing*:
1. *Video Processing*: Maximize speed of video decoding, rendering and encoding by utilizing multiple GPU processors.
 2. *Deep Learning Parallel Processing*: Maximize speed of deep learning parallel processing through scalable utilization of multiple GPU processors.
 3. *Video Processing Performance Criteria*: Achieve video processing throughput on specified GPUs in both on-demand and real-time with a resolution of 1080p, 15 fps and default complexity, as shown in Table 2 below.
 - a. *Basis of Measurement*: Hs/H indicates number of hours of video that can be processed in one hour. For example, 8 Hs/H means that 8 hours of video fetched from a particular camera can be processed in 1 hour. Real-Time Channels refers to number of concurrent on-demand processing or real-time channels per GPU (dependent on available GPU RAM).

Table 2. Video Processing Throughput Performance.

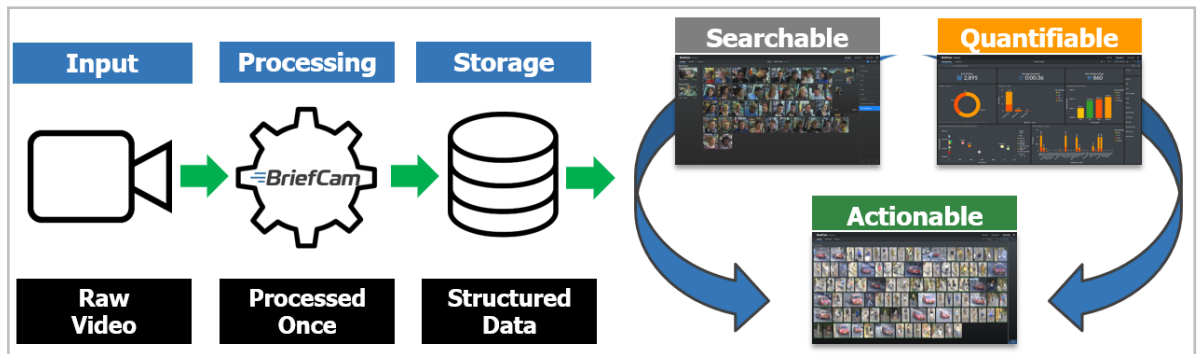
GPU	On-Demand Hs/H Real-Time Channels
Tesla P4	14.6 Hs/H 11
Tesla T4	16.7 Hs/H 16
Quadro RTX4000	23.9 Hs/H 13
Quadro P4000	14.9Hs/H 13
GTX 1080Ti	24.4 Hs/H 16

- D. *Modular System Design*: Provide modular system design and product version variants to enable per-deployment selection of system functional capabilities according to video surveillance and business operation needs.
- E. *System Scalability*: Provide deployment scalability via physical, virtual and software architectures.
- F. *Adaptive Streaming Technology*:
 - 1. *HLS Protocol*: To assure that video streams can traverse any firewall or proxy server that lets through standard HTTP traffic (as opposed to UDP-based protocols like RTP), utilize the HLS protocol for video streaming.
 - 2. *Optimal Viewing*: Automatically select one of two resolution levels (according to available bandwidth) to enable optimal video viewing, based on the quality of the network/internet connection at any given moment.
- G. *Video Resolution*: Minimum CIF, Maximum 4K
- H. *Frame Rate (FPS)*: Support these frame rates: 8-30 frames per second. Note that better performance is achieved with a frame rate of no more than 15 fps.
- I. *Video File Formats*: Support these video file formats: AVI, MKV, MPEG4, MOV, WMV, DVR, ASF, RT4, DIVX, 264, GE5, TS, 3GP, DAV, XBA (single & multi-stream), MP4, and FLV.
- J. *Video Codecs*: Support these video codes: H.264, H.265/HEVC, MPEG-4, and H.263. Note that H.265 is supported for selected VMSs and cameras.
- K. *File-based Ingestion*: Support multi-file videos and single file videos.
- L. *Camera Types*: Support fixed cameras.
- M. *Single Sign-On (SSO)*: Support Microsoft Active Directory, including user groups (OU support).
- N. *Face Recognition*: Minimum face size: 24x24 pixels.
- O. *Browser Support*: Support Google Chrome v 77.* and above, Mozilla Firefox v 69.* and above, and Microsoft Edge v 80 and above desktop browsers.

2.4. SYSTEM FUNCTIONALITY

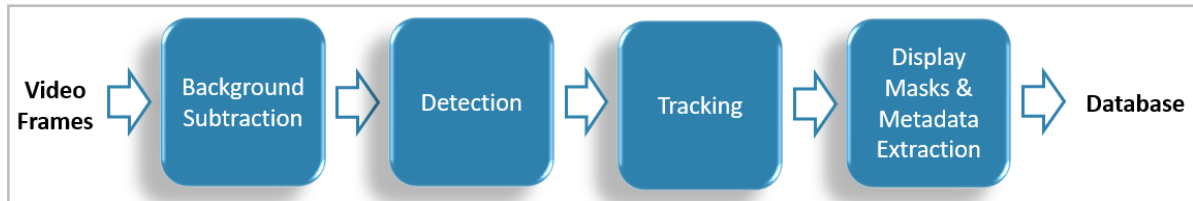
- A. *Video-to-Insight Pipeline*: Provide functionality to process live video received from integrated VMSs, recorded video from VMS or manual video file import and generate video content metadata that is searchable, quantifiable and actionable via use of the REVIEW, RESPOND and RESEARCH software modules, as depicted in and Figure 2 below and described below.

Figure 1. Video-to-Insight Pipeline diagram.



- 1. *Video Processing Object Extraction*: With the goal of identifying everything an individual watching video can learn and understand by detailed review of video, automatically perform extraction functions on video with no manual intervention required, as diagrammed in Figure 1 above:
 - a. Detect every foreground object.
 - b. Extract object information.
 - c. Track every object with no limitation on number of concurrent objects.
 - d. Learn three-dimensional geometry of scene over time.

Figure 2. Video Processing Object Extraction diagram.



2. **Video Content Analytics Engine:** Create structured and indexed video data out of unstructured raw video. Analyze entire content of video, creating an indexed database of information that is searchable, quantifiable and actionable as shown in the left portion of Figure 1 above and diagrammed in Figure 2 above.
3. **User Insight Modules:** Provide user functionality for searching video images, researching video content, and responding to real-time alerts and situational-awareness-based alerts on live VMS video streams, represented in the right portion of Figure 1 above.
 - a. **REVIEW Module:** Search functions for after-the-fact forensic investigations and deep-learning-based synopsis-based review of video that is orders of magnitude faster than standard video review, enabling precision-adjustable pin-pointing of subjects of interest using appearance similarity for people, vehicles and activity; face recognition; license plate recognition; and a broad range of people and vehicle characteristics as search criteria.
 - b. **RESPOND Module:** Functions for enabling response actions based on real-time alerts and smart situational-awareness-based alerts for live VMS video streams, using face and license plate watchlists and count-based rules based on time period totals or concurrent activity, with notifications to VMS, messaging systems or other interfaced systems and services.
 - c. **RESEARCH Module:** Quantitative analysis functionality to provide actionable insights for business intelligence and operational efficiency including customizable dashboards, which include detailed analysis of KPIs, behavior trending, object movement, demographic segmentation, and people interaction with objects, plus out-of-the-box extensible library of vertical-specific analytics tools to enable visual correlation between video metadata and third-party data displayed in dashboard widgets for visual correlation.

2.5. VIDEO CONTENT METADATA

- A. **Video Content Metadata:** Generate class and attribute video metadata to serve as video classification, alerting and search criteria, including but not limited to classes and attributes described below.
 1. **Classes:** Provide high-level classification followed by more detailed classification within each high-level class as shown below.
 - a. **High-Level:** People, Two-Wheeled Vehicles, Other Vehicles, Animals, Illumination Changes.
 - b. **People:** Man, Woman, Child plus all Person attribute classes:
 - 1) **Upper Wear:** Long Sleeves, Short Sleeves, Colors.
 - 2) **Lower Wear:** Long, Short, Colors.
 - 3) **Hat:** No Hat, Hat.
 - 4) **Face Mask:** No Mask, Mask.
 - 5) **Bag:** No Bag, Backpack, Handheld.
 - c. **Two-Wheeled Vehicles:** Bicycle, Motorcycle.
 - d. **Other Vehicles:** Car, Pickup, Van, Truck, Bus, Train, Airplane, Boat.
 - e. **Animals:** Animal.
 - f. **Illumination Changes:** Lights On, Lights Off.
 - 1) **Usage:** Disabled by default, filter for windows or other lights that were turned on and off, presented in a chronological video synopsis where illumination change events are represented as objects and displayed once for lights-on and once for lights-off.
 - 2) **Changes Not Detected:**
 - a) Short changes of lights on and lights off. Tolerance level can be changed by the administrator.
 - b) Illumination changes in very small areas. Tolerance level can be changed by the administrator.
 - c) Gradual illumination changes (e.g., light and shadow changes by sun movement).
 2. **Attributes:** Determine specific class attributes of color, size, speed, dwell and direction.
 - a. **Color:** Identification of brown, red, orange, yellow, green, lime, cyan, purple, pink, white, gray and black colors.
 - b. **Size:** Object's real-life size.
 - c. **Speed:** Object's speed of travel.
 - d. **Dwell:** Length of time a moving object paused.
 - e. **Direction:** Direction of object travel.

- f. *Proximity*: Distance between objects.

2.6. REVIEW MODULE

- A. *Functional Requirements*: Process file-based and VMS video sources (depending on specific license acquired) on demand or according to pre-defined scheduling. Support case management, creation of video synopsis for each video source, and multi-camera search, enabling pinpointing of objects of interest via appearance similarity and face recognition as well as with broad range of filter presets.
- B. *Case Management*: Provide case management interface presenting an integrated view of video assets of an investigation held in single container. Provide bookmarking of objects of interest and summarizing case findings in an exportable report, with the capability for dynamic collaboration on cases with other users. See example image in Figure 3 below.

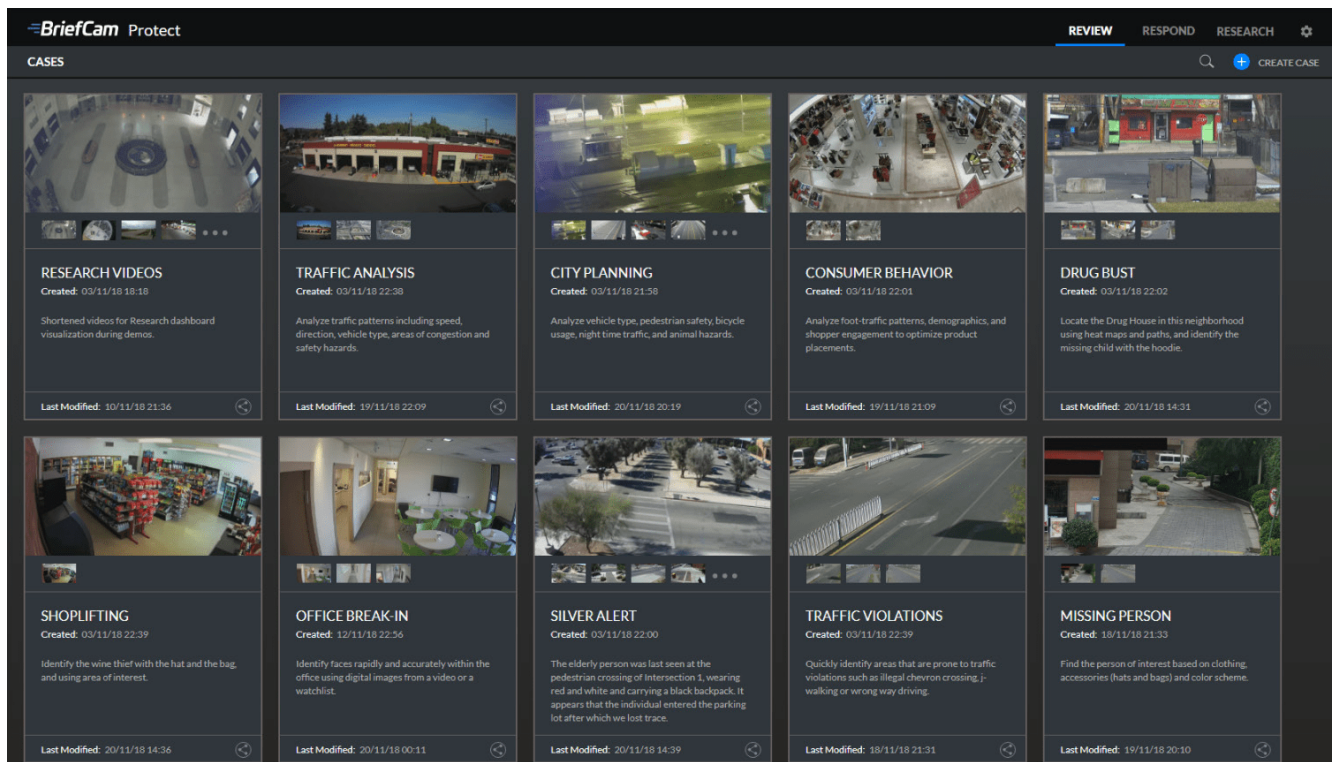


Figure 3. Example Case Management display.

1. *Case Collaboration*: Provide case collaboration whereby case creators can share case with other users or groups, providing other users with read-only access or the ability to modify the case content.
 - a. *Read Only Access Privileges*: Users with read-only access can:
 - 1) Add faces from case to faces list.
 - 2) Add identities to case.
 - 3) Add identities to watchlist.
 - 4) Save and delete presets.
 - 5) Add, edit and delete bookmarks, including visual layer bookmarks.
 - b. *Read Only Access Restrictions*: Users with read-only access cannot:
 - 1) Update or delete case.
 - 2) Add or delete sources.
 - 3) Retry the processing of sources.
 - 4) Exclude a case from maintenance.
- C. *Video Synopsis*: Using patented BriefCam VIDEO SYNOPSIS technology, simultaneously present objects that have appeared at different times within video. Produce a dramatically shorter video segment that fully preserves viewer's ability to analyze a scene, enabling review of hours of video in minutes and sometimes seconds. See example VIDEO SYNOPSIS images in Figure 4 below and Figure 5 on page 18.



Figure 4. Example Video Synopsis Playback Display.

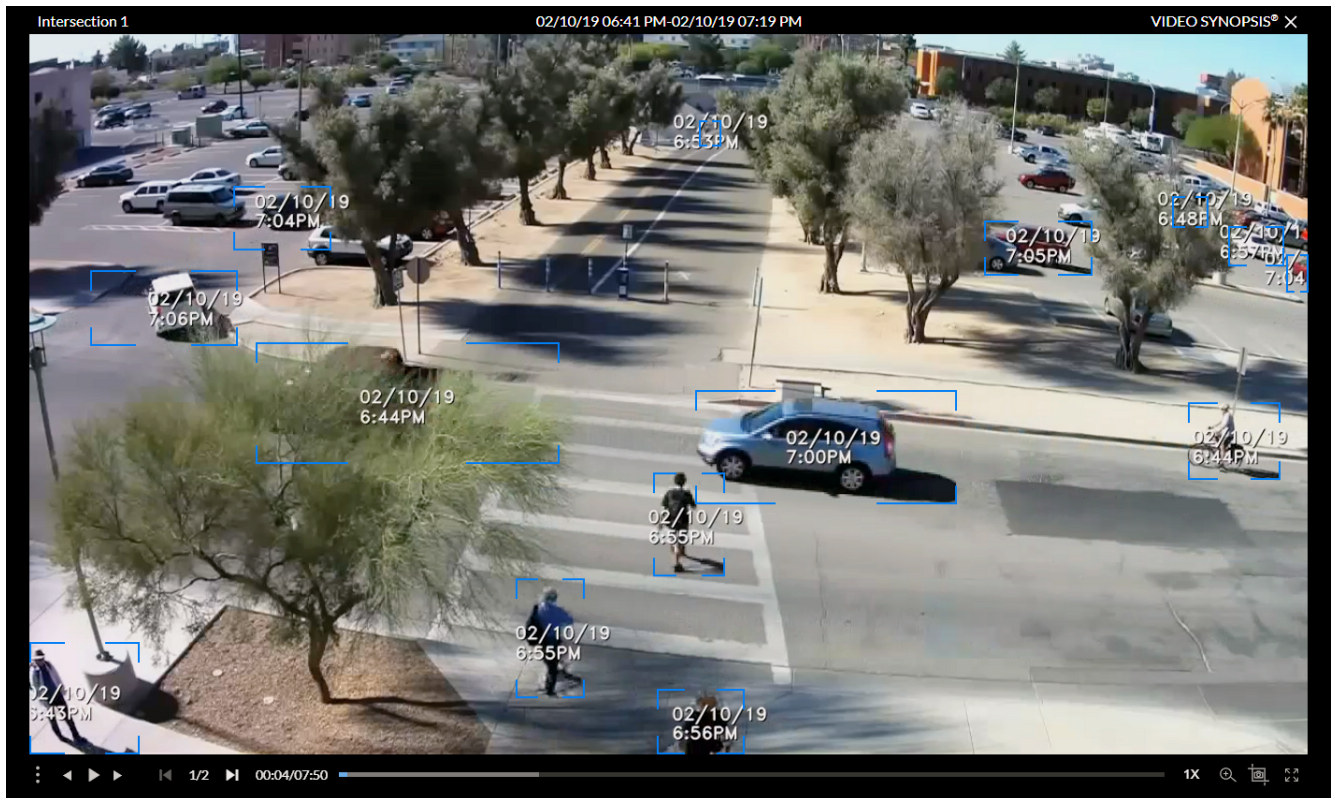


Figure 5. Example Video Synopsis Playback Display with Bounding Boxes.

1. **Timestamps:** Optionally display timestamp next to each object being presented during synopsis playback. Enable timestamps (date and time) by default with user option to change options.

2. **Bounding Boxes:** Provide visual rectangular highlighting of all objects shown in synopsis or in original video, to help ensure that no object is overlooked and to select objects for further actions such as bookmarking, finding similar objects. Bounding box display is enabled by default and may be toggled off and on.
3. **Density Control:** During synopsis playback, allows users to increase or decrease number of objects shown simultaneously.
4. **Sort Control:** Provide selection of object sort order by either relevance to search filter criteria (e.g., highly certain match to less likely match) or time of occurrence. If no filters are applied, sorting defaults to by time or occurrence order.
5. **Object Filters:** Provide users with search filters based on appropriate object metadata plus face recognition and appearance similarity.
 - a. **Metadata Filters:** Display objects based on one or more selected metadata values:

1) Source	4) Color	7) Dwell	10) Proximity
2) Class	5) Size	8) Direction	
3) Person Attributes	6) Speed	9) Time Range	
 - b. **Appearance Similarity:** Display people, vehicles, and other items of interest by searching for objects with similar attributes by using a specialized DNN.
 - c. **Face Recognition:** Pinpoint people of interest using digital images extracted from video or external sources, either by specific person image selected or per watchlist.
 - d. **License Plate Recognition:** Find license plates through existing video or real-time streams and compare to watchlists. For use in "in the wild" surveillance scenarios.
- D. **Multi-Camera Search:** Provide advanced search capability by which video from multiple cameras can be searched at once to identify objects of interest, displaying only objects whose meta-data matches user's filter criteria, including face recognition and license plate recognition. Objects are displayed in thumbnail mode in a Case.
- E. **Scheduling:** Enable per-video-source scheduling of daily or weekly automatic video processing.
- F. **Filter Tolerance:** Provide adjustments to optimize search results for precision and completeness, via filters based on class, attributes, color, dwell time, direction, area, path, face recognition, license plate recognition, and appearance similarity. Each filter shall have adjustable tolerance levels described below.
 1. **Precision:** Search results accuracy – percentage of correct results out of all results.
 2. **Recall:** Search results completeness – percentage of correct results returned out of all available correct results.
 3. **Tolerance Levels:**
 - a. **Strict:** High precision and low recall – few correct matches may be missed, and some false matches may be included.
 - b. **Normal:** Default value - good precision and good recall – majority of results are correct matches, with few wrong matches.
 - c. **Loose:** Low precision and high recall – all correct matches will be included, along with more wrong matches than with Normal setting.
- G. **Filter Presets:** Provide a combination of global and source-specific (Area, Path, and Line Crossing) filters that may be applied to case objects and saved as presets for later reuse.
- H. **Color Tolerance:** Provide fine-tuning of color filter control as well as colors for Upper/Lower Wear using Coverage and Shade tolerance filter settings:
 1. **Coverage Tolerance Settings:** Select Low, Medium or High to set how much of object must match selected color to be considered a match.
- I. **Shade Tolerance Settings:** Select Approximate, Close or Precise to set how flexible a filter should be in terms of item shade and how far color tone can be from selected color to be considered a match.
- J. **Direction Tolerance:** Provide angle settings of Narrow, Normal (default) or Wide specify amount of departure allowed from specified direction of travel for objects. A specific number of degrees for Angle may also be specified.
- K. **Visual Layers:** Provide analytics-based visual overlay elements according to specific search criteria. Visual layers shall be available for viewing when synopsis processing is complete. Available visual layers shall be:
 1. **Activity Heat Map:**
 - a. Highlight areas in which increased event movement has been detected.
 - b. Provide Activity Heat Map legend to indicate number of detected objects associated with each heat map color.
 2. **Dwell Heat Map:**
 - a. Highlight areas in which objects lingered for extended periods of time, at least for 10 seconds.

- b. Provide Dwell Heat Map legend to indicate number of detected objects having dwelled at the highlighted areas.
 - 3. **Common Paths:**
 - a. Superimpose common paths layer that highlights paths most commonly taken by objects detected in video.
 - b. Provide Common Paths legend to indicate the number of detected objects having followed the paths indicated by each path color.
 - 4. **Background Changes:**
 - a. Highlight areas where changes occurred in the scene background, to indicate which items in the background scene were interacted with more than others. Frame in red objects that haven't moved at all. Provide no legend.
- L. **Reports:** Provide concise case findings summary reports including all relevant exhibits, with capability to view original video featuring relevant objects in summary report.
 - 1. **Add to Report:** Provide "Add to Report" capability to build report content when reviewing synopsis so that selecting objects bookmarks object and adds it to report. Prompt for entry of bookmark title and description.
 - 2. **Bookmarks:** Provide thumbnail representations of video clips with user-provided title and optional description.
 - 3. **Bookmark Export:** Provide capability to export bookmarks in ZIP file format, including selected objects' original video, close-up clip in MP4 file format, and thumbnail, plus image file in JPG format for visual layer if included.

2.7. RESPOND MODULE

- A. **Functional Requirements:** Provide rule-based alerts for issuance of notifications to video content analysis platform users and to integrated VMS, PSIM or other interfaced systems in form of smart alerts and real-time alerts of critical events, described below. Provide alert reporting capability. By default, generate minimal visual asset when processing videos in the RESPOND module for increased throughput and savings in consumed disk space.
- B. **Alerts:**
 - 1. **Smart Alerts:** Trigger rule-based alerts to respond to complex environment situational changes, balancing sensitivity, accuracy and efficiency. Alerts can be triggered for all filters including class, face recognition, proximity, face masks, bags, hats, license plate recognition, color, size, speed, dwell, direction, object count, area, path, and line crossing.
 - 2. **Real-Time Alerts:** Trigger real-time, rule-based alerts in time-s
 - 3. **Real-Time Alerts:** Trigger real-time, rule-based alerts in time-sensitive situations by face recognition, vehicles, people of interest, object count and activity, such as wrong direction.
 - 4. **People Counting Alerts:** Trigger rules to monitor the increase or decrease of people in a pre-defined range of view or area. This type of alert is ideal for queue and waiting areas that are crowded with people that are static (not moving). The People Counting data is retrieved every few minutes (two minutes by default). When there are people moving through an area, use the Count filter in the Smart or Real-Time alerts:
 - **Count-based Alerts:** Enable alerts to be triggered when certain number of objects meets filter criteria in a predefined period (time-dependent count) or concurrently (concurrent count).
 - 5. **Alert Characteristics:** Provide alert characteristics described in Table 3 below.

Table 3. Alert Types.

	Smart Alerts	Real-Time Alerts
Advantage	More accurate because it uses more frames per object.	Better in crowded scenes because it uses face tracking instead of full body tracking.
Alert time	30-60 seconds.	Up to 5 seconds.
BriefCam object type	Video clip.	Still image.
Repeated alerts	A single alert per object.	Multiple alerts may occur for a single object in certain conditions because the object tracking is basic and not as accurate as with smart alerts.

	Smart Alerts	Real-Time Alerts
Available filters	All.	Class, Face Recognition, Count (time-dependent only) and Area.

- C. *Audio Annunciation*: Provide optional sound-file based audio annunciation of alerts.
- D. *Alert Report*: Provide capability to summarize daily smart alerts in short VIDEO SYNOPSIS.
- E. *External Notifications*: Provide for sending of notifications to messaging services, and VMS alarms area. Integration with Genetec Security Center, Milestone XProtect, IndigoVision Control Center, Qognify's (formerly OnSSI) Ocularis user interface and Verint's Nextiva.
- F. *Rules*: Provide Management and sharing of named camera
- G. *Rules*: Provide Management and sharing of named camera-specific alert rules for rapid notification of events as they occur, based on specific filter criteria.
1. *Rule Ownership*: Establish rules "ownership" by which users who create rules retain the authority to make them sharable, giving others read-only or read-write use of shared rules.
 2. *Duplicate a rule*. Provide the capability to duplicate rules across cameras, creating selected rules for each selected camera and applying the same global filters to duplicated rules (except for path, area, and line crossing filters), with newly created rules being owned by the user who duplicated them.
 3. *Rule Collaboration*: Allow user who created rule to share rule via user or group selection.
 - a. *Rule Sharing*: Allow rules to be shared in read-only or read-write access mode, subject to permission conditions listed below.
 - 1) Ensure user selected for sharing has permissions to view rule's camera.
 - 2) Ensure user selected for sharing has permissions to watchlists user does not own (external and shared watchlists).
 - 3) When rule is configured to use watchlists, those watchlists must be shared as well.
 - 4) Ensure sharing process does not share watchlists that user does not own (shared and external watchlists).
 - 5) Share watchlists with the users/groups in read-only mode with one exception: if watchlist was already shared in advance with user or groups in full control mode, do not change sharing mode.
 4. *Flexible Scheduling*: Allow manual rule execution rules or schedule-based automatic activation on a daily or weekly basis.
- H. *Responding to Alerts*:
1. *Alerts Display*: Provide alert response window containing three sections:
 - a. *Synopsis Pane*: Column for synopsis thumbnails for cameras having alerts in selected time range. Cameras having more than one rule are shown as a single synopsis. Clicking synopsis thumbnail initiates synopsis playback.
 - b. *Thumbnails Pane*: Grid-like display of thumbnails, with newest alerts at top of grid.
 - 1) *Smart Alert Thumbnails*: Playable/downloadable video thumbnails that use a red line under thumbnail to indicate thumbnail has not yet been watched. Five response action selections are displayed to the right of the playing synopsis image:
 - a) *Original Video*: View original video of alert-generating event.
 - b) *Create Bookmark*: Create bookmark to flag alert for later review in the Bookmarks tab.
 - c) *Mark As Unwatched*: Restores the red line under thumbnail.
 - d) *Start A Review Case*: Add footage from video of one or more alerts to new or existing Review Case.
 - e) *Download Clip*: Download MP4 file of close-up clip.

The left-hand side of the alert provides information about the alerts, including the alert time (the viewer's local time), event time (the event's local time), and rule name. When relevant, additional information is seen, such as when a face was matched, the watchlist name is displayed and a match score (confidence level) between 0-100%, indicating the match confidence between the two faces.
 - 2) *Count-Based Alerts*: Count-based alerts have consolidated display thumbnails, where all the objects counted in the alert are stacked one on top of another.
 - 3) *Real-Time Alerts*: Viewable image thumbnails provide the option to view original video and create a bookmark for the alert.
 - c. *Filters Pane*: Provides options for filtering alert thumbnails by source, date, rule and display category (All, Bookmarked, Watchlist, and Unwatched).

2.8. RESEARCH MODULE

- A. *Functional Requirements*: Provide quantitative video analysis functionality to support informed, data-driven decisions regarding business operations. Provide widget-based visual dashboards for data presentation, review and analysis. By default, generate minimal visual asset when processing videos in the RESEARCH module for increased throughput and savings in consumed disk space.
- B. *Dashboards*: Incorporate BI (business intelligence) functionality based on aggregate video metadata, with visualization of range of analytics, such as key performance indicators, and performance of trend analysis. See example dashboards in Figure 6 on page 35.
- C. *Sources*: Provide manual and automated video and data ingestion. Enable scheduling of manual or automatic generation of dashboards for VMS video sources or video files. Provide capability to specify one or more areas, paths, and/or line crossings in video scene to obtain a count of objects entering areas, traveling along paths or crossing a line in a defined direction.
 - 1. *Settings*:
 - a. *Source Generation Scheduling*: Provide Continuous, Daily and Weekly scheduling settings.
 - b. *Object Duration*: Allow specification of minimum duration in path or duration in area to qualify object to be counted.
 - c. *Coverage Tolerance Settings*: Provide Low, Medium and High tolerance settings for specifying how closely an object must follow defined path or area to be included in count, so that High coverage tolerance level results in inclusion only of objects closely adhering to the drawn Path or Area, and Low coverage tolerance setting results in inclusion of additional objects that only loosely follow defined Path or Area.
- D. *Source Groups*: Create groups of sources to be used for face matching and other grouping needs within the dashboards, such as grouping all the cameras on the 1st floor or all ATM cameras.
- E. *Trend Analysis*: Enable comparison of visitor, pedestrian, and traffic patterns of any desired timeframe, i.e. days, months, years, to spot trends, outliers and insights. Show visual layer dwell patterns, common paths, and activity level heat maps. Facilitate identification of which areas are more active than others, where objects remain for longer periods of time, and how most objects are moving through the scene, are some benefits. Enable tracking people across cameras using face recognition when a high-quality camera is used, to count the number of distinct visitors according to the faces in the store, measure the average time people stay in a store, calculate bounce rates, exclude employees from visitor counts and measure new versus repeat visitors. Enable tracking people and vehicle movement patterns over time, identify demographic segmentation trends, A/B test evaluation for traffic management controls, retail store promotions, and other types of operational programs.
- F. *Base Dashboard Library*: To shorten initial system configuration time, provide out-of-the-box, extensible library of vertical-specific dashboards to visually represent object movement, demographic segmentations, behavior trending, hotspots, and object interactions. Can be used as baseline templates from which to create customized dashboards specific to user needs.
- G. *Customizable Dashboards*: Provide visually intuitive interface for rapidly customizing and creating new single or multi-camera dashboards for specific personas and use cases. Support a wide variety of visualization elements such as: Bar chart, pie chart, histogram, gauge or another visual element used to graphically depict a set of information.
 - 1. *Sheet*: Dashboard display surface on which to locate visualizations.
 - 2. *Sheet Types*: Provide the following sheet types:
 - a. *Public Sheets*: Out-of-the-box sheets for quick and easy dashboard setup.
 - b. *Community*: Sheets shared by other users in organization.
 - c. *Published by Me*: Sheets shared by logged-on user with the community.
 - d. *My Sheets*: Sheets created by logged-on that are visible only to that user.
 - 3. *Dimensions*: Determine how the data in a visualization are grouped (this often refers to time, class, etc.).
 - 4. *Measures*: The results of calculations (these are often aggregates, such as sum, count, or average).
 - 5. *Chart Suggestions*: Suggest charts based on measures and dimensions user adds to dashboard.
 - 6. *Insight Advisor*: Use a cognitive engine to suggest and prioritize charts and analytics, based on previous selections.
 - 7. *Multi-Camera Dashboards*: Present object counts from multiple sources in the same sheet.
- H. *Filters*: Filter by class and/or attributes to control what data is displayed in the visualizations of the sheet (dashboard).
- I. *Bookmarks*: Use bookmarks to save selections within the sheet. A bookmark can later restore filters and dashboard selection.
- J. *Stories*: Create customized stories (presentations) that include snapshots of charts and embed sheets for an interactive story.
- K. *Third-Party Data Sources*: Seamlessly correlate video analytics with third-party data sources, such as Point of Sale, Time Management, and Access Control.
 - 1. *Data Ingestion*: Enable external sources data ingestion based on .xls and .csv files in a self-served on-demand manner or integrated with a continuous data source through ODBC, Oracle, MySQL or other databases.

- a. *Professional Services*: Provide BriefCam professional technical services to implement continuous data ingestion for deployments.
- 2. *Visual Data Correlation*: Third-party data can be displayed on same dashboard widgets and graphs as data extracted from video, and through that display assist in later analysis of correlations between external data and foot-traffic, vehicle-traffic, duration, paths, areas or any other analysis that can only be done based on video metadata BriefCam extracts.
- L. *Chart Types*: Provide dashboard chart and object types described in Table 5 below.

Table 4. Dashboard Chart Types.

Chart/Object Type	Description
Bar Chart	Displays bar for each dimension value. Bar length corresponds to its numerical measure value.
Box Plot	Compares range and distribution for groups of numerical data, illustrated by a box with whiskers, and a center line in the middle.
Combo Chart	Combines bars and lines in same chart. Bars and lines have different axes to enable comparisons of percentages and sums.
Container	Adds visualizations in a limited space using tabs. Shows or hides the visualizations inside the container based on conditions.
Distribution Plot	Compares range and distribution for groups of numerical data. Data is plotted as value points along an axis.
Filter Pane	Provides control of what data is shown in visualizations on a sheet. Filter pane can filter data of several dimensions at once.
Gauge	Used to display value of single measure lacking dimensions.
Histogram	Used for visualizing distribution of numerical data over a continuous interval, or a certain time period. The data is divided into bins.
KPI	Used to present central performance figures.
Line Chart	Displays data lines between values. Line charts are often used to visualize trends in data over intervals of time.
Map	Used to combine geographical data and measure values, such as sales in region or store.
Mekko Chart	Used for comparing groups, while being able to compare category items contained within these groups. The dimension axis shows the groups, while the measure axis shows the normalized percentage value for each category item. The size of each group shows its value.
Pie Chart	Shows relationship between single dimension and single measure.
Pivot Table	Presents dimensions and measures as rows and columns of table. Allows analysis of data in multiple dimensions simultaneously. Data in pivot table can be grouped based on combination of dimensions, and partial sums can be shown.

Chart/Object Type	Description
Scatter Plot	Presents values from two measures. Useful to show data in which each instance has two numbers, for example, country (population and population growth). Optional third measure can be used and is reflected in the size of the bubbles.
Table	Displays values in record form so that each row of table contains fields calculated using measures. Typically includes one dimension and multiple measures.
Text & Image	Use to add text, images, measures and links to sheet. To add image, enable Use Background Image setting, click on image, and select image from the list or add image by clicking Upload Media option (then click image and then plus icon).
Treemap	Shows hierarchical data. Can show large number of values simultaneously within a limited space.
Waterfall chart	Used for illustrating how an initial value is affected by intermediate positive and negative values. The starting and the final values are represented by whole bars, and intermediate values by floating bars. Can also be used to show subtotals in the chart.

M. *Dimensions and Measures:*

1. *Description:* Provide visualizations that consists of at least one measure or one dimension; in most cases, visualizations have both, and sometimes more than one dimension or measure.
 - a. *Dimensions:* Typically determine how data are grouped (often refers to time, class, etc.) in visualization.
 - b. *Measures:* Results of calculations; often aggregates, such as sum, count, or average.
2. *Available Dimensions:* Provide dimensions described in Table 6 below.
3. *Available Measures:* Provide dimensions described in Table 7 below.

Table 5. Available Dimension.

Dimension Name	Description
1-min. Intervals	Groups of data in 1-minute time intervals.
5-min. Intervals	Groups of the data in 5-minute time intervals.
10-min. Intervals	Groups of the data in 10-minute time intervals.
15-min. Intervals	Groups of the data in 15-minute time intervals.
30-min. Intervals	Groups of the data in 30-minute time intervals.
Class	Object class.
Class (People)	Only "People" object classes, meaning: Man, Woman and Child.
Class (Road Vehicles)	Only "Road Vehicles" object classes, meaning: Motorcycle, Car, Pickup Truck, Van, Truck, Bus.

Dimension Name	Description
Class Category	Contains the following class categories: <ul style="list-style-type: none"> • People: Man, Woman, Child • Bicycles: Bicycle • Road Vehicles: Motorcycle, Car, Pickup Truck, Van, Truck, Bus • Other Vehicles: Train, Airplane, Boat • Illumination Changes: Lights On, Lights Off • Animals: Animals
Color	Object main color.
Custom Dimensions	Custom dimension name (as configured in Sources module). This includes the path, area and line crossing filters.
Date	Object date.
Date Time	Object date time.
Day	Object day.
Day (Num)	Object day number (for example, 19 if date is 19/03/2018).
Direction	Object direction in degrees.
Direction Label	Object general direction: <ul style="list-style-type: none"> • Up: $0^{\circ} < \text{direction} < 45^{\circ}$ or $315^{\circ} < \text{direction} < 360^{\circ}$ • Right: $45^{\circ} \leq \text{direction} \leq 135^{\circ}$ • Down: $135^{\circ} < \text{direction} < 225^{\circ}$ • Left: $225^{\circ} \leq \text{direction} \leq 315^{\circ}$
Duration	Object duration in seconds, calculated as difference between Object start time and Object end time in the frame.
Dwell (Sec)	Objects having dwelled for user-specified period of time or more, in seconds.
Face Mask	Object's Face Mask classification: Mask, No Mask or Unknown.
Hour	Object time in hour range format.
Hour (hh)	Object time in hour format.
Hour (Num)	Object time in hour number format.
License Plates	Objects detected as license plates
Month	Object time in month format.
Month (Num)	Object time in month number format.

Dimension Name	Description
Object End Time	Object end time in frame.
Object Start Time	Object start time in frame.
People Counting: 10-min. Intervals	Groups of the data in 10-minute time intervals for people counting.
People Counting: 15-min. Intervals	Groups of the data in 15-minute time intervals for people counting.
People Counting: 30-min. Intervals	Groups of the data in 30-minute time intervals for people counting.
People Counting: Area	Custom area dimension name (as configured in the Sources module) for people counting
People Counting: Date	Date that people were counted
People Counting: Date Time	Date and time that people were counted
People Counting: Day	Day of the week that people were counted
People Counting: Day (Num)	Number of the day that people were counted (for example, 19 if the date is 19/03/2018)
People Counting: Hour	Time, in hour range format, that people were counted
People Counting: Hour (hh)	Time, in hour format, that people were counted
People Counting: Hour (Num)	Time, in hour number format, that people were counted
People Counting: Month	Time, in month format, that people were counted
People Counting: Month (Num)	Time, in month number format, that people were counted
People Counting: Source	Source name (as configured in the Sources module) for people counting
People Counting: Time Drill Down-Time	Time drill down within object visualization for people counting, according to: Date, Hour, 30-min, 10-min
People Counting: Week #	Time, in week number format, that people were counted
Size	Object size in meters or feet (as per user settings).

Dimension Name	Description
Speed	Object speed in km/hour or miles/hour (as per user settings).
Source	Source name (as configured in Sources module).
Source Group	Source Group name (as configured in the Source Group tab).
Source Group Watchlist	The name of the external watchlists associated with a Source Group.
Time Drill Down	Time drill down within object visualization, according to: Date, Hour, 30-min, 10-min, 5-min, 1-min.
Tolerance	Allows users to select the threshold of object relevancy included in the dashboard, which impacts detection sensitivity: Loose, Normal, Strict.
Watchlist Identity	The identity name within a watchlist. This is available if this face is related to an external watchlist.
Week #	Object time in week number format.

Table 6. Available Measures.

Measure Name	Description
# of Bicycles	Total count of objects identified as bicycles.
# of Bicycles in Custom Dimensions	Total count of objects identified as bicycles within the custom dimensions, areas, paths or line crossing. An object can be counted in more than one area/path/line crossing.
# of Bicycles in Specific Source	Total count of objects identified as bicycles in specific source.
# of Bicycles in Specific Source and Custom Dimensions	Total count of objects identified as bicycles in a specific source and path, area or line crossing.
# of Bounced Visitors	The number of unique visitors to a particular Source Group who navigate away from the site after less than 1 minute (by default) within the same day (by default).
# of Bounced Visitors in Custom Dimensions	The number of unique visitors to a particular Source Group with a custom dimension (area, path, or line crossing) who navigate away from the site after less than 1 minute (by default) within the same day (by default).
# of Bounced Visitors in Specific Source, Source Group and Custom Dimensions	The number of unique visitors in a specific source, source group and custom dimension (path, area or line crossing), who navigate away from the site after less than 1 minute (by default) within the same day (by default).
# of Illumination Changes	Total count of objects identified as illumination changes (Lights on, Lights off).

Measure Name	Description
# of Illumination Changes in Area	Total count of objects identified as illumination changes within custom dimension, area. Object can be counted in more than one area.
# of Illumination Changes in Specific Source	Total count of objects identified as illumination changes in specific source.
# of Illumination Changes in Specific Source and Area	Total count of objects identified as illumination changes in specific source and area. Used, for example, to count number of illumination changes in same sheet.
# of License Plates	Total count of objects identified by license plates.
# of License Plates in Custom Dimensions	Total count of objects identified by license plates within the custom dimensions, areas, paths or line crossing. An object can be counted in more than one area/path/line crossing.
# of License Plates in Specific Source	Total count of objects identified by license plates in a specific source.
# of License Plates in Specific Source and Custom Dimensions	Total count of objects identified as license plates in a specific source and path, area or line crossing.
# of New Unique Identities	Total count of new identities with a unique face ID.
# of Objects	Total count of objects.
# of Objects in Custom Dimensions	Total count of objects within the custom dimensions, areas, paths or line crossings. An object can be counted in more than one area/path/line crossing.
# of Objects in Specific Source	Total count of objects in a specific source. Used, for example, to count objects from different sources in same sheet.
# of Objects in Specific Source and Custom Dimensions	Total count of objects in a specific source and path, area or line crossing. Used, for example, to count the number of objects in different areas in same sheet.
# of People	Total count of objects identified as people (Man, Woman, Child).
# of People in Custom Dimensions	Total count of objects identified as people within custom dimensions, areas, paths, or line crossings. Object can be counted in more than one area/path/line crossing.
# of People in Specific Source	Total count of objects identified as people in specific source.
# of People in Specific Source and Custom Dimensions	Total count of objects identified as people in a specific source and path, area or line crossing. Used, for example, to count number of people in different areas in the same sheet.
# of Road Vehicles	Total count of objects identified as road vehicles (Motorcycle, Car, Pickup Truck, Van, Truck, Bus).
# of Road Vehicles in Custom Dimensions	Total count of objects identified as road vehicles within the custom dimensions: areas, paths or line crossings.
# of Road Vehicles in Specific Source	Total count of objects identified as road vehicles in specific source.

Measure Name	Description
# of Road Vehicles in Specific Source and Custom Dimensions	Total count of objects identified as road vehicles in a specific source and path, area or line crossing.
# of Road Vehicles in Custom Dimensions	Total count of objects identified as road vehicles within the custom dimensions, areas, paths or line crossings. An object can be counted in more than one area/path/line crossing.
# of Speeding Road Vehicles	Total count of objects identified as road vehicles (Motorcycle, Car, Pickup Truck, Van, Truck, Bus) whose speed exceeds the speed specified on the Speed Limit Slider (available in the visualization folder).
# of Unique Identities	Total count of identities with a unique face ID.
# of Unique Identities in Custom Dimensions	Total count of identities with a unique face ID within the custom dimensions: areas, paths or line crossings.
# of Unique Identities in Specific Source, Source Group and Custom Dimensions	Total count of identities with a unique face ID in a specific source, source group and path, area or line crossing.
Avg # of New Unique Identities	Average count of new identities with a unique face ID.
Avg # of Objects	Average object count (per day).
Avg # of Objects in Custom Dimensions	Average object count (per day) within the custom dimensions, areas, paths or line crossings. An object can be counted in more than one area/path/line crossing.
Avg # of Objects in Custom Dimensions by Hour	Average object count (per hour) within the custom dimensions, areas, paths or line crossings. An object can be counted in more than one area/path/line crossing.
Avg # of Objects in Specific Source	Average object count (per day) in a specific source. Provides the average object count from different sources in the same sheet.
Avg # of Objects in Specific Source and Custom Dimensions	Average object count (per day) within the custom dimensions, areas, paths or line crossings. An object can be counted in more than one area/path/line crossing.
Avg # of Proximity Violation Contacts	Average number of people who have passed the proximity threshold with the selected person.
Avg # of Proximity Violation Contacts in Specific Source	Average number of people who have passed the proximity threshold with the selected person in a specific source.
Avg # of Returning Unique Identities	Average count of returning identities with a unique face ID.
Avg # of Unique Identities in Custom Dimensions	Average count of identities with a unique face ID (per day) within the custom dimensions: areas, paths or line crossings.
Avg # of Unique Identities in Custom Dimensions by Hour	Average count of identities with a unique face ID (per hour) within the custom dimensions: areas, paths or line crossings.
Avg # of Unique Identities in Specific Source, Source Group and Custom Dimensions	Average count of identities with a unique face ID (per day) within specific source, source group and custom dimensions (areas, paths or line crossings).

Measure Name	Description
Avg Duration	Average object duration in seconds.
Avg Duration Bicycles	Average duration in seconds of objects identified as bicycles.
Avg Duration in Custom Dimensions	Average duration in seconds of objects within the custom dimensions, areas, paths or line crossings
Avg Duration in Specific Source	Average duration in seconds of objects within a specific source. Provides the average duration of different Sources in same sheet.
Avg Duration in Specific Source and Custom Dimensions	Average object duration time in seconds of objects within the custom dimensions, areas, paths or line crossings. Provides the average duration of different areas/paths/line crossings in the same sheet.
Avg Duration License Plates	Average duration in seconds of objects with detected license plates
Avg Duration People	Average duration in seconds of objects identified as people (Man, Woman, Child).
Avg Duration Road Vehicles	Average duration in seconds of objects identified as road vehicles (Motorcycle, Car, Pickup Truck, Van, Truck, Bus).
Avg Max Proximity	Average maximum distance that a person had with other people for a certain amount of time.
Avg Max Proximity in Specific Source	Average maximum distance that a person had with other people for a certain amount of time in a specific source.
Avg Min Proximity	Average minimum distance (in meters) that a person had with other people for a certain amount of time.
Avg Min Proximity in Specific Source	Average minimum distance (in meters) that had a person had with other people for a certain amount of time in a specific source.
Avg Speed	Average speed per object in km/hour.
Avg Size	Average size per object in meters or feet (as per user settings).
Avg Visit Duration Unique Identities	The average visit duration time of identities with a unique face ID, calculated within the same day (by default), across cameras within the same Source Group.
Avg Visit Duration Unique Identities in Custom Dimensions	The average visit duration time of identities with a unique face ID, calculated within the same day (by default), across cameras within the same Source Group and within the custom dimensions (areas, paths or line crossings).
Avg Visit Duration Unique Identities in Specific Source, Source Group and Custom Dimensions	The average visit duration time of identities with a unique face ID, calculated within the same day (by default), across cameras within a specific source in the same Source Group and within the custom dimensions (areas, paths or line crossings). The duration time is calculated by taking the person's latest appearance time and subtracting by the first appearance time.
Max # of New Unique Identities	Maximum count of new identities with a unique face ID.
Max # of Returning Unique Identities	Maximum count of returning identities with a unique face ID.

Measure Name	Description
Max Avg Visit Duration Unique Identities	The maximum visit duration time of identities with a unique face ID, calculated within the same day (by default). The duration time is calculated by taking the person's latest appearance time and subtracting by the first appearance time.
Max Bicycles/Hour	Maximum count of objects per hour, identified as bicycles.
Max Illumination Changes /Hour	Maximum count of illumination changes per hour.
Max License Plates/Hour	Maximum count of license plates per hour
Max Objects/Hour	Maximum count of objects per hour.
Max Objects/Hour in Custom Dimensions	Maximum count of objects within the custom dimensions, areas, paths or line crossings, per hour
Max Objects/Hour in Specific Source	Maximum count of objects in a specific source within the custom dimensions, areas, paths or line crossings, per hour. Used, for example, to present the maximum number of objects per hour in different sources in the same sheet.
Max People/Hour	Maximum count of objects identified as people (Man, Woman, Child), per hour.
Max People Not Wearing Face Mask/Hour	Maximum count of objects identified as people not wearing a face mask, per hour.
Max People Wearing Face Mask/Hour	Maximum count of objects identified as people wearing a face mask, per hour.
Max Road Vehicles/Hour	Maximum count of objects identified as road vehicles (Motorcycle, Car, Pickup Truck, Van, Truck, Bus), per hour
Max Unique Identities/Hour	Maximum count of identities with a unique face ID per hour
Max Unique Identities/Hour in Custom Dimensions	Maximum count of identities with a unique face ID within the custom dimensions (areas, paths or line crossings), per hour
Max Unique Identities/Hour in Specific Source, Source Group and Custom Dimensions	Maximum count of identities with a unique face ID in a specific source and source group within the custom dimensions (areas, paths or line crossings), per hour.
People Counting: Avg # of People	Average people count (per day)
People Counting: Avg # of People in Area	Average people count (per day) within the custom area dimensions. A person can be counted in more than one area.
People Counting: Avg # of People in Specific Source	Average people count (per day) in a specific source.
People Counting: Avg # of People in Specific Source and Area	Average people count (per day) in a specific source within the custom area dimension. An object can be counted in more than one area.
People Counting: Max # of People/Hour	Calculates the average # of people per hour and then finds the maximum value.
People Counting: Max # of People/Hour in Area	Calculates the average # of people per hour within the custom area dimensions and then finds the maximum value.

Measure Name	Description
People Counting: Max # of People/Hour in Specific Source	Calculates the average # of people per hour in a specific source and then finds the maximum value.
People Counting: Max # of People/Hour in Specific Source and Area	Calculates the average # of people per hour in a specific source within the custom area dimensions and then finds the maximum value.
Visitors Bounce Rate	The percentage of bounced visitors (see # of Bounced Visitors measure) out of the number of unique identities (see # of Unique Identities measure) within the same day (by default).
Visitors Bounce Rate in Custom Dimensions	The percentage of bounced visitors within custom dimensions (see # of Bounced Visitors in Custom Dimensions measure) out of the number of unique identities (see # of Unique Identities in Custom Dimensions measure) within the same day (by default).
Visitors Bounce Rate in Specific Source, Source Group and Custom Dimensions	The percentage of bounced visitors within specific source, source group and custom dimensions (see # of Bounced Visitors in Specific Source, Source Group and Custom Dimensions measure) out of the number of unique identities (see # of Unique Identities in Specific Source, Source Group and Custom Dimensions measure) within the same day (by default).

Example Dashboards: Example dashboards are presented in Figure 6 and Figure 7 below.



Figure 6. Example Dashboard - Retail Trends.

Figure 7. Example Dashboard – Intersection Analysis.



2.9. MOBILE APPLICATION

A. *Mobile App Functionality:* Extend REVIEW module capability onto iOS and Android mobile devices to make system video searchable by field personnel, as described below. See Figure 8 and Figure 9 below.

Figure 8. BriefCam Android mobile app.

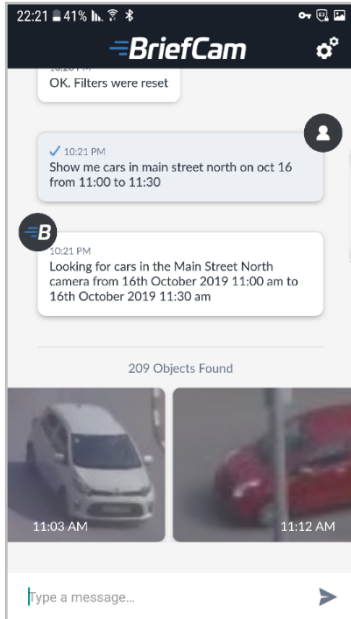
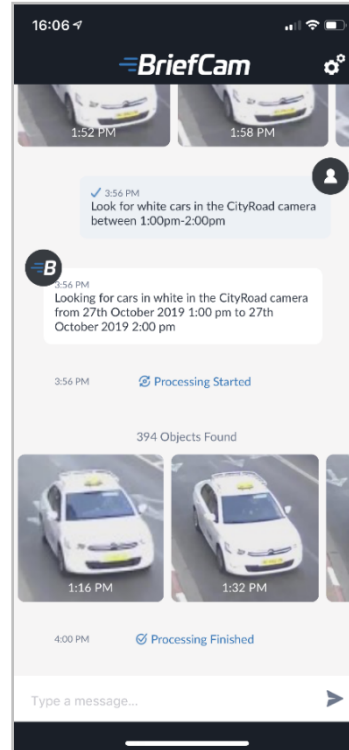


Figure 9. BriefCam iOS mobile app.



1. *Natural Language Chatbot:* Search for objects of interest using chatbot-based processing technology.
 2. *Multi-Camera Search:* Identify objects of interest across multiple cameras.
 3. *Search by Class:* Locate men, women, children, animals and various types of vehicles, including two-wheeled vehicles, trucks, buses, airplanes and more.
 4. *Search by Color:* Further refine object search, based on clothing or vehicle color.
 5. *Search by Face Recognition:* Locate identified persons of interest based on digital images extracted from video or the mobile device gallery and camera.
 6. *Thumbnail Gallery View:* Display of search results in a gallery for review at a glance.
 7. *Enlarged Thumbnail:* Magnify thumbnail to zoom into object of interest.
 8. *Closeup Clip:* Full-screen playback of closeup clip of object of interest.
 9. *Download Clip:* Download object's original video to device's gallery, enabling review of video at a later time or sharing with other interested parties.
- B. *Available Search Filters:*
1. *Source:* Filter objects from specific cameras.
 2. *Time Range:* Filter search criteria based on specific time ranges.
 3. *Class:*
 - a. *Class Categories:* People, Two-Wheeled Vehicles, Other Vehicles, Animals.
 - b. *People:* Man, Woman, Child.
 - c. *Two-Wheeled Vehicle:* Bicycle and Motorcycle.
 - d. *Other Vehicles:* Car, Pickup, Van, Truck, Bus, Train, Airplane, and Boat.
 - e. *Animals:* Animals moving in or through camera's field of view.
 4. *Color:* Identify objects according to any combination of Brown, Red, Orange, Yellow, Green, Lime, Cyan, Purple, Pink, White, Grey, and Black.
 5. *Face Recognition:*
 - a. *Search for Faces:* Identify people using digital images extracted from video or the mobile device gallery and camera.

- b. *View all Faces*: View all the faces that were detected in the video in a dedicated search gallery.

2.10. USER SETTINGS

- A. *Watchlists*: Provide management and sharing of scalable face recognition and license plate recognition watchlists:
 - 1. *Identities*: To maximize face match capabilities, provide watchlists with identity functionality whereby a collection of face images known to be of the same individual is utilized rather than just a single image. Search for people that are on a watchlist (Include mode) and for people that are not on a watchlist (Exclude mode).
 - 2. *License Plates*: To maximize license plate match capabilities, provide watchlists with license plate functionality including advanced search capabilities, including the use of wildcards and a Mismatches Allowed selector. Search for license plates that are on a watchlist (Include mode) and for license plates that are not on a watchlist (Exclude mode).
 - 3. *Face Image Quality*: Provide a three-level star-based ranking system for face images whereby ranks are assigned based on a combination of face detection, resolution, image quality, landmarks, and pose.
 - a. *Star Ratings*:
 - 1) *1-Star*: Faces that are not possible for AI to match well.
 - 2) *2-Star*: Faces that AI can match with medium confidence.
 - 3) *3-Star*: Faces that AI can match with high confidence.
 - b. *Use of Ratings*:
 - 1) In REVIEW module, allow 2-star and 3-star images to be added to filters. Do not allow 1-star images to be added.
 - 2) In RESPOND module, enable 3-star images to trigger alerts and disallow 1-star images from triggering alerts. By default, disallow 2-star images to trigger alerts; however, for high-sensitivity configurations, allow 2-star images to be set to trigger alerts.
- B. *Localization*: Provide settings to adjust user interface language, date and time display formats, measurement size values, and speed values.
 - 1. *Language Support*: Support the following languages: Arabic, Brazilian Portuguese, Chinese (Simplified), Chinese (Traditional), Danish, Dutch, English (default), Finnish, French, German, Italian, Japanese, Korean, Spanish (Latin American), Thai, Turkish, Ukrainian, and Vietnamese.
 - 2. *Date*: DD/MM/YY or MM/DD/YY (default).
 - 3. *Time*: 12h (default) or 24 hours.
 - 4. *Speed*: mi/h or km/h (default value is mi/h).
- C. *Data Protection*: Provide settings to allow data managers to view, export and delete data on individuals or vehicles that are stored in the systems. The Data Protection tab is enabled for users added by the administrator to the Data-Manager group.

2.11. USER DATA AND SECURITY

- A. *Users and User Groups*: Provide administrative functionality, both internal to 28 23 15 - Video Content Analytics Platform and via Microsoft Active Directory integration, for managing users and user groups as well as user and group permission assignments. Support single sign-on via SAML.
 - 1. *Concurrent User Licensing*: Limit total number of concurrent users to licensed user count.
 - 2. *Admin Application*: Provide web-based Admin application to set up either BriefCam or Microsoft Active Directory-registered users and groups.
 - 3. *Active Directory Integration*:
 - a. *User and Group Importation*: Provide for importation of users and user groups, automatically including sub-groups in data import, with configuration setting to specify maximum sub-group nesting level.
 - b. *Synchronization*: Provide manual and schedule synchronization of Active Directory user and group additions and removals.
 - 4. *Users and Groups*:
 - a. *Default User*: Provide Administrator default user for management of users' permissions and camera authorizations for all users.
 - b. *Additional Users*: Allow additional users to be created.
 - 1) *BriefCam Users*: Administrator user creates additional users.
 - 2) *AD-Imported Users*: Active Directory Administrator manages users and user groups in AD.
 - 3) *SAML Users*: SAML SSO authentication provider creates and manages users.
 - c. *Default User Groups*: Provide default user groups:
 - 1) *Data-Manager*: Provides access to user information.
 - 2) *Everyone*: Automatically created group containing all users.

- 3) *Research-Editors*: Provides access to RESEARCH Module in read-write mode.
- 4) *Research-Viewers*: Provides access to RESEARCH Module in read-only mode.
- 5. *Additional Groups*: Allow additional user groups to be created.
 - a. *Sharing*:
 - 1) Make cases, watchlists and rules sharable with other users.
 - 2) To facilitate sharing, present users with selection list of other users and user groups.
 - 3) Provide administrative capability to restrict which users other users can select for sharing.
- B. *User Data Storage*:
 - 1. *Database*: Password-protect database.
 - 2. *BriefCam Internal Users*:
 - a. Save usernames in plain text in database.
 - b. Store password hashes in database.
 - 3. *BriefCam Administrator User*:
 - a. Store password hash in database.
 - 4. *BriefCam AD Users*:
 - a. Save usernames in plain text.
 - b. Do not save passwords. Whenever user enters password check it against AD server in real time.
 - 5. *BriefCam SAML Users*:
 - a. Save usernames in plain text.
 - b. SAML users perform authentication process outside of platform and their authenticated identity is delivered to BriefCam as one-time token. There are no passwords provided to platform.
- C. *Password Hashing and VMS/AD Credentials*:
 - 1. *Password Hashing*: One-way hashing function according to RFC 2898 <https://www.ietf.org/rfc/rfc2898.txt>, using standard .NET framework implementation.
 - 2. *VMS and AD Credentials*: Encrypt credentials used by platform for VMS and AD authentication using standard symmetric Rijndael encryption implementation, provided by .NET framework, and store in database. Hard-code encryption keys in platform.

2.12. SYSTEM INTEGRATION

- A. *Existing VMS Integrations*: Integrations with products from the following companies.
 - 1. Avigilon.
 - 2. Axis Communications.
 - 3. Bosch Security Systems.
 - 4. CASD.
 - 5. Digifort.
 - 6. Digital Watchdog.
 - 7. Exacq.
 - 8. FLIR (formerly DVTel).
 - 9. Genetec.
 - 10. Geutebrück GmbH.
 - 11. IndigoVision.
 - 12. IPConfigure.
 - 13. ISS.
 - 14. LenelS2*.
 - 15. March Networks*.
 - 16. Milestone.
 - 17. NX (Network Optix).
 - 18. Panasonic i-PRO Sensing Solutions Corporation of America*.
 - 19. Pelco*.
 - 20. Qognify (formerly Nice, SeeTec/OnSSI).
 - 21. Salient.
 - 22. Synectics*.
 - 23. Teleste.
 - 24. Verint.

*This plug was developed by the VMS partner and certified by BriefCam.

- B. *System Integration Developer Tools*: Provide tools for expanding and adding additional system integrations capabilities via APIs.
 - 1. *BriefCam's Video Integration API (VIA)*: An HTTP RESTful request-based plug-in which enables third-party integration including real-time (RSTP) video ingestion.

2. *BriefCam Open API (BOA)*: Unified REST API allowing developers to deepen integration with third-party applications or introduce BriefCam platform functionality into their own applications. API includes:
 - a. Returning a list of all VMS cameras available to currently authenticated user.
 - b. Creating, reading, updating and deleting cases.
 - c. Retrieving case objects and metadata.
 - d. Exporting case report assets.
 - e. Creating, reading, updating and deleting watchlists, watchlist identities, and identities' images.
 - f. Matching either an object having a face or a watchlist against existing watchlists.
 - g. Acquiring platform's basic HealthCheck information response.
 - h. Initiating video processing by selecting cameras and time ranges, and to query processing status.
3. *Outbound API*: BriefCam Respond Outbound API enables integration of BriefCam alerts into third-party alerting infrastructure by issuing a generic RESTful call to third-party alerting custom endpoint with detailed information on alerting event, downloadable thumbnail, and downloadable video clip.
4. *System Events API*: *Whenever a new event is registered in the BriefCam Administrator Console, a message can be sent to a webhook provided by the user using BriefCam's System Events API.*

2.13. LOG FILES

- A. *Troubleshooting Logs*: Provide log files to facilitate troubleshooting.
 1. *Server-Related Log Files*:
 - a. *Log File Set*: Maintain auto rotating seven-day log file set, one log file per day of week.
 - b. *Log Granularity*: Maintain separate log file for each instance of module or service.
 - c. *Synopsis Requests*: Maintain a log file of synopsis requests.
 - d. *Log Archiving*: If log reaches 50 MB in size, automatically ZIP it into archive file and create new log file by same name. If there are five files, they will be automatically zipped into an archive. The log size and number of files are configurable.
 - e. *Security*: Log files should not store sensitive data, such as passwords and access tokens.
 - f. *Privilege*: Write logs with Administrator privilege.
- B. *Audit Logs*: Provide log of user activities in system.

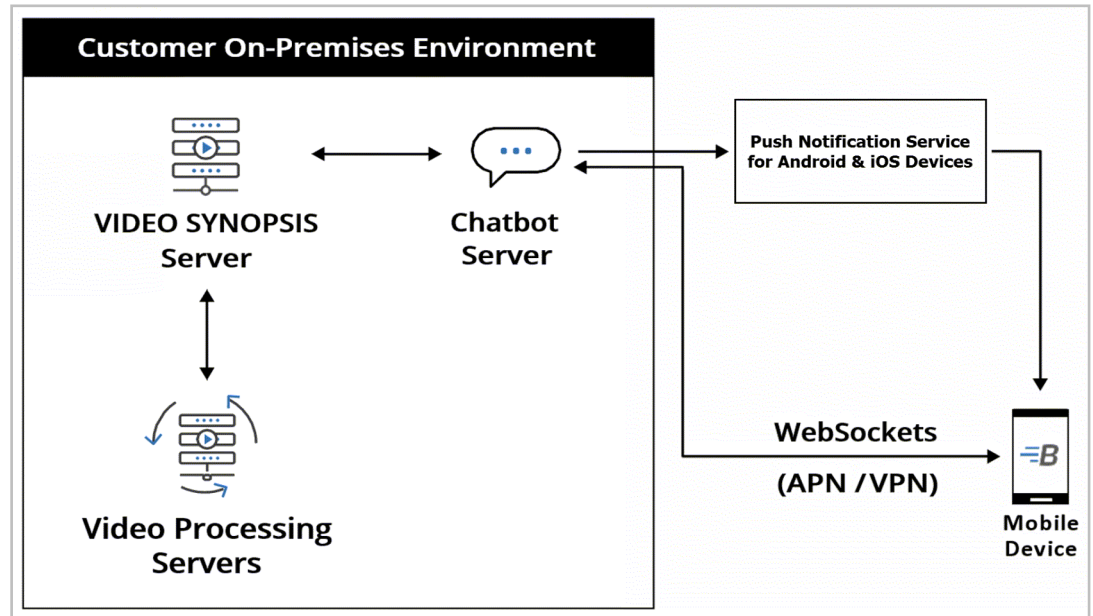
2.14. SYSTEM ARCHITECTURES

- A. *Physical System Architectures*: Provide physical system architectures to enable multiple scales and scopes of feature deployment:
 1. *All-in-One Architecture*: Single tower or rack-mount server.
 2. *Distributed Architecture*: Two or more servers.
- B. *Large Scale Deployment Architectures*: Provide the ability to support and handle large scale deployments:
 1. BriefCam can work with the following components:
 - a. MongoDB – MongoDB is a document-oriented NoSQL database that stores data in JSON-like documents with a dynamic schema. MongoDB can be used in large scale deployments to improve the performance and scalability.
 - b. RabbitMQ – RabbitMQ is recommended to use for large scale deployments to enhance the system's task queue management.
 2. Support clustering of multiple database instances together, so that in case of failure in the master database, an automated failover procedure will switch to using a replicated server.
 3. Support the deployment of multiple instances of web services behind a load balancer to serve a large number of users simultaneously. The load balancer will distribute the traffic efficiently and will enable both scaling and high availability.
- C. *Virtual System Architectures*: Provide virtual architectures to match end-customer preferred virtual deployment preferences:
 1. *Virtual Architecture*: Deployment on a virtual server or hyper-converged infrastructure platform whose allocated virtual resources match or exceed 28 23 15 - Video Content Analytics Platform's physical computing requirements.
 2. *Cloud Architecture*: Deployment in a cloud-based virtual environment having inbound network capacity to support required video stream ingestion.
- D. *Software Architecture*: Provide software architectures enabling granular scalability of system functionality in deployment. Provide software modules, server components and services, which may be run on a single server or on separate servers, depending on expected system workloads, as named and described below.
 1. *Software Modules*: Provide three key platform software modules:

- a. *REVIEW Module*: For after-the-fact forensic investigations.
- b. *RESPOND Module*: For real-time alerts and situational awareness.
- c. *RESEARCH Module*: For business intelligence and operational efficiency.
2. *Server Components*: Provide four key server service components:
 - a. *VS (Video Synopsis Server)*: Responsible for web, video streaming, data analytics and aggregation services, metadata database management, video file storage, load balancing, VMS plug-ins, and user management. Additionally, responsible for various maintenance and monitoring-related activities:
 - 1) Watchdogging Respond tasks in case of task failure.
 - 2) Creating new Respond tasks when rule is created or modified by user.
 - 3) Providing live image for Respond task configuration wizard.
 - 4) Providing list of cameras for Web Admin's Camera Activation dialog.
 - 5) Creating scheduled Research tasks.
 - 6) Sending outbound alerts to outbound API and sending alerts to VMS clients with real-time alerts integration.
 - 7) Triggering data maintenance activity.
 - 8) Clearing inactive sessions.
 - b. *RS (Research Server)*: Hosts advanced business intelligence platform for analysis of video sources and production of interactive quantitative dashboards tailored to users' business objectives.
 - c. *PS (Processing Server)*: Equipped with single or multiple GPU cards and responsible for on-demand video decoding, rendering, object extraction, and classification for processing (REVIEW and RESEARCH modules).
 - d. *APS (Alert Processing Server)*: Equipped with single or multiple GPU cards and responsible for real-time video processing (RESPOND and real-time RESEARCH).
3. *Service Components*: Provide key service components:
 - a. *Fetching Service*: Responsible for fetching the videos from the video management system (VMS).
 - b. *Filtering Service*: Responsible for handling in-memory object filtering for various scenarios in all modules.
 - c. *Face Recognition Service*: Responsible for monitoring the external watchlist folders for new face images. Also responsible for providing the aggregated status of uploaded face images for the web UI.
 - d. *Face Recognition Matching Service*: Responsible for comparing face queries to watchlists in order to find matches for filtering in the REVIEW module and for RESPOND alerts. The processing is done in-memory.
 - e. *LPR Matching Service*: Responsible for processing license plates to find matches for filtering in the REVIEW module and for RESPOND alerts.
 - f. *Rendering Service*: Responsible for generating visual and video artifacts for the web client, such as rendering the synopsis videos and visual layers, exports and original videos. Also responsible for Validating uploaded video files before processing.
 - g. *BI Rule Engine*: Responsible for preparing extracted objects' metadata for the BI engine.
 - h. *BI Face Recognition Service*: Responsible for advanced face matching functionalities used in the RESEARCH module.
 - i. *Notification Service*: Responsible for managing all aspects of notification and message delivery between the client application and the server side.
 - j. *Maintenance Service*: Responsible for running automatic maintenance processes.
4. *Mobile Device Application*: Provide a mobile device application (mobile app) with architecture as illustrated in Figure 10 below and functionality described below, to extend post-event video review investigation capabilities to field personnel.

- a. *Architecture:* Mobile app utilizes a Chatbot server component in addition to existing system VIDEO SYNOPSIS and Processing server components. Apple and Google push services are optional.
- b. *Component Functionality:*

Figure 10. Mobile Application



- 1) *Video Synopsis Server:* Responsible for web, video streaming, data analytics and aggregation services, metadata database, video file storage, load balancing, VMS plugins, and user management.
- 2) *Processing Server:* Responsible for video decoding, rendering, object extraction and classification. Comprised of single or multiple GPU cards. Multiple servers can be deployed per site depending on video processing requirements.
- 3) *Chatbot Server:* Responsible for textual search in natural language for INSIGHTS and PROTECT, by connecting to customer’s BriefCam on-premises deployment and automatically triggering processing when needed.
- 4) *Push Notification Services:* Optional component for delivering push notifications to devices, alerting users when new search results are available for review, even if mobile app is closed.

2.15. PRODUCT VARIATIONS

- A. To support typical scopes of end-user video deployment usage, offer Video Content Analytics Platform in several of variations, as described in Table 7 below.

Table 7. BriefCam Platform Variations

Variation	BriefCam Investigator	BriefCam Investigator for Teams	BriefCam Investigator , Cloud Edition	BriefCam Rapid Review	BriefCam Insights	BriefCam Protect
Video sources	File-based	File-based	File-based	VMS	VMS	File-based and VMS
Modules included	REVIEW	REVIEW	REVIEW	REVIEW	REVIEW, RESEARCH , RESPOND	REVIEW, RESEARCH , RESPOND
User count	Single-user	Multi-user	Multi-user	Multi-user	Multi-user	Multi-user

2.16. APPLIANCES

- A. To support simplified turn-key system deployment, provide two appliances:
 - 1. *Starter Kit Appliance*: Provide pre-configured REVIEW module appliance on BriefCam-certified hardware that can be deployed in less than five minutes including seamless integration for supported deployed VMS software.
 - 2. *Investigator Appliance*: Provide pre-configured REVIEW module appliance for file-based video sources.

2.17. HARDWARE AND DEPLOYMENT SIZING

- A. *Compute Power and Storage*: Size hardware according to per average usage requirements.
 - 1. *Computing Power*: Determine required computing power based on concurrent real-time processing volumes and the number of hours of video footage to be processed per hour.
 - 2. *Storage Space*: Determine required storage space based on expected overall number of videos, as well as metadata and video asset retention periods.

2.18. GPU SUPPORT

- A. *Certified GPUs*:
 - 1. Tesla P4 8GB
 - 2. Tesla T4 16GB
 - 3. Quadro RTX 4000 8GB
 - 4. Quadro P4000 8GB
 - 5. GeForce GTX1070 8GB
 - 6. GeForce GTX1080 8GB
 - 7. GeForce GTX1080Ti 11GB
- B. *Supported GPUs*:
 - 1. Tesla P40 24GB
 - 2. Tesla P100 12GB and 16GB
 - 3. Tesla V100 16 and 32GB
 - 4. Quadro P5000 16GB
 - 5. GeForce RTX 2070 8GB
- C. *Unsupported GPUs*: Intel, AMD or any other non-NVIDIA GPUs are not supported at this time.
- D. *GPU Use Restriction*: BriefCam does not support using more than one type of GPU on the same machine.

2.19. LICENSING

- A. *System Licensing*: Provide per-camera licensing according to specific variant: Investigator (single user or multi-user), Insights, or Protect. Provide user licensing based on the number of concurrent users. For specific variants, provide expansion licenses to increase number of:
 - 1. Concurrent users.
 - 2. RESEARCH users: by default, provide one Editor user, who has full privileges, and four Viewer users, who have read-only privileges.
 - 3. Camera channels.
 - 4. RESPOND real-time camera channels.

PART 3 - EXECUTION**3.1. INSTALLATION**

- A. The contractor shall install all proposed software and hardware in accordance with manufacturers' instructions.

3.2. PROJECT CLOSE-OUT

- A. Contractor shall test and verify that provided software and hardware are operating according to contract documents and specifications.

3.3. COMMISSIONING

- A. *Commissioning Procedure*.
 - 1. Owner's representative shall witness Commissioning procedure.
 - 2. Contractor shall conduct Commissioning procedure.

3. Commissioning procedure shall consist of demonstration of full system functionality as Owner intends to use it.

3.4. SYSTEM ACCEPTANCE

- A. As a requirement of Owner acceptance, Commissioning procedure shall be completed and documented.
- B. Warranty coverage shall not begin until Commissioning documentation has been accepted by Owner.

END OF SECTION 282315

SECTION 282400 - GYMNASIUM AUDIO SYSTEM, LED MOTION VIDEO BOARDS, LED SCORER'S TABLE, AND LOCKER ROOM GAME CLOCKS

PART 1 - GENERAL

1.1 PROJECT INFORMATION

- A. Abbreviations - Definitions:
1. (AVC) – Audio Video Contractor
 2. (EC) – Electrical Contractor
 3. (GC) – General Contractor
- B. Provisions:
1. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-1 Specification sections, apply to work of this section.
 2. It is understood and agreed by the Audio-Video Contractor (AVC), that the work herein described shall be complete in every detail to supply, install and integrate a totally functional AV system per these specifications.
 3. It is hereby understood and agreed that verbal only communication is not sufficient. Emails and hard paper documents, faxes, mail, transmittals, etc. will be utilized for project communication of any type.
 4. The AV Consultant or Owner reserves the right to substitute new products which become available provided that:
 - a. The (AVC) has not yet purchased the specified equipment.
 - b. The substitute equipment shall not increase the (AVC) cost.
 5. Requests for AV specification or drawing clarification shall be made, in writing or via email, not later than (10) days prior to the bid date.
 6. All materials and equipment shall be fully insured against loss or damage up until final acceptance of the system by the Owner or until Owner relieves the Contractor in writing of this responsibility.
- C. Typical Audio-Video Contractor (AVC) Scope & Requirements:
1. At a minimum, the Audio-Video Contractor (AVC) shall be responsible for the following system scope requirements and the installation/integration there of:
 - a. Engineering, Verification of Site Working Conditions, Dimensions, etc.
 - b. Electronic (AVC) PDF Submittals & PDF (AVC) System Shop Drawings.
 - c. New (AVC) Equipment & Low Voltage Cable, (Per Specifications).
 - d. Complete Installation of all (AVC) Equipment and Low Voltage Cable.
 - e. Integration and Programming of all (AVC) Equipment & Control Devices.
 - f. (AVC) Cable and Device Labeling, (Per Specifications).
 - g. Coordination as required with other appropriate Contractors or Trades.
 - h. Power Sequencing via Low Voltage Control, Remote Controls, etc.
 - i. Field Confirmation & Coordination of Complete LV Conduit System.
 - j. Scheduling and Sequencing with the General and Electrical Contractor.
 - k. 5:1 Safety Rigging/Overhead Suspension, Structural Stamped Drawing.
 - l. Audio Network, Dante, AES50, Network Switches, Fiber, Programming.
 - m. Installation of Speaker Suspension Beam Clamps, Uni-Strut, Nuts, Bolts, etc.
 - n. Custom Steel Brackets, Welding, etc.
 - o. Rental Equipment as Required.
 - p. Highly Experienced Specialized Manpower and Site Supervision.
 - q. Fire Alarm Interrupt/Shut Down (AVC) System Interface.
 - r. Daily Cleanup of Boxes, Packing Materials, Surplus Debris Discard.
 - s. Site Safety Directives and Jobsite Meetings.
 - t. Testing, Inspection, Alignment, and Final Adjustments.
 - u. Demonstration - (16 Hrs.) Training, Video and Operational Instructions.
 - v. Built Drawings and Closeout Documents.
 - w. Contractor to furnish and install pre-approved Uni-Strut Frame/Devices or Factory Made Speaker Manufacturer Devices for the speaker suspension.
- D. Code & Regulation Requirements:
1. All equipment shall be UL and or CE listed and shall comply with the National Electrical Code or equivalent authority. All applicable regulations of serving utilities and governmental bodies having jurisdiction shall also apply.
 2. All required Federal, State, County, City license and permits shall be provided as required by law.

1.2 BID PROPOSAL - PRICE

GYMNASIUM AUDIO SYSTEM, LED MOTION VIDEO BOARDS, LED SCORER'S TABLE, AND LOCKER ROOM GAME CLOCKS

282400 - 1

A. Instructions to Bidders:

1. Carefully examine the contract documents and the construction site (if applicable) to obtain first-hand knowledge of any existing conditions. The (AVC) will not be given extra payments for conditions which can be determined by examining documents or site and will not be relieved of any obligations with respect to bid.
2. By submitting a bid the proposing (AVC) indicates that he has studied the contract documents, the (AVC) system drawings and specifications, and is in agreement that the specified system is a functional and fully operable system for the owner. It is the responsibility of the (AVC) to supply systems in full working order and furnish all minor equipment or any items needed for a complete system even if not specifically mentioned in these specifications or in the associated drawings without claim for additional payment. Notify the owner of any discrepancies in part numbers or quantities before bid. Failing to provide such notification, supply items and quantities according to the intent of the specification and drawings, without claim for additional payment.
3. Submit a Bid Proposal - Price to the appropriate designated contractor for this section of work, including all equipment as specified, complete installation and integration labor, applicable taxes, fees, licenses, shipping charges, freight, rental equipment, engineering, programming of any kind, per diem, travel expenses, bonding, special needs, work by others to be included in the bid price, etc.

1.3 SUBSTITUTIONS

A. Procedure:

1. To obtain prior pre-approval for substitutions of items identified as "or pre-approved equal", submit written requests at least 10 days before the bid date. Requests received after this time will not be considered. Requests shall clearly describe the product for which approval is asked, including all data necessary to demonstrate acceptability. In some cases, a physical demonstration may be required for surety. Be advised that the consultant has specified products which he feels best represents the quality level of the (AVC) system desired by the owner. This is not an effort to sole source any particular product line, but is a simple effort to guarantee specific functionality and desired operational performance from a professional quality (AVC) system.
2. Alternative pre-approved manufacturers are also listed with each product below. It is still however a requirement by the (AVC) to submit a proposed model by the listed pre-approved manufacturer for approval – should the (AVC) desire to use a different piece of equipment. Reasonable product comparisons and functionality research should be utilized in choosing this alternative for pre-approval submission.
3. Verify with manufacturers availability and cost of all equipment proposed, including equipment specified herein. No cost increases will be allowed for manufacturers' cost increases, or for substitutions required because of unavailability of proposed equipment.

1.4 CONTRACTOR EXPERIENCE

A. Qualifications:

1. The (AVC) or a project staff member shall be a specialist in the field of Audio Video Control System installations for a minimum period of 5 years.
2. The (AVC) installation team office shall be located a maximum of 150 miles from the project site.
3. The (AVC) or a project manager shall have completed a minimum of (4) like systems in the past 3 years.
4. The (AVC) shall have been an authorized dealer or representative of the major manufacturers listed in this specification for a minimum of (1) year.
5. The right is reserved by the Owner, Architect, Electrical Engineer or Consultant to inspect previous equipment or systems as furnished or installed by the proposing (AVC). In addition, the right is reserved to reject a (AVC) who has failed in any respect to comply with the provisions of previous contracts.
6. The Owner, Architect, Electrical Engineer or Consultant shall be the final judge of suitability of experience.

1.5 WORK BY OTHERS (NOT INCLUDED) IN THIS (AVC) BID PROPOSAL – PRICE

A. Work Statement:

1. Electrical Contractor to supply & install all applicable power conduit, low voltage conduit, AC power, screw cover back boxes – recessed or flush mounted, ceiling back boxes of any kind, speaker back-cans furnished by the (AVC) standard back boxes, pull strings, cable tray, etc.
2. The Electrical Contractor shall supply and install any required fire alarm interrupt relay or interface as required to the RK1 location.
3. Electrical Contractor shall install the AV floor box furnished by the (AVC).

4. General Contractor to provide and install all applicable structural steel support, welding or special attachment, modifications for speaker suspension beyond typical speaker rigging, if required, etc.
5. General Contractor to provide and install all applicable structural steel support, welding or special attachment, modifications for both Large Wall Mounted LED Video Boards, one on each end of the gymnasium.

1.7 COORDINATION ITEMS WITH OTHERS:

- A. Assistive Information Requirements:
 1. The (AVC) shall assist the Owner, Architect, General Contractor or Electrical Contractor in “finalizing device locations”, dimensions, speaker locations, floor and wall box locations, etc.
 2. Submit Shop Drawings with dimensioned details as required for any of the above items per Section 1.7 below.

1.8 MISCELLANEOUS REQUIREMENTS

- A. Jobsite:
 1. Safety Meeting Attendance as required.
 2. Construction Meeting Attendance as required.
 3. Project Gantt, Microsoft Project, Schedule or other Timeline Charts as required to the General Contractor, Electrical Contractor, etc.
 4. All other jobsite provisions as required or stated in the general provisions of the contract.
- B. Communication Regarding Any Potential (AVC) Project Issue:
 1. Photographs with Dates, email narratives, etc. of potential problem construction areas, issues, or concerns shall be submitted to the immediate supervising project manager via email or RFI.

1.9 SUBMITTALS

- A. Data:
 - (1) PDF File including Data and Specification Sheets on All (AVC) Equipment with the following information:
 - a. Title Page - (AVC) Company Logo, Date, Project Name, Description, Address, Phone Number, Email Address.
 - b. Architect Name, Address, Phone Number, Project Manager Name, Phone Number, Email Address.
 - c. Electrical Engineer Company Name, Address, Phone Number, Project Manager Name, Phone Number, Email Address.
 - d. (AVC) Company Name, Address, Phone Number, Project Manager Name, Phone Number, Email Address.
 - e. 1st Page – Itemized Equipment List with Quantities, Model Number and Manufacturer Description.
 - f. Consecutive Pages – Specification Sheets (highlighted with yellow marker to note pertinent information, colors, model numbers, etc).
 - (1) PDF File of Autocad Single Line Drawings, Lucid Chart Single Line Drawings, or Intaglio Single Line Drawings including the following minimum information:
 - a. Title Page with Table of Contents
 - b. Legend - Connectivity Page
 - c. Floor Plan Pages – Device Locations
 - d. Reflected Ceiling Plan Pages – Device Locations
 - e. Single Line Drawings – Audio
 - f. Single Line Drawings – Video
 - g. Single Line Drawings – Control with Touchscreen Function Narrative
 - h. Custom Plates/Panels – Detail Each to Scale – Consecutive Number
 - i. Floor and Wall Box Details
 - j. Speakers and Rigging Details
 - k. Projection Screen Elevations, Dimensions and Rigging Details
 - l. Projector Throw Distances to Screens
 - m. Misc. Mounting and Other Custom Details As Required
 - n. Rack Elevations, Control Booth Elevations with Stated Devices

PART 2 - (AVC) PRODUCTS

2.1 - (AVC) SYSTEM EQUIPMENT LIST

- A. General:

1. Major Quantities of (AVC) equipment are indicated in specifications to follow. Include any and all ancillary (AVC) equipment/parts not stated in this specification to provide the owner with complete installed (AVC) systems.
2. Refer to auxiliary electrical drawings for (AVC) device locations and quantity information.
3. Should the (AVC) desires to submit an alternative (AVC) product for pre-approval, the acceptable equipment manufacturers are also stated below under each specified device.

B. *Gymnasium* (AVC) Base Bid Equipment List with Major AVC Equipment Quantities:

QTY.	MODEL #	DESCRIPTION
<u>GYMNASIUM SOUND SYSTEM</u>		
8	CBR15	YAMAHA 15" SPEAKER (S1)
2	CBR12	YAMAHA 12" SPEAKER (GYM FLOOR DOWNFILL) (S2)
10	AS REQUIRED	SPEAKER FLY- SUSPENSION HARDWARE
1	TF RACK	YAMAHA DSP MIXER
1	MUQW2LL/A	APPLE IPAD MINI
1	UAG-IPDM4-BLK-VP	URBAN ARMOR CASE
3	PX10	YAMAHA POWER AMPLIFIER
1	EA6340	LINKSYS ROUTER
1	CAT6-10B	PEARSTONE CAT6 CABLE
1	ND8006	MARANTZ MEDIA PLAYER
1	BLX24R/SM58	SHURE WIRELESS HANDHELD SYSTEM
1	813	WEST PENN RG58 / 50-OHM COAX
1	DFINB	RF VENUE EXTERNAL ANTENNA
2	454	WEST PENN WIRE
1	FL-600P-BLK-C	FSR FLOOR BOX (HOME SIDE ONLY)
1	FL-600P-6-B	FSR BACKBOX (HOME SIDE ONLY)
1	DB-CIJ3	RDL LINE LEVEL TRANSFORMER INTERFACE MODULE @ FB1
2	DB-XLR2F	RDL DUAL XLR FEMALE
1	DB-XLR2M	RDL DUAL XLR MALE
1	EREN-27E	AURAY EQUIPMENT RACK
1	CQ1520	JUICE GOOSE POWER SEQ WITH FIRE ALARM CONTACT (AT RACK)
1	RM-DC1	JUICE GOOSE POWER RELAY FOR FIRE ALARM
2	CQ2200	JUICE GOOSE SPEAKER POWER SEQ. UNITS
2	TT-ISO	AURAY MICROPHONE DESKTOP STANDS
2	MS5230F	AURAY BOOM STAND
4	SM58S	SHURE ANNOUNCE MICROPHONE
4	AT-8314-30	AUDIO TECHNICA CABLE
2	SMYC-2RM20	PEARSTONE STEREO RCA TO 1/8" MINI TRS
1	ALD 800/AA	NADY ASSISTIVE LISTENING SYSTEM (FREQ CC: 72.5)
1	RD-L-2U	AURAY 2 RU STORAGE DRAWER
1	MISC.	HARDWARE/CONNECTORS/PANELS/RACK SHELVES/SCREWS/RAILS, ETC.
<u>LED MOTION VIDEO BOARDS X 2</u>		
2	1488704/2108554.0	WATCHFIRE INDOOR 3.9MM LED RGB VIDEO DISPLAY (5.5.06IN X 8FT. 8.43IN L X 3.52IN D) (800 NITS) PIXEL PITCH: INDOOR03.9MM LED RGB PIXEL MATRIX (HXW): 384 X 640 CABINET SIZE: 5FT 5.06IN H X 8FT 8.43IN L X 3.52IN D VIEWING AREA (HXW): 1500MM X 2500MM CABINET STYLE: SINGLE FACE SIGNPAK
4 - 282400		GYMNASIUM AUDIO SYSTEM, SCOREBOARDS, VIDEO DISPLAY, AND LOCKER ROOM CLOCKS

APPROX. WEIGHT: 248.00 LBS.
 WARRANTY: STANDARD 5 YEAR WATCHFIRE WARRANTY APPLIES.
 MFG. LEAD TIME: 6-8 WEEKS (AFTER THIS DOCUMENT IS SIGNED & RETURNED AND RECEIPT OF DOWN PAYMENT).
 ELECTRICAL SERVICE: REFER TO THE INSTALLATION MANUAL FOR DETAILS ON WIRING.
 BRIGHTNESS 800 NITS MAXIMUM
 COLOR LED SMD 3-IN-1
 ENERGY-CONSCIOUS LED USE OPTIONAL SIGN BRIGHTNESS ADJUSTMENT TO RUN SIGN AT LESS THAN 800 NITS
 VIDEO UP TO 60FPS
 VIEWING ANGLES 160 HORIZONTAL/160 VERTICAL
 DATA REDUNDANCY NOT REQUIRED
 VIRTUAL SCORING INTERFACE NOT REQUIRED
 DATA CONNECTION CUSTOMER SUPPLIED ETHERNET (LESS THAN 300FT)
 CONTENT SOURCES SINGLE HDMI
 CONTENT PLAYER IGNITE SPORTS (WITH LIVE VIDEO INPUT)
 FACE PROTECTION NONE
 HORN INCLUDED
 BORDERS 3" EXTRUSION
 ASSEMBLY KIT 5X8 S READYDISPLAY
 DISPLAY MOUNTING MODULAR WALL FRAMES
 IGNITE SPORTS ACCESSORIES WIRELESS TABLET
 SOFTWARE TRAINING WEB BASED SOFTWARE TRAINING
 CONTENT SCALER NOT REQUIRED
 MOUNTING SURFACE CONCRETE BLOCK (CMU)
 TECHNICIAN ON-SITE DURING INSTALLATION
 SPARE PARTS KIT 3.9 5X8

2	AS REQUIRED	CAT6 ETHERNET CONNECTION FROM FLOOR BOX to "SB"
1	AS REQUIRED	INSTALLATION
1	CR2024 (CONFIRM COLOR @ SUBMITTAL)	AVFI ROLLING RACK STATION FOR IGNITE SPORTS PC, ETC.
1	RS1215RA	TRIPPLITE RACK MOUNT POWER STRIP
1	RD-L-2U	AURAY 2 RU STORAGE DRAWER

SCORERS TABLE X 1

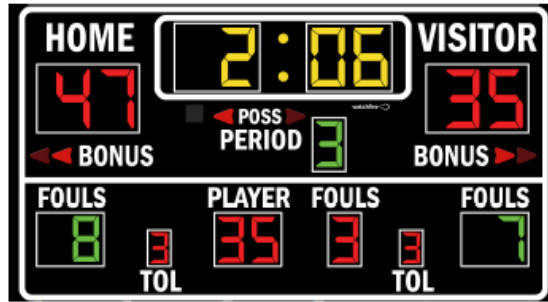
1	CST-1004	WATCHFIRE OUTDOOR 15" 4 DIGIT CLOCK - REAR VENTILATION (4mm) (39 9/16" H X 118" L X 39 3/8" D W 18") INCLUDES IGNITE SPORTS & CONTROLLER INSTALLATION
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LOCKER ROOM GAME CLOCKS X 4

4	8IN H X 22IN L X 4IN D <i>(PROVIDE WITH (2) WIRELESS TRANSMITTERS AS SHOWN ON PLANS "TX")</i>	WATCHFIRE LOCKER ROOM GAME CLOCKS CABINET SIZE: 8IN H X 22IN L X 4IN D APPROX. WEIGHT: 15.00 LBS. WARRANTY: STANDARD 5 YEAR WATCHFIRE WARRANTY APPLIES. MFG. LEAD TIME: 4-8 WEEKS ELECTRICAL SERVICE: 120 VOLT, 16 WATTS, 2-WIRE AND GROUND
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- CABINET COLOR BLACK (STANDARD)
- LED DIGIT COLOR STANDARD LAYOUT
- SCOREBOARD CONTROLLER NOT ORDERED/NOT NEEDED (WIRELESS, ONE DISPLAY)
- CAPTION COLOR BLACK OR WHITE
- CONTROLLER CASE NOT INCLUDED
- HAND SWITCHES/CONTROLLERS C-15
- WARRANTY STANDARD 5-YEAR PARTS WARRANTY

TYPICAL SCOREBOARD LAYOUT:



TYPICAL LOCKER ROOM CLOCK LAYOUT:



ADVERTISEMENT VIDEO DISPLAY:

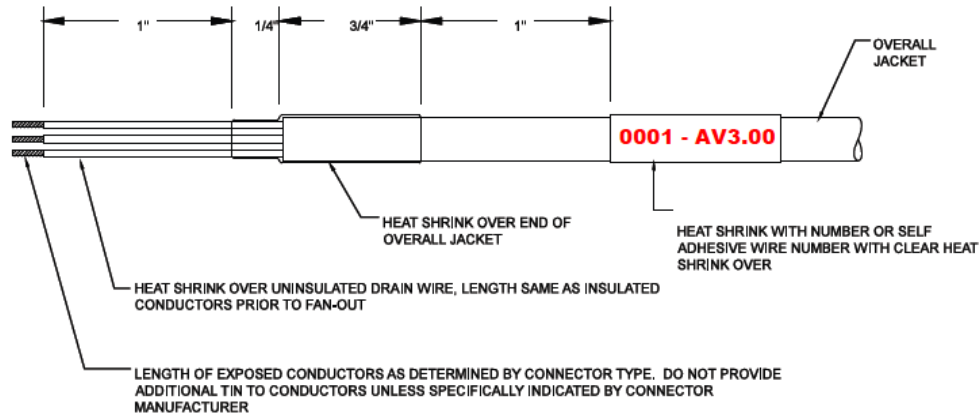


PART 3 - INSTALLATION

3.1 EXECUTION

- A. Project Worksite Staffing:
 - 1. The job must be adequately staffed at all times. Unless circumstances beyond the control of the (AVC) occur, the same on-site individual shall be in charge throughout.
- B. Wire and Cable Installation:
 - 1. All (AVC) wire and cable pulls of any kind shall be continuous - without splices - unless a designated termination point is shown on the design drawings.
 - 2. All (AVC) wire and cable shall be segregated as follows in their respective conduit systems:
 - a. Mic Level (less than -20 dBm)
 - b. Line Level, Intercom (-20dBm to +30 dBm)
 - c. Video Level, Control, Fiber
 - d. Speaker Level (more than +30 dBm)
 - 3. Do not pull (AVC) wire or cable through any box fitting or enclosure where change of raceway alignment or direction occurs. Do not bend conductors to less than recommended radius. Employ temporary guides, sheaves, rollers and other necessary items to protect cables from excess installation.

4. Provide (AVC) wire pulling lubricants and pulling tensions strictly in accordance with the wire and cable manufacturers' recommendations.
 5. Each (AVC) cable that breaks out from a harness for termination to a device shall be provided with an ample service loop. Provide ample service loops at all other terminations so that plates, panels and equipment can be de-mounted for service and inspection.
 6. Neatly comb and lace all (AVC) cabling utilizing appropriate "Black" cable ties. All cable ties shall be trimmed with a cable tie gun and free from burrs or sharp edges.
 7. Separate (AVC) wiring of differing classifications by at least four (4) inches wherever possible. Wherever lines of differing classification must come closer together than four (4) inches, cross them perpendicular to each other.
 8. Use only Balanced (AVC) Signal Circuits throughout the entire (AVC) system. It is permissible to utilize unbalanced circuits for certain systems or locations with Hi-Fi CD Players, DVD Players, etc. Refer to design drawings.
 9. Under No Circumstances shall the "shield" from any (AVC) wire or cable be cut off and discarded. It shall be dressed, terminated and secured as required.
 10. Every device with low voltage wiring interconnect shall be installed with regard for proper polarity. Absolute polarity shall be maintained through the entire system.
- C. (AVC) Wire and Cable Dressing – Labeling:
1. Label all permanently installed (AVC) wires on both ends with accepted Permanent Heat-Shrink labels, Panduit labels, (either direct hot-stamped or permanently printed heat-shrink labels or self-adhesive wire numbers).
 2. (AVC) Wire and Cable Labeling Scheme as Follows:



- D. Equipment Labeling:
1. Custom receptacles, plates and panels shall be engraved per drawings using 1/8" engraved lettering filled with contrasting paint unless otherwise specified.
 2. Label all portable equipment with engraved block letters using initials and/or text. Label all portable cables similarly with printed heat-shrinkable tags located 12 inches from the male connector end.
 3. Provide self-adhesive dots to all normally user-adjustable front-panel controls to indicate their nominal settings. Controls on mainframe modules shall be marked on the appropriate internal labels.
- E. Connections:
1. Make connections using 60/40 Rosin-Core solder or accepted mechanical connectors. Utilize a temperature controlled soldering station where possible.
 2. Soldering workmanship standards NASA-STD-8739.3 and NASA-STD-8739.4 are recommended references for proper soldering and cable termination, see <http://nepp.nasa.gov/>.
 3. For coaxial or D type pin connectors, use crimping tools, which are specifically designed for the application. The presence of non-accepted crimping tools in the Contractor's shop or on the job-site shall constitute prima-facie evidence of improper crimp-type connections, and may result in all crimp-type connections being redone.
 4. Use insulated spade lugs or fork terminals on all screw terminals. The following manufacturers are acceptable. See design drawings for additional direction.
 - a. Amp
 - b. Hubbell
 - c. Molex
 - d. IDEC

- e. Entelec
 - f. Wago
5. Acceptable Manufacturers and Connectors (where applicable):
 - a. Switchcraft AAA Series, R Series, EH Series, HPC Series, E Series, etc.
 - b. Neutrik X Series, XX Series, DL Series, SPX Series, FC Series, STX Series, NL Series, C Series, PX Series, Powercon, etc.
 - c. Hosa REAN
 - d. Whirlwind
 - e. Canare
 - f. Kings
 - g. ADC
 - h. Ramlatch
 - i. Gepco
 - j. Extron
 - k. West Penn
 - l. Bittree
 - m. Amphenol
 - n. Conxall
 - o. LEX
 - p. Hubbell
 - q. Rapco/Horizon
 - r. ProCo
 6. All Connectors shall have "silver or nickel" pins or sockets as a minimum level of quality. Specific details are provided on all (AVC) wall plates and panels, etc.
 7. All 70V type speaker connections shall utilize WAGO Lever Nuts for splicing connections as required.
- F. Equipment Racks:
1. When possible, pre-assemble and test all racks before delivery to the job site.
 2. Provide adequate ventilation in racks to maintain in-rack temperatures of less than 100 degrees F. If required, provide accepted ventilation fans.
 3. Provide and install sized appropriately Middle Atlantic or Raxxess Rear Rack Rails for each rack.
 4. Use Middle Atlantic EB Series or Raxxess EFG flanged blank panels where applicable for unused spaces.
 5. Use Middle Atlantic EVT or Raxxess EVP slotted vent panels where applicable for unused spaces.
 6. Use Middle Atlantic HP or Raxxess PPSW rack screws.
 7. Provide distribution of electrical power within the A/V equipment rack as shown on drawings and/or stated on the equipment list.
 8. Use rubber grommets around cut-outs and knock-outs where conduit or chase nipples are not installed.
 9. Supply and install any brackets, braces, velcro or misc. supports where necessary.
 10. Utilize rear rack rail "L-Shape Slotted Lacing Bars" where applicable for crossing cabling and combing.
 11. Provide Rear Rack Back Planes to electrical contractors at rough-in when Middle Atlantic SR Series Racks are utilized.
 12. Bond to the building grounding system with #4 cu green stranded cable. Provide internal rack ground bus.
 13. Provide appropriately sized Middle Atlantic or Raxxess rack mounted shelves as required for misc. device mounting in the front or rear of the rack.
- G. Overhead Rigging:
1. All overhead rigging shall be performed by qualified and insured personnel.
 2. Overhead suspension systems shall conform to a 7:1 Safety Ratio.
 3. All overhead rigging shall use qualified "drop forged" graded materials.
 4. All shackle pins and turnbuckles shall be "moused".
 5. All nuts shall be of a locking type. No jam nuts are to be used.
 6. Thimbles shall be used on all wire rope eyes.
 7. Suspended items shall have a "Gripple" safety cable as a means of secondary support and shall be considered an emergency fail secure device.
 8. Crosby Products is the preferred rigging product line.

PART 4 - TESTING

4.1 REQUIREMENTS

- A. Procedure
1. Provide the following information in PDF form to the Project Electrical Engineer for review - prior to submitting close out documents.
 2. Submit electronically via email in the following format:

- a. Title Page - (AVC) Company Logo, Date, Project Name, Description, Address, Phone Number, Email Address.
 - b. Architect Name, Address, Phone Number, Project Manager Name, Phone Number, Email Address.
 - c. Electrical Engineer Company Name, Address, Phone Number, Project Manager Name, Phone Number, Email Address.
 - d. (AVC) Company Name, Address, Phone Number, Project Manager Name, Phone Number, Email Address.
 - e. 1st Page – Excel Spreadsheet illustrating testing results as follows.
 - * Item Number
 - * Origination Point
 - * Final Termination Point
 - * Cable Type (Microphone, Line, Intercom, Etc.)
 - * Cable Number
 - * Impedance
 - * Polarity + or –
 - * DC Resistance to Ground Each Speaker Leg
 - * Sine Wave Sweep / Buzzes – Rattles? Yes or No
 - * Continuity Test
 - * UTP/FTP – Pass or Fail
 - f. Consecutive Pages – Continued as required.
- B. Speakers & Speaker Cabling:
1. For passive speakers, run an impedance sweep on all speakers recording the readings at 1000Hz.
 2. Utilizing a Galaxy Cricket, check for correct speaker wiring polarity for each speaker.
 3. Utilizing a Fluke Ohm meter, measure the resistance from each speaker conductor leg to earth ground.
 4. Confirm that loudspeakers and mountings are free of buzzes and rattles when the speaker is swept with sine wave tones over its rated bandwidth at one-half (1/2) its maximum rated power.
 5. For all internally amplified speakers, if available, provide a systems self-test report.
 6. Provide PDF documented results for the above.
- C. Microphone, Line and Intercom Cabling:
1. Provide a cable polarity and continuity test on each system microphone, intercom or line cable utilizing an EBtech CZ Tester.
 2. Provide PDF documented results for the above.
- D. CAT5e, CAT6 UTP and FTP Cabling Verification:
1. Provide a UTP Cable Certification Tester such as manufactured by Fluke, Tektronix, Byte Brothers, Platinum, etc.
 2. Certification Testing Device – Minimum Capabilities of Tester:
 - a. Wire-mapping Test – T568B – Each Pair
 - b. TDR - Reflectometer Length Test
 - c. Attenuation
 - d. Crosstalk (NEXT)
 - e. Gigabit Power-sum (NEXT)
 - f. Propagation Delay
 - g. Return Loss
 3. Pass – Fail Response: Enter Result
 4. Provide PDF documented results for the above.

PART 5 - TRAINING, SYSTEM DEMONSTRATION & EVENT ATTENDANCE

5.1 REQUIREMENTS

- A. Attendance:
 1. Provide a Sign-In Sheet of all Owner Provided Attendees to the (AVC) System Training and System Demonstration. Include Date, Phone Numbers, Emails, Department Locations and Names.
- B. Training Time Required:
 1. (16 Hours) - Specifically Addressing the Following Items Below with Training and System Demonstration.
- C. Locations and Points of Direction:
 1. Control Booth:
 - a. Power Sequencing and Control.
 - b. XLR Patch Panel Cross Connecting.
 - c. Digital Mixer Fader Level Control, Muting, Creating Mute Groups, Creating and Recalling Presets, Naming Presets, USB Flash Drive Storage, External Drive Recording, Input Gain and Output Gain

- Stages and Structure, Auxiliaries, Sub-Woofer Level Control, General Mixing Operation, Effects, etc.
- d. Media Playback and Record Devices.
- e. (NOM) Number of Open Microphones Gain Structure Control.
- f. Wireless Microphone Operation and Battery Support.
- g. Loose Gear Inventory.
- h. Misc. Cables and Connections.
- i. IPAD, iPhone or Other Media Playback Device Interfacing.
- j. IPAD Mix Control APP.
- k. Power Sequencing.
- 2. Stage:
 - a. Stage Floor and Wall Box Connectivity.
 - b. Microphone Cables and Connections.
 - c. Direct Box Connectivity.
 - d. Microphone Types and Techniques.
 - e. Amplifier Rack.
 - f. Speakers, Floor Monitors.
 - g. Tie Line Patching.
 - h. Cross Connections as Required.
 - i. Monitor Mix Control APP.
 - j. Power Sequencing.
- D. Operational Burn-In and Owner Demonstration:
 - 1. Provide media source playback material as desired of different music genre.
 - 2. Demonstrate system functionality and points of capability.
- E. Recommended Software and Reading Material to the Owner (If Desired) at an Additional Cost:
 - 1. Stage Plot Pro Software
 - 2. Yamaha Sound Reinforcement Handbook
 - 3. Studio Six Digital "Audio Tools" APP

PART 6 - WARRANTY/SERVICE

6.1 SUPPORT

- A. Warranty:
 - 1. The (AVC) shall supply the owner with a (1) Year Installation Warranty from the written date of substantial completion or system first use by the owner; whichever comes first. These items shall be provided in the form of a "Signed Warranty Certificate" and included as a PDF on the project close out documentation.
 - 2. The (AVC) equipment warranty from each (AVC) manufacturer shall be in effect for each full respective term from the factory.
 - 3. In the event that an equipment failure takes place after the 1 year installation warranty has expired (but yet the manufacturer equipment warranty is still in effect), the owner shall pay the (AVC) their typical service rate to remove, pickup and return the failed device to the manufacturer for repair and then back again.
 - 4. In the event the owner has purchased a 2nd year installation warranty service agreement, disregard item #3 above.
 - 5. Provide a (6) month and (1) year general checkup on the system. Schedule as required.
- B. Emergency Service:
 - 1. Contractor shall provide emergency service and support 24 hours a day - 7 days a week. This service is intended as emergency response to failures or problems that require immediate help from a qualified systems technician. This emergency service must include a return call from a qualified systems technician within 2 hours. This emergency service must also provide an on-site visit from a qualified systems technician within 12 hours of the initial phone call, should it be deemed necessary by both parties to resolve the service issue. This emergency service and support shall be made available throughout the warranty period at no additional charge to the owner.

PART 7 - PROJECT CLOSE-OUT

7.1 PROCEDURE

- A. Punch List:
 - 1. The (AVC) shall confirm that any and all punch list items have been addressed and completed with the Awarding Contractor and/or Electrical Engineer.
 - 2. The (AVC) shall provide the following Close Out Documents in PDF form to the Awarding Contractor via USB Flash Drive:

- a. Title Page - (AVC) Company Logo, Date, Project Name, Description, Address, Phone Number, Email Address.
 - b. Architect Name, Address, Phone Number, Project Manager Name, Phone Number, Email Address.
 - c. Electrical Engineer Company Name, Address, Phone Number, Project Manager Name, Phone Number, Email Address.
 - d. (AVC) Company Name, Address, Phone Number, Project Manager Name, Phone Number, Email Address.
 - e. Provide a letter to the Awarding Contractor stating that the system is 100% Installed, Punch List Completed and Fully Operational as Specified.
 - f. Itemized Equipment List with Quantities, Model Number and Manufacturer Description.
 - g. Itemized Inventory of Loose (AVC) Equipment Signed by the Owner's Representative.
 - h. Reviewed Testing Documents by the Electrical Engineer.
 - i. PDF File of Scrubbed and Corrected - Autocad Single Line As-Built Drawings, Lucid Chart As-Built Single Line Drawings, or Intaglio As-Built Single Line Drawings COMPLETE WITH WIRE NUMBERS PER ABOVE SECTION 3.1/C/2.
 - j. State on the drawings in the form of a 45 Degree Semi Transparent Water Mark – "AS-BUILT & DATE".
 - k. Signed Warranty Certificate which shall start on the written date of substantial completion or (AVC) system first use by the owner and run for a period of 1 Year Excluding Lamps, Bulbs, Owner Abuse or Acts of God.
3. (1) USB Flash Drive of Final Audio DSP Settings.
 4. (1) USB Flash Drive of all Native Control System Programming Files.
 5. (1) USB Flash Drive of PDF Owner Manuals & PDF Final As-Built Docs.
 6. Provide Year #2 Installation Service Agreement Proposal.

END OF SECTION 282400

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1. SUMMARY

1.1.1. FIRE AND MN

Provide all permits, labor, equipment, materials and services to furnish and install a fully tested functional, UL Listed, code compliant, intelligent addressable networked fire alarm, mass notification and active smoke control system including but not limited to all initiation and notification appliances, all raceways and wiring, connection to a central monitoring station.

The *fire alarm system* supplied under this specification shall utilize modular low voltage design with direct wired, node to node, peer-to-peer network communications. The system shall utilize independently addressed, fire detection devices, input/output control modules, audio amplifiers, telephone communications and notification appliances as described in this specification. Network panels shall contain the required user interfaces for all functions.

The *mass notification system* supplied under this specification shall consist of a new Central Control Station (CCS) that shall provide the command and control for all buildings. The CCS shall also provide annunciation for all mass notification and fire alarm events as required by UL 864, UL 2572 and this specification.

The system shall be designed for interior building audibility of 15 dBA-fast over ambient condition and intelligibility. Intelligibility shall be designed to ensure Common Intelligibility Standard (CIS) rating of 0.7 or Sound Transmission Index of 0.5 in all areas designated on the drawings to have intelligible audio.

All equipment shall be new and the current products of a single manufacturer, actively engaged in the manufacturing and sale of digital fire detection devices for over ten years.

Also included are system wiring, fiber optic cable, raceways, pull boxes, terminal cabinets, mounting boxes, and any accessories and miscellaneous items required for a code compliant system.

The system drawings show the intended of coverage and suggested device locations. Final device quantity, location, and AHJ approval are the responsibility of the contractor.

The final system shall be complete, tested, and ready for operation as described elsewhere in this specification before owner acceptance.

Strict conformance to this specification is required to ensure that the installed and programmed system will function as designed, is compatible with existing systems, and will accommodate the future requirements and operations of the building owner. All specified operational features must be met without exception.

1.2. REFERENCES

1.2.1. CODES-GENERAL

All work and materials shall conform to all applicable federal, state, and local codes and regulations governing the installation. If there is a conflict between the referenced standards, federal, state or local codes, and this specification, it is the bidder's responsibility to immediately bring the conflict to the attention of the engineer for resolution. National standards shall prevail unless local codes are more stringent.

1.2.2. FIRE AND MNS CODES

The equipment and installation shall comply with the provisions of the following codes and standards unless the authority having jurisdiction has adopted an earlier version:

National Fire Protection Association (NFPA)

NFPA 70 - 2020 *National Electric Code*®

NFPA 72 - 2015 *National Fire Alarm Code*®

NFPA 90A - 2012 *Installation of Air-Conditioning and Ventilating Systems*

NFPA 92A - 2009 *Smoke-Control Systems Utilizing Barriers and Pressure Differences*

NFPA 92B - 2009 *Smoke Management Systems in Malls, Atria, and Large Areas*

NFPA 101- 2012 *Life Safety Code*®

Underwriter's Laboratories, Inc
UL 864 - Control Units for Fire Protective Signaling Systems.
UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
UL 268A - Smoke Detectors for Duct Applications.
UL 217 - Single and Multiple Station Smoke Alarms
UL 521 - Heat Detectors for Fire Protective Signaling Systems.
UL 228 - Door Closers-Holders, With or Without Integral Smoke Detectors.
UL 464 - Audible Signaling Appliances.
UL 38 - Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
UL 1971 - Signaling Devices for the Hearing-Impaired.
UL-1480 - Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
UL 1481 - Power Supplies for Fire Protective Signaling Systems.
UL 1711 - Amplifiers for Fire Protective Signaling Systems.
UL 1635 - Digital Alarm Communicator System Units
UL-1638 - Signaling Appliances - Private Mode Emergency and General Utility Signaling
UL 2572 - Control and Communication Units for Mass Notification Systems
Note: Control equipment shall listed to both UL 864 and UL2572 standards.

Factory Mutual (FM) approval

International Code Council
International Building Code
International Fire Code
International Mechanical Code

Federal Codes and Regulations
Americans with Disabilities Act (ADA)

1.2.3. DEFINITIONS AND ABBREVIATIONS

ACU: Autonomous Control Unit.
ADA: Americans with Disabilities Act.
AFF: Above Finished Floor.
AHJ: Authority Having Jurisdiction.
Approved: Unless otherwise stated, materials, equipment or submittals approved by the Authority or AHJ.
Circuit: Wire path from a group of devices or appliances to a control panel or transponder.
CCS: Central Control Station.
CPU: The central computer of a multiplex fire alarm or voice command control system.
ECS: Emergency Communication System.
FACP: Fire Alarm Control Panel.
FCC: Fire Command Center.
FM: FM Global (Factory Mutual)
HPSA: High Power Speaker Array.
HVAC: Heating Ventilating and Air Conditioning.
IDC: Initiating Device Circuit.
LCD: Liquid Crystal Display.
LED: Light Emitting Diode.
LOC: Local Operating Console.
MN: Mass Notification.
MNEC: Mass Notification Emergency Communications.
NAC: Notification Appliance Circuit.
NFPA: National Fire Protection Association.
NICET: National Institute for Certification in Engineering Technologies
NRTL: Nationally Recognized Testing Laboratory
RCP: Remote Control Panel
SLC: Signaling Line Circuit.
Style 4: As defined by NFPA 72, Class B.
Style 6: As defined by NFPA 72, Class A.
Style B: As defined in NFPA 72, Class B.
Style D: As defined in NFPA 72, Class A.
Style Y: As defined in NFPA 72, Class B.
UL or ULI: Underwriters Laboratories, Inc.
UL Listed: Materials or equipment listed and included in the most recent edition of the UL Fire Protection Equipment Directory.
Zone: Combination of one or more circuits or devices in a defined building area, i.e. 3 speaker circuits on a floor

combined to form a single zone.

1.3. SYSTEM DESCRIPTION

1.3.1. GENERAL FIRE AND MN

The system supplied under this specification shall be a new UL Listed modular fire alarm & mass notification network that uses independently addressed fire detection devices, input/output control modules, amplifiers and speakers.

The fire network shall utilize token ring, peer-to-peer communications. The network shall consist of one main and multiple remote Autonomous Control Unit/Fire Alarm Control Panels (ACU/FACP). To enhance survivability, each ACU/FACP shall be an equal, active functional member of the network, capable of making all local decisions and initiating network tasks for other panels. In the event of an ACU/FACP failure or communications failure between units, ACU/FACPs shall be capable of forming sub-networks and remain operational between communicating units. Master/slave system configurations shall not be considered as equal.

The system shall be fully field programmable such that virtually any combination of system output functions may be correlated to any type of input event(s). Inputs may be combined using Boolean logic, be time dependent or under manual control, as defined by required system operation. All software operations are to be stored in a non-volatile programmable memory within the fire alarm control panels. There shall be no limit, other than maximum system capacity, as to the number of addressable devices which may be in alarm simultaneously.

Addressable smoke detector sensitivity settings for both pre-alarm and alarm activation shall be automatically individually configurable for both daytime and nighttime operation. Addressable smoke detectors shall be UL listed for automatic sensitivity testing.

Ease of maintenance shall be facilitated by the use of panel based and PC based system diagnostics.

1. The system shall automatically test smoke detector sensitivity, eliminating the need for manual sensitivity testing.
2. Ground fault detection and annunciation shall be by individual module address for supervised input and output devices.
3. System test operation shall be configurable by individual addressable devices, and not disable entire circuits.
4. The system shall be capable of generating a graphical map of connected all addressable devices to aide in circuit troubleshooting.
5. Placement supervision of addressable devices shall couple a device's location (not its address) to the programmed system response.

The system shall provide a one-way multi-channel emergency communication sub-system for the distribution of emergency messages to facility occupants.

The mass notification network shall connect the main ACU/FACP or Central Command Station (CCS) to all remote ACU/FACPs. The CCS shall be capable of initiating live and prerecorded audio messages to any combinations of ACU/FACPs connected to the network, as detailed under the Performance Requirements section of this specification. System ACU/FACPs and LOCs shall utilize configurable message routing and selective event messaging to direct event information only to the required system displays and printers as determined by the event type and location.

The existing fire alarm shall be removed and discarded and new control panels, power supplies, audio/visual indicating appliances (wiring may be reused if warranted as new and will work with new system if electrically sound) and related equipment shall be installed as specified.

1.3.2. FIRE ALARM PERFORMANCE

1.3.2.1. GENERAL REQUIREMENTS

- A. Comply with the provisions of NFPA 72 and the operational requirements of this specification.
- B. The system shall identify all off normal conditions and log each condition into the system as an event.
 - a. The system shall automatically display on the control panel Liquid Crystal Display (LCD) the first (oldest) event of the highest priority by type. The event priority shall be alarm, supervisory, trouble, and monitor.
 - b. The system shall utilize four event queues and shall not require event acknowledgment by the system operator. Labeled, color coded indicators shall be provided for each type of event queue: alarm - red, supervisory - yellow, trouble - yellow, monitor - yellow. When an unseen event exists for a given type, the indicator shall be lit.

- c. For each event, the display shall include the current time, the total number of events, the type of event, the time the event occurred and up to a 42-character custom user description.
 - d. The user shall be able to review each event queue by simply selecting scrolling keys (up-down) for the event type.
 - e. New alarm, supervisory, or trouble events shall sound a distinct, silenceable audible signal at the control panel.
 - f. The LCD shall show the number of active alarms, supervisory, trouble and monitor events
 - g. The LCD shall show the system time and the number of active and disabled points in the system.
 - h. Specific input/output devices shall operate in accordance with the alarm, supervisory, trouble, monitor sections that follow and the input/output matrix.
- C. All critical systems, sub-systems and circuits shall be monitored for integrity. System faults shall be annunciated.
- D. Strobes shall be synchronized on each floor.
- E. Batteries shall be sized to support the system for 24 Hrs. of standby operation followed by 15 minutes of alarm operation at the end of the 24-Hour period.
- F. Off premises reporting of the loss of AC mains power to any system component shall be automatically delayed for a period of time acceptable to the AHJ to reduce traffic at the central monitoring station due to wide-area power failures.
- G. The system shall provide configurable service groups to facilitate "one man" testing of the system based on the physical layout of the building. Each service group shall be capable of supporting any combination of system devices, independent of the circuit on which they are installed. Systems that disable entire circuits, circuits serving multiple floors or fire zones for testing shall not be considered as equal. Activated devices on a service group shall be capable of initiating alternative system test responses to facilitate system maintenance and minimizing occupant disturbances while in test mode.
- H. Event processing and display shall be prioritized as follows:
- a. Fire alarms
 - b. Supervisory events
 - c. Trouble events
 - d. Monitor events

1.3.2.2. ALARM OPERATION - MN

Signals shall be prioritized and processed in accordance with UL 2572 as indicated below:

Mass Notification (MN)
 Fire Alarm/Life Safety
 Other

Only the Central Control Station, a building's Autonomous Control Unit/Fire Alarm Control Panel (ACU/FACP), or a Local Operations Console (LOC) shall be capable of **initiating mass notification operation**. No automatic operation shall be permitted.

Operation of any Mass Notification Emergency Communication (MNEC) functions by a user at a building ACU/FACP or LOC shall be indicated at the CCS.

Operation of any MNEC functions by a user at the CCS shall be indicated at the ACU/FACP(s) and LOC(s) that the respective building system(s) is in the MNEC mode.

The CCS, ACU/FACP(s) and LOC(s) shall display the following information:

Power On indication.

The status of all signaling zones.

The off-normal status of all control switches.

The off-normal status of all circuits and functions monitored for integrity.

The system shall observe the following priorities for evacuation and relocation signals:

The FACP shall not automatically override mass notification messages.

Live pages shall override previously and subsequently initiated signals to the operator selected areas.

Message sources shall be prioritized as follows:

Live *local* mass notification and fire evacuation messages.

Live *remote* mass notification and fire evacuation messages.

Automatic pre-recorded mass notification and fire evacuation messages.
Non-emergency messages.

A library of pre-recorded messages shall be available for the operator at the CCS or a building ACU/FACP or LOC.
The library shall consist of the following messages:

Lockdown
Weather warning
All Clear
Evacuation
Stand by
Chemical emergency
Test

The CCS shall be capable of transmitting messages to any combination of destination buildings.
The ACU/FACP or LOC shall be capable of transmitting messages only within its respective building.

The system shall be capable of live voice page from the CCS, an ACU/FACP, or a LOC
The CCS shall be capable of live paging to any combination of destination buildings.
The ACU/FACP or LOC shall be capable of live paging only within its respective building.

When any mass notification audio circuits are active, synchronized amber ALERT strobes shall activate in the same areas.

Upon the **alarm activation** of any area smoke detector, heat detector, manual pull station, sprinkler waterflow, the following functions shall automatically occur:

The system shall remain in the alarm mode until all initiating devices are reset and the fire alarm panel is manually reset and restored to normal.
The internal audible device shall sound at the control panel or command center.
Display the alarm event on the graphical workstation.
The LCD Display shall indicate all applicable information associated with the alarm condition including zone, device type, device location and time/date.
All system activity/events shall be documented on the system printer and logged into system history.
Any remote or local annunciator LCD/LED's associated with the alarm zone shall be illuminated.

The following audio messages and actions shall occur simultaneously:

An evacuation message shall be sounded on fire floors (zones) immediately above and below (adjacent to) the fire floor (zone) general alarm evacuation. It is the intent of this message to advise occupants hearing this message that they are near danger and should leave the building via the stairs (nearest exit) immediately.

Activate visual strobes on the fire floors immediately above and below (adjacent to) the fire floor (zone) general alarm evacuation. The visual strobe shall continue to flash until the system has been reset. The visual strobe shall not stop operating when the "Alarm Silence" is pressed.

An alert message shall be sounded on the remainder of building. It is the intent of this message to advise occupants to prepare for evacuation if necessary.

An instructional message shall be sounded in the stairwells instructing occupants to move carefully and quickly down the stairs to exit the building and to exit to a safe floor if you encounter smoke in the stairwell.

An instructional message shall be sounded in the elevator cabs. It is the intent of this message to advise elevator occupants that an emergency exists, the elevator has been directed to the ground floor, and that occupants should quickly exit the building.

An instructional message shall be sounded in the lobby. It is the intent of this message to advise lobby occupants to leave the lobby and clear the area for arriving firefighters.

An instructional message shall be sounded in the concourses connected to the building's lobby. It is the intent of this message to prevent new entries into the lobby by advising occupants not to attempt to enter the lobby of the affected building.

Provide selective paging to each individual floor (zone). In addition to the message/channels detailed above, a dedicated page channel shall be capable of simultaneously providing live voice instructions without interrupting any of the messages listed above shall be provided.

The notification appliance dedicated to sprinkler system water flow alarm shall not be silenced while the sprinkler system is flowing at a rate of flow equal to a single head.

Transmit signal to the building automation system.

Transmit signal to the central monitoring station with point identification.

Activate automatic smoke control sequences.

All automatic events programmed to the alarm point shall be executed and the associated outputs activated.

1. Activation of elevator lobby or elevator equipment room smoke detectors shall initiate recall of the bank of elevators to the 1st floor and lockout the elevator controls. Activation of the first-floor elevator lobby smoke detector shall recall shall be to an alternate floor, and lockout the elevator controls.

2. Activation of heat detectors in elevator shafts and machine rooms shall activate the elevator power shunt trip circuit breaker.

All stairwell/exit doors shall unlock throughout the building.

All self-closing fire/smoke doors held open shall be released.

All Civic Center Sound Systems shall be shut down upon activation of the Mass Notification and Life Safety System. Provide and install required devices/equipment to perform sound system shutdown without damage to sound system.

1.3.2.3. SUPERVISORY OPERATION

Upon **supervisory activation** of any sprinkler valve supervisory switch, waterflow, duct smoke detector, fire pump off-normal, elevator shunt trip supervision, the following functions shall automatically occur:

The internal supervisory event audible device shall sound at the control panel.

Display the event on the graphical workstation and display a pictorial image.

The LCD display shall indicate all applicable information associated with the supervisory condition including zone, device type, device location and time/date.

All system activity/events shall be documented on the system printer and logged to system history.

Any remote or local annunciator LCD/LED's associated with the supervisory zone shall be illuminated.

Transmit signal to the central monitoring station with point identification.

1.3.2.4. TROUBLE OPERATION

Upon activation of a **trouble condition** or signal from any device or internal system integrity monitoring function on the system, the following functions shall automatically occur:

The internal panel audible device shall sound at the control panel.

Display the event on the graphical workstation and display a pictorial image.

The LCD keypad display shall indicate all applicable information associated with the trouble condition including zone, device type, device location and time/date.

Trouble conditions that have been restored to normal shall be automatically removed from the trouble display queue and not require operator intervention. This feature shall be software selectable and shall not prevent the logging of trouble events to the historical file.

All system activity/events shall be documented on the system printer and logged to system history.

Any remote or local annunciator LCD/LED's associated with the trouble zone shall be illuminated.

Transmit a trouble signal to the central monitoring station with point identification.

1.4. SUBMITTALS

1.4.1. SUBMITTAL GENERAL

- A. The contractor shall not purchase any equipment for the specified system until the owner has approved the project submittals in their entirety and has returned them to the contractor.
- B. Approved submittals allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications.
- C. Each submittal shall include a detailed list of variations that the submittal may have from the requirements of the contract documents.
- D. The contractor shall provide specific notation on each shop drawing, sample, data sheet, installation manual, etc. submitted for review and approval, of each variation.
- E. Any conflicts in the contract documents and/or with Authority Having Jurisdiction (AHJ) requirements shall be submitted to the owner in writing 7 days prior to bid.

F. Submittals shall be approved by authorities having jurisdiction prior to submitting them to the Architect.**1.4.2. PRODUCT DATA**

System components proposed in this specification shall be UL listed to operate together as a system. The supplier shall provide evidence, with his submittal, of listings of all proposed equipment and combinations of equipment.

For each product submitted provide the following information:

1. **Manufacturer's catalog data, to include material description, agency approvals, operating characteristics, electrical characteristics, dimensions, mounting requirements and accessories.**

Product data sheets for system components shall be highlighted to indicate the specific products, features, or functions required to meet this specification.

Alternate or as-equal products submitted under this contract shall provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.

2. Manufacturer's product installation sheets: A copy of the documentation that is required to be shipped with all listed products by UL.

1.4.3. SHOP DRAWINGS

Submit for approval three (3) sets of shop drawings to the consulting engineer for review and comment. Drawings shall be either D-size or E-size AutoCAD drawings and of a sufficient resolution to be completely read. Drawing sets shall be bound. Additional copies may be required at no additional cost to the project.

Contained in the title block of each drawing shall be symbol legends with device counts, wire tag legends, circuit schedules for all addressable and notification appliance circuits, the project name/address, and a drawing description which corresponds to that indicated in the drawing index on the coversheet drawing. A section of each drawing title block shall be reserved for revision numbers and notes.

Shop drawings shall meet the following requirements:

1. Shop drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by the manufacturer of the submitted equipment in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, Level IV minimum or a registered Professional Engineer.
2. **Coversheet** with project name, address and drawing index.
3. **General notes** drawing with peripheral device backbox size information, part numbers, device mounting height information, and the names, addresses, point of contact, and telephone numbers of all contract project team members.
4. Provide device **floor plans** for all areas served by the fire alarm system. Utilize the CAD Files provided by the consulting engineer in the preparation of the floor plans. Floor plans shall indicate accurate locations for all control and peripheral devices. Drawings shall be NO LESS THAN 1/8-INCH SCALE. If individual floors need to be segmented to accommodate the 1/8" scale requirements, KEY PLANS and BREAK-LINES shall be provided on the plans in an orderly and professional manner.
 - o All addressable devices shall be shown. Coordinate the device address with the same device shown on the riser diagram.
 - o Identify all notification appliances with a circuit and item number. Coordinate the circuit and item number with the same device shown on the riser diagram.
 - o Show all raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used.
 - o Areas required to meet intelligibility requirements shall be clearly identified. Wide area mass notification system plot drawings shall identify all project areas that must meet intelligibility requirements as well as environmentally sensitive areas on or off of the project site where system output shall be minimized.
5. Device **riser diagram**, which individually depict all control panels, annunciators, addressable devices, and notification appliances. Shall include a specific, proposed device description above each addressable device. Shall include a specific, discrete device address that corresponds to addresses shown on the floor plans. Drawings shall provide wire specifications, and wire identification for all conductors depicted on the riser diagram. All circuits shall have identifiers that shall correspond with those required on the control panel and floor plan drawings. End-of-line resistors (and values) shall be depicted.
6. **Control panel drawing(s)** shall show internal component placement and all internal and field terminations. Provide details indicating where conduit connections shall be made to avoid conflicts with internally mounted batteries. For each additional fire alarm panel, a separate drawing which clearly indicated the panel designation, service and location of the control enclosure.

7. Provide typical **device wiring diagrams** that show all system components, and the respective field wiring. Wire type, gauge, and jacket shall be indicated. When an addressable module is used in multiple configurations for monitoring or controlling equipment, provide a drawing for each application. End-of-line resistors (and values) shall be shown.
8. Provide a fire alarm system **function matrix** that illustrates alarm input/out events in association with initiation devices. Matrix summary shall include system supervisory and trouble output functions.
9. **System Calculations** as detailed elsewhere in this specification.
Upon receipt of approved drawings from the Authority Having Jurisdiction, the supplier shall immediately forward two sets of drawings to the owner. These drawings shall either be stamped approved or a copy of the letter stating approval shall be included.

1.4.4. CLOSEOUT

Two (2) copies of the following documents shall be delivered to the building owner's representative at the time of system acceptance.

Project specific operating and maintenance manuals covering the system as installed. The manuals shall contain a description of the system architecture, inputs, notification signaling, auxiliary functions, annunciation, sequence of operations, expansion capability, application considerations and limitations. A generic instruction and operation manual shall not be acceptable.

Technical literature (manufacturer's data sheets and installation manuals/instructions) for all parts of the system, including control panels, smoke detectors, batteries, manual stations, alarm notification appliances, power supplies, and remote alarm transmission means.

Software and Firmware Operational Documentation:

THE END-USER SHALL RETAIN COMPLETE RIGHTS AND OWNERSHIP TO ALL SITE-SPECIFIC SOFTWARE RUNNING IN THE SYSTEM. The fire alarm equipment supplier shall provide hard and soft copies of the software database to the end-user at the end of the warranty period. The database provided shall be useable by any authorized and certified distributor of the product line and shall include all applicable passwords necessary for total and unrestricted use and modification of the database.

Drawings

Provide "As Built" drawings of record of all the shop drawings used in the installation of the system.

Refer to the Submittals - Shop Drawings section of this specification for drawing requirements.

Record of Completion

System supplier and contractor shall provide a certified test report to verify that the system and all components functioned properly and as intended.

A filled-out Record of Completion similar to NFPA 72, 2007 edition figure 4.5.2.1 shall be provided.

Warranty

Provide copies of the warranty documentation as detailed in the Warranty section of this specification.

Service Organization

Provide the name, address and telephone of the authorized factory representative.

Training

Conduct the required training as detailed in the Startup and Commissioning - Training section of this specification.

1.5. QUALITY ASSURANCE

1.5.1. QUALIFICATIONS OF SUPPLIER

The system supplier shall have a minimum of 10 years of experience in distribution and service of the proposed equipment brand.

The supplier shall have successfully designed and installed similar system fire detection, evacuation voice and visual signaling control components on a previous project of comparable scope, size and complexity.

The supplier shall have in-house engineering and project management capability consistent with the requirements of this project. The project shall be supervised by personnel certified by NICET as fire alarm Level IV technicians.

The supplier shall employ qualified and manufacturer certified system designers to perform the detailed engineering design, system calculations, for all the system equipment and programming.

The supplier shall produce all panel and equipment drawings, submittals, and operating manuals, as detailed elsewhere in this specification.

The supplier shall be responsible for providing qualified on-site representative(s) for coordination of system installation, and final system testing and commissioning in accordance with these specifications.

1.5.2. QUALIFICATIONS OF INSTALLER

- A. Codes, Standards, Ordinances, and Permits:
1. All work shall comply with the current codes adopted and enforced by the following agencies: Designer of Record, shall verify the edition of the applicable codes at the time of design and construction.
 - a. Alabama Department of Construction Management
 - 1) International Fire Code
 - 2) International Mechanical Code
 - 3) NFPA 70, National Electrical Code
 - 4) ADA Accessibility Guidelines for Buildings and Facilities
 - b. State Fire Marshal's Office (National Fire Protection Association (NFPA) National Fire Codes)
 - 1) NFPA 72, National Fire Alarm Code
 - 2) NFPA 90A, Installation of Air Conditioning and Ventilating Systems
 - 3) NFPA 101, Life Safety Code
 - c. Tuscaloosa Fire and Rescue Service
 - 1) International Fire Code and referenced standards
 2. All work and products shall also conform to the following nationally recognized standards:
 - a. ANSI S3.41, Audible Emergency Evacuation Signal
 - b. UL 864, Control Units for Fire Protective Signaling Systems
 - c. UL 1481, Power Supplies for Fire Protective Signaling Systems
 - d. UL 268, Smoke Detectors for Fire Protection Signaling Systems
 - e. UL 464, Audible Signal Appliances, 8th Edition
 - f. UL 1971, Signaling Devices for the Hearing Impaired
 - g. UL 1480, Speakers for Fire Protective Signaling Systems
 3. All work and materials shall conform to all Federal, State and local codes and regulations governing the installation, including the current editions of the International Building and Fire Codes, and the codes, standards, guides and recommended practices included in the current NFPA National Fire Codes.
 4. If there is a conflict between the referenced NFPA standards, federal, state or local codes, and this specification, it is the Contractor's responsibility to immediately bring the conflict to the attention of the Owner for resolution. Where conflict arises between the International Fire Code and NFPA 101, Life Safety Code, the most stringent code requirement will be enforced.
 5. All devices, appliances, systems, equipment, and materials furnished and installed shall be new and listed by Underwriters Laboratories Inc. (UL) for their intended use. All equipment shall be installed in accordance with the manufacturer's recommendations and the UL listing limitations. Listing requirements for separate voice, fire alarm systems, smoke control system equipment and smoke detectors shall be met. The Contractor shall provide evidence with his submittal of listings for all proposed equipment and combinations of equipment.
 6. All devices, appliances, systems, equipment, and materials furnished and installed shall be of types or models approved and required by NFPA Standards or UL listing for use in systems and occupancies of this type.
 7. The Contractor shall be responsible for filing of all documents, paying all fees (including, but not limited to plan checking and permit) and securing all permits, inspections, and approvals necessary for conducting this work. Upon receipt of approved drawings from the Authority Having Jurisdiction, the Contractor shall immediately forward two sets of drawings to the Owner. These drawings shall either be stamped approved or a copy of the letter stating approval shall be included.

B. Contractor Qualifications

1. The Contractor shall:
 - a. Any contractor or subcontractor engaged in the installation, modification, configuration, programming or testing of a fire alarm system shall have a valid State Fire Alarm permit. This includes the installation or termination of fire alarm wiring, devices, panels and other equipment.
 - b. Provide a job site supervisor/foreman who is to be present on site each day that work is actively in progress, as appropriate. The jobsite supervisor/foreman shall be a minimum National Institute for Certification in Engineering Technologies (NICET) Level II in Fire Alarm Systems. A daily site visit is required as a minimum. This individual shall be the same person throughout the course of the project, unless otherwise approved in writing by the Owner.
 - c. System configuration, installation, programming, and testing shall be supervised by a technician who is NICET Level III or IV in Fire Alarm Systems, trained by the Contractor.
 - d. Hold all licenses and permits necessary to perform this work in Alabama thru the State of Alabama Fire Marshal's Office.
 - e. Have at least five years of experience in the installation of systems of this type and shall be familiar with all applicable local, state, and federal laws and regulations. Provide a project list representing projects of similar scope in the past three years including references.
 - f. Technicians, who shall be on-site or have a level of responsibility and involvement with this project, shall be submitted for review and acceptance. A copy of their NICET Certification (minimum Level III or IV, Fire Alarm Systems) shall be submitted with the submittal documents.
 - g. Be regularly engaged in the design, servicing, installation, and testing of fire detection, alarm, and emergency voice/alarm communication systems.

1.6. WARRANTY**1.6.1. INSTALLATION WORKMANSHIP AND PARTS**

The contractor shall warranty the parts, installation, and workmanship for one (1) year from date of final acceptance. A copy of the manufacturer's warranty shall be provided with closeout documentation and included with the operation and installation manuals. The full cost of maintenance, labor and materials required to correct any defect during the warranty period shall be included in the submittal bid.

During the warranty period, each year the contractor shall perform detector sensitivity testing and provide a report to the owner. If the system is UL Listed to perform automatic detector sensitivity testing without manual intervention, and if a detector falls outside of sensitivity window the system automatically indicates a devices trouble, then this requirement shall be waived. Documentation from UL shall be provided as proof of automatic sensitivity testing operation.

The system supplier shall maintain a service organization with adequate spare parts stock within 75 miles of the installation. Provide a telephone response to owner's questions within 4 hours and on-site assistance within 24 hours.

Permit the owner's fire alarm technicians to perform temporary bypasses and emergency repairs on the system without voiding the warranty.

1.7. STARTUP AND COMMISSIONING**1.7.1. TEST AND INSPECTION - FIRE AND MN**

A. Testing, general

1. In addition to tests required in this Section, the Contractor shall perform all electrical and mechanical tests required by the equipment manufacturer, the Architect and the Authority having jurisdiction.
2. The contractor shall perform all testing in occupied facilities at times of day that present the lowest impact and disruption to business and activities. Coordinate all testing in occupied buildings with the building owner's representative to assure that fire alarm system testing does not interrupt operations. This may require extensive after hours work to perform such testing.>
3. All equipment, instruments, tools and labor required to conduct the system tests shall be provided by the installing contractor. At a minimum, the following equipment shall be made available testing:
 - a. Ladders and scaffolds as required to reach all installed equipment.
 - b. Meters for reading voltage, current and resistance.
 - c. Two-way communication devices
 - d. Simulated smoke, heat-producing devices for heat detectors, extension poles for introducing

- smoke into detectors, as needed.
 - e. Manufacturer's instruments to measure air flow through duct smoke detectors.
 - f. Decibel meter and intelligibility testing equipment.
 - g. Status and diagnostic software and PC.
- B. All testing shall utilize a written acceptance test plan for testing the system components and operation in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the acceptance test plan, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and system programming.
- 1. The systems operation matrix created by the equipment supplier shall be used to identify each alarm input and verify all associated output functions.
- C. The system test plan shall include but not be limited to the following:
- 1. Visually inspect all wiring.
 - 2. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final acceptance test.
 - 3. System wiring shall be tested to demonstrate correct system response for the following conditions:
 - a. Open, shorted, and grounded signal line circuits.
 - b. Open, shorted, and grounded notification appliance circuits.
 - 4. System indications shall be demonstrated as follows:
 - a. Correct message content for each alarm input at all system displays.
 - b. Correct annunciator light for each alarm input at each graphic display.
 - c. Correct history logging for all system activity.
 - d. Correct sensitivity for all smoke detection devices. The use of system generated sensitivity reports is acceptable in meeting this requirement.
 - e. Correct signals sent to the Central Monitoring Station.
 - 5. Notification appliances shall be demonstrated as follows:
 - a. All alarm notification appliances actuate as programmed
 - b. The system shall be tested for interior building audibility of 15 dBA-fast over ambient condition and intelligibility. Intelligibility shall be tested to ensure Common Intelligibility Standard (CIS) rating of 0.7 or Sound Transmission Index of 0.5 in all areas designated on the drawings to have intelligible audio. The mean value of at least 3 readings shall be required to compute the intelligibility score at each test location.
 - c. HPSAs shall be tested for an outside audibility level of 15 dBA-fast over ambient condition and intelligibility. Intelligibility shall be tested to ensure Common Intelligibility Standard (CIS) rating of 0.7 or Sound Transmission Index of 0.5 in outdoor areas during normal weather conditions. Intelligibility may be less than 0.7 CIS in areas of the zone if it can be determined that a voice signal is being broadcast and an individual could walk less than 164 feet to find a location in the zone with at least 0.7 CIS. Values of 0.65 through 0.74 shall be rounded to 0.7. The mean value of at least 3 readings shall be required to compute the intelligibility score at each test location.
 - d. For 24VDC NACS, measure and record the voltage at the most remote appliance on each notification appliance circuit, while operating.
 - 6. System control functions shall be demonstrated as follows:
 - a. In accordance with the system operation matrix.
 - 7. System off premises reporting functions shall be demonstrated as follows:
 - a. Correct information received for each alarm and trouble event
 - 8. Secondary power supply (battery) capacity capabilities shall be demonstrated as follows:
 - a. System battery voltages and charging currents shall be measured and recorded at the fire alarm control panels
 - b. System battery voltages and charging currents shall again be measured and recorded at

the fire alarm control panels.

9. Verify the "As Built" record drawings are accurate.

Preliminary Testing

Conduct preliminary tests to ensure that all devices and circuits are functioning properly. Tests shall meet the requirements of the written test plan. Correct any deficiencies, omissions or anomalies and retest the affected devices to assure proper function per the specification.

Acceptance Testing

1. A final acceptance test shall not be scheduled until the system manuals are provided to and approved by the owner and the following are provided at the job site:
 - (1) "As Built" Record drawings of the system as actually installed
 - (2) A copy of the system operation matrix.
2. The acceptance inspector shall use the system "As Built" record drawings in combination with the system operation matrix and the written acceptance test plan during the testing to verify system operation.
3. Should the system not perform to the above criteria it shall not be accepted and the Contractor shall correct all deficiencies and shall re-test the system at Contractor's expense in the presence of the Architect using the same test criteria.
4. The building owner's representative shall witness the final tests.
5. The central monitoring station and/or fire department shall be notified before final test in accordance with local requirements.
6. Operate every installed device to verify proper operation and correct annunciation at control panel.
7. Open signaling line circuits and notification appliance circuits in at least 2 locations to verify presence of supervision.

Test Reports

A "Fire Alarm System Record of Completion" per the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in shall be prepared by the Contractor. Submit three (3) copies to the Architect. The report shall include, but not be limited to:

- A list of all equipment installed and wired.
- Certification that all equipment is properly installed and functions and conforms to these specifications.
- Sensitivity settings for each ionization and photoelectric detector as measured in place with the HVAC system operating.
- Technician's name, certificate number and date.

1.7.2. TRAINING

The system supplier shall schedule and present a minimum of eight (8) hours of formal site-specific instruction for the building owner, detailing the proper operation and maintenance of the installed system.

The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.

Copies of all training aids, presentations, etc. shall be left with the owner.

1.8. MAINTENANCE

1.8.1. SPARE PARTS

The contractor shall furnish the following extra material that matches the products installed. Spares shall be packaged with protective covering for storage and identified with labels describing contents.

Automatic detection devices - Two (2) percent of the installed quantity of each type, no less than one piece.

Manual fire alarm stations - Two (2) percent of the installed quantity of each type, no less than one piece.

Audible and visible devices - One (1) percent of the installed quantity of each type, but no less than two (2) devices.

Keys - A minimum of three (3) sets of keys shall be provided and appropriately identified.

1.8.2. MAINTENANCE CONTRACT

The supplier shall offer for the owner's consideration at the time of system submittal a priced inspection, test, maintenance and repair agreement for the installed system in compliance with the inspection and maintenance requirements of NFPA 72 for a period of 12 months, to commence after the expiration of the maintenance agreement included in this contract,

The owner shall have the option of renewing the agreement at the price quoted, in yearly increments up to a maximum of five (5) years.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

- A. The manufacturer of the system equipment shall be regularly involved in the design, manufacture, and distribution of the products specified in this document. These processes shall be monitored under a quality assurance program that meets ISO 9000/9001 requirements.
- B. The catalog numbers used are those of EDWARDS, a UTC Company or equal, and constitute the type and quality of equipment to be furnished.
- C. If equipment of another manufacturer is to be submitted for approval as equal, the contractor shall, at the time of bid, list all exceptions taken to these specifications, all variances from these Specifications and all substitutions of operating capabilities or equipment called for in these specifications and forward said list to the engineer. Any such exceptions, variances or substitutions not listed at the time of bid and are subsequently identified in the submittal, shall be grounds for immediate disapproval without comment. Final determination of compliance with these specifications shall rest with the engineer, who, at his discretion, may require proof of performance.
- D. Alternate product submissions shall provide proof of no less than three (3) factory authorized and certified manufacturer's distributors within 50 miles of the project job site. These distributors shall provide installation support, shall have a service organization capable of 24-hour emergency call service and SHALL HAVE BEEN CONTRACTED AND DELIVERED NO LESS THAN FIVE (5) SIMILIAR PROJECTS USING THE SUBMITTED PRODUCT OVER THE PAST YEAR. Alternate submissions without the required references shall be rejected.
- E. Alternate product submissions based upon use of a product line considered proprietary in its distribution, design, application software, or ongoing maintenance and repair shall not acceptable. Proof of a product's non-proprietary nature shall be the burden of the contractor at the time of bid and shall be in the form of written documentation. The determination of a product's compliance to this requirement shall be exclusively that of the engineer.

All products used shall be of a single manufacturer. All products shall be listed by the manufacturer for their intended purpose. Submission of notification appliances, auxiliary relays, or documentation from other than a single manufacturer shall not be acceptable and will be grounds for immediate disapproval without comment.
- F. Approved Products: All panels and peripheral devices shall be of the standard product of single manufacturer and shall display the manufacturer's name of each component. The catalog numbers specified under this section are those of EDWARDS, a UTC Company, and shall constitute the type, product quality, material and desired operating features.

2.2. FIRE ALARM PANEL

2.2.1. GENERAL - FIRE Overview

All materials, equipment, accessories, devices and other facilities and appurtenances covered by these specifications or noted on the drawings shall be new, best suited for the intended use and shall conform to applicable and recognized standards for their use, and supplied by a single manufacturer. Should any equipment provided under this specification be supplied by a different manufacturer, that equipment shall be recognized compatible by BOTH manufacturers and listed as such as required by Underwriters' Laboratories.

The fire alarm control panel(s) shall be a multi-processor based networked system designed specifically for fire, one-way and two-way emergency audio communications, smoke control, <extinguishing agent releasing system>, and guard patrol applications. The control panel shall be listed and approved for the application standard(s) as listed in the References section of this specification.

The control panel shall include all required hardware, software, and site-specific system programming to provide a complete and operational system. The control panel(s) shall be designed such that interactions between any applications can be configured and modified using software provided by the manufacturer. The control panel(s) operational priority shall assure that life safety takes precedence among the activities coordinated by the control panel.

The operating controls shall be located in a dead-front steel enclosure behind a locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified. All panel modules shall be placement supervised for and signal a trouble if damaged or removed.

System Features

Each control panel shall include the following capabilities:

- Supervision of the system electronics, wiring, detection devices and software
- Up to 2500 analog/addressable input/output points
- Network connections with up to 63 other control panels and annunciators.
- Support multiple dialers (DACTs) and modems
- Two communication ports
- An internal audible signal with different patterns to distinguish between alarm, supervisory, trouble and monitor events
- Support multiple 24 VDC and Audio NACs
- User configurable switches and LED indicators to support auxiliary functions
- Log up to 1740 chronological events
- The ability to download all applications and firmware from the configuration computer at a single location on the fire network
- A real-time clock for time stamps and timed event control
- Electronic addressing of intelligent addressable devices
- Provide an independent hardware watchdog to supervise software and CPU operation
- "Dry" alarm, trouble and supervisory relay contacts
- Control panel modules shall plug in to a chassis assembly for ease of maintenance
- Field wiring shall connect to the panel using removable connectors

User Oriented Features

Each control panel shall include the following user-oriented features:

- An LCD user interface control/display that shall annunciate and control system functions.
- Provide discreet system control switches for reset, alarm silence, panel silence, drill switch, previous message switch, next message switch and details.
- A "lamp test" feature shall verify operation of all visual indicators on the panel.
- An authorized user shall have the ability to operate or modify system functions including system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
- An authorized user shall have the ability to disable/enable devices, zones, actions, timers, and sequences.
- An authorized user shall have the ability to activate/restore outputs, actions, sequences, and simulate detector smoke levels.
- An authorized user shall have the ability to enter time and date, reconfigure an external port for download programming, initiate programming, and change passwords.
- An authorized user shall have the ability to test the functions of the installed system.
- Service groups shall facilitate one-man walk testing. Service/test groups shall be capable of being configured with any combination of addressable devices, independent of SLC wiring. It shall be possible to program alternate device responses when the device's service group is active. Devices not in an active service group shall process all events normally.
- Provide internal system diagnostics and maintenance user interface controls to display/report the power, communication, and general status of specific panel components, detectors, and modules.
- SLC loop controller diagnostics shall identify common alarm, trouble, ground fault, Class A fault, and map faults. Map faults include wire changes, device type changes by location, device additions/deletions and conventional open, short, and ground conditions. Ground faults on the supervised circuit wiring of remote addressable modules shall be identified by device address.
- An authorized user shall have the ability to generate a report history for alarm, supervisory, monitor, trouble, smoke verification, watchdog, and restore activity.
- System reports shall provide detailed description of the status of system parameters for corrective action or for preventative maintenance programs. Reports shall be displayed by the operator interface or capable of being printed on a printer.

An authorized user shall have the ability to display/report the condition of addressable analog detectors. Reports shall include device address, device type, percent obscuration, and maintenance indication. The maintenance indication shall provide the user with a measure of contamination of a device upon which cleaning decisions can be made.

Programmability

A Windows-based Configuration Utility (CU) shall be used to create the site-specific system programming. The utility shall facilitate programming of any input point to any output point. The utility shall allow customization of fundamental system operations using initiating events to start actions, timers, sequences and logical algorithms.

- Zoning of initiation devices.
- Initiation of events by time of day, day of week, day of year.
- Initiation of events by matrix groups (X-Y coordinate relationships) for releasing systems.
- Initiation of events using OR, AND NOT and counting functions.
- Prioritizing system events.
- Programmable activation of detector sounder bases by detector, groups of bases, or all bases.
- Directing selected device messages to specific panel annunciators
- Detector sensitivity selection by time of day
- Support of 256 Central Monitoring Station accounts and directing selected device messages to any one of ten Central Monitoring Stations.

The configuration utility shall time and date stamp all changes to the site-specific program and shall facilitate program versioning and shall store all previous program version data. The utility shall provide a compare feature to identify the differences between different versions of the site-specific program.

The configuration utility shall be capable of generating reports which detail the configurations of all fire alarm panels, addressable devices and their configuration settings including generating electrical maps of the addressable device SLCs.

The configuration utility shall support the use of bar code readers to expedite electronic addressing and custom programming functions.

Please refer to the *General, System Description Section* for this project's site-specific system operating requirements.

The fire alarm control panel shall be an EDWARDS 3-CPU3 and support components in an appropriately sized enclosure.

2.2.2. POWER SUPPLY

System power supply(s) shall be a high efficiency switched mode design providing multiple supervised power limited 24 VDC output circuits as required by the panel and external loads fed by the panel. Initial power supply loading shall not exceed 80% of power supply capacity in order to allow for future system expansion.

Each system power supply shall be individually supervised. Power supply trouble signals shall identify the specific supply and the nature of the trouble condition.

It shall be possible to parallel system power supplies to increase capacity or to provide redundant operation.

Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to secondary power without losing any system functionality.

All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.

All standby batteries shall be continuously monitored by the power supply. The power supply shall be able to perform an automatic load test of batteries and indicate a trouble condition if the batteries fall outside a predetermined range. Power supplies shall incorporate the ability to adjust the charge rate of batteries based on ambient temperatures. The power supply shall automatically disconnect the battery before low voltage damages the battery. Low battery and disconnection of battery power supply conditions shall immediately be annunciated as battery trouble and identify the specific power supply(s) affected.

Batteries shall utilize sealed lead acid chemistry. Initial battery capacity shall provide 125% of calculated capacity requirements in order to allow for future system expansion.

All AC power connections shall be to the building's designated emergency electrical power circuit and shall meet the

requirements of NFPA 70 and NFPA 72. The power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside each control panel the disconnect serves.

The power supply shall be an EDWARDS 3-PPS/M series.

2.2.3. USER INTERFACE

2.2.3.1. PANEL LCD AND COMMON CONTROLS

The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the facility.

Each fire alarm control panel (system node) shall be capable of supporting a backlit LCD display. The display on each system node shall be configurable to *display* the status of any and/or all combinations of all alarm, supervisory, trouble, monitor, or service group event messages on the network. Each LCD display on the system shall be capable of being programmed to allow *control* functions of any combination of nodes on the entire network. The system shall support both 168 character and 960-character LCD displays on the same network.

The LCD display shall provide separate alarm, trouble, supervisory, and monitor event queues of to minimize operator confusion. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device. The integral audible devices shall produce a sound output upon activation of not less than 85 dBA at 10 feet.

The LCD display shall contain the following system status indicators:

- System Power Indicator
- System Test Indicator
- System CPU Fail Indicator
- Ground Fault Indicator
- Disabled Points Indicator
- System Normal Indicator
- System Common Alarm Indicator
- System Common Trouble Indicator
- System Common Supervisory Indicator
- System Common Monitor Event Indicator

The LCD display shall contain the following system switch/indicators:

- System Reset Switch with Indicator
- System Alarm Silence Switch with Indicator
- System Panel Silence Switch with Indicator
- Drill Switch with Indicator
- Alarm Acknowledge Switch with Indicator
- Trouble Acknowledge Switch with Indicator
- Supervisory Acknowledge Switch with Indicator
- Monitor Acknowledge Switch with Indicator

The LCD display shall contain the following system function switches

- System Event Message Queue Scroll Switch.
- Event Details Switch (provides an additional 2000-character message about the device highlighted by the operator.)
- Command Menu Switch
- 10-Digit Keypad with Enter and Backspace switches

The user interface shall provide a backlit LCD that will allow custom event messages of up to 42 characters. The interface shall provide a minimum of eight lines by 21 characters and provide the emergency user hands free viewing of the first and last highest priority events. The last highest priority event shall always display and update automatically. Events shall be automatically placed in one of four easy to access queues. It shall be possible to scroll through and view specific alarm, trouble, supervisory and monitor events separately. Having to scroll through a mixed list of event types shall not be considered as equal. The total number of active and disabled events by type shall be displayed. Visual indication shall be provided of any event type that has not been acknowledged or viewed. It shall be possible to customize the designation of all user interface LEDs and Switches for local language requirements.

Instructional text messages shall support a maximum of 2,000 characters each.

The system 168-character LCD display shall be an EDWARDS model 3-LCD.

The user interface shall provide a backlit LCD that will allow custom event messages of up to 42 characters. The interface shall provide a minimum of 24 lines by 40 characters and provide the emergency user hands free viewing of the first seven (7) and last highest priority events. The last highest priority event shall always display and update automatically. Events shall be automatically placed in one of four easy to access queues. It shall be possible to view specific alarm, trouble, supervisory and monitor events separately. Having to scroll through a mixed list of event types shall not be considered as equal. The total number of active events by type shall be displayed. Visual indication shall be provided of any event type that has not been acknowledged or viewed. It shall be possible to customize the designation of all user interface LEDs and Switches for local language requirements.

Instructional text messages support a maximum of 2,000 characters each.

The system 960-character LCD display shall be a EDWARDS model 3-LCDXL1.

2.2.3.2. LEDS AND SWITCHES

A modular series of switches and LED indicators shall be available to customize the fire alarm control panel operation in accordance with this specification. All LED and switch functions shall be software programmable. Switches shall be configurable for momentary, maintained, toggle, or "exclusive or" operation as required by the application. LEDs shall be configurable for slow flash, fast flash or steady operation. LED/Switch modules shall be capable of mounting in any available fire panel module position. All LED/Switch modules shall be supervised. LEDs shall be available in a variety of colors to facilitate identification from a distance. The LED/Switch modules shall provide ample room for custom function text labels under a protective membrane. **Provide a minimum of 12 Programmable Switches to be installed at the ACU/FACP and at each of the Local Operating Consoles (LOCs). Coordinate with Owner for programming and special function assignment of switches.**

The LED/Switch modules shall be EDWARDS 3-24x series, 3-12xx series, and 3-6/3S1xxx series devices.

2.2.3.3. AUDIO ANNUNCIATION AND CONTROL

Provide a master one-way emergency audio control unit as part of the main fire alarm control panel. The emergency audio control shall contain a paging microphone and shall be capable of generating and delivering multi-channel audio messages simultaneously over copper and/or fiber media to remote parts of the facility.

All audio messages and live pages shall originate at the one-way audio control unit. The one-way audio control unit shall store up to 32 minutes of pre-recorded audio messages digitally as WAV files. These messages shall be automatically directed to various areas in a facility under program control. The unit shall have the capacity to store up to 200 individual audio messages and to simultaneously play back seven (7) different messages in addition to live page message. **Coordinate with Civic Center Personnel to create and program up to 12 different audio message WAV files per owner and AHJ requirements that can be directed up to 7 different zones simultaneously in addition to live paging to an eighth zone.**

During non-alarm conditions, the control unit shall continuously distribute a default audio message to all amplifiers, providing total audio path supervision. To enhance system survivability, each remote FACP cabinet containing an amplifier shall play the default audio message in the event of a fire AND a control network system failure.

The one-way emergency audio control shall provide control switches to direct live paging messages as follows:

- "All Call" to direct the page messages to all areas in the facility, overriding all other messages and tones.
- "Page to Evacuation Area" to direct the message to the evacuation area(s), overriding all other messages and tones.
- "Page to Alert Area" to direct page messages to the area(s) receiving the alert message and tones, overriding all other messages and tones.
- "Page to Balance Building" to direct page messages to the areas) in the facility NOT receiving either the evacuation area or alert area messages.
- "Page by Phone" switch to select the firefighter's telephone system as the paging source.

The system shall automatically deliver a preannounce tone of 1000 Hz for three seconds when the emergency operator presses the microphone PTT key. A 'ready to page' LED shall flash during the preannounce phase and turn steady when the system is ready for the user's page delivery. The system shall include a page deactivation timer which activates for 3 seconds when the emergency user releases the microphone talk key. Should the user subsequently press the microphone key during the deactivation period a page can be delivered immediately. Should the timer complete its cycle the system shall automatically restore emergency signaling and any subsequent paging will be preceded by the pre-announce tone. A VU display shall indicate voice level to the emergency operator.

The one-way audio control unit shall be capable of supporting up to 64 remote microphone inputs and a line level audio input.

The fire alarm control panels shall support remote cabinets with zoned amplifiers to receive, amplify and distribute

messages through speakers over supervised circuits.

The master one-way emergency audio control unit shall be an EDWARDS 3-ASU.

2.2.3.4. REMOTE MICROPHONE

Remote microphones shall be included in the LOCs as indicated on the drawings.

The remote microphone shall facilitate live page announcements over the ACU/FACP system from locations distant from the ACU/FACP. It shall be possible to connect up to 63 remote microphones to an ACU/FACP.

The remote microphone shall feature a Push-to-Talk switch, local and remote page active LEDs, and a trouble LED.

The remote microphone shall operate on filtered-regulated 24 VDC power derived from the panel power supply. Power shall be supplied directly from the ACU/FACP or listed auxiliary power supply, ensuring a reliable and monitored power source.

The remote microphone shall be an EDWARDS 3-REMIC series.

2.2.3.5. REPORTS

The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the main LCD and shall be capable of being printed on any system printer.

The system shall provide a report that gives a sensitivity listing of all detectors that have less than 80% environmental compensation remaining. The system shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any particular detector.

When addressable CO detectors are installed, performing a "sensitivity" check from the panel shall report the approximate number months of sensor life remaining.

The system shall provide a report that gives a listing of the sensitivity of all of the detectors on any given panel in the system, or any given analog/addressable device loop within any given panel.

The system shall provide a report that gives a chronological listing of at least the last 1000 system events.

The system shall provide a listing of all of the firmware revision listings for all of the installed components in the system.

2.2.4. SIGNALING LINE CIRCUITS

2.2.4.1. EST3 SYSTEM

The signaling line circuit connecting panels/nodes to intelligent addressable devices including, detectors, monitor modules, control modules, isolation modules, intrusion detection modules and notification circuit modules shall be Class B (style 4). All signaling line circuits shall be supervised and power limited.

When the addressable devices on a signaling line circuit cover more than one designated fire/smoke compartment, a wire-to-wire short on the circuit shall not affect the operation of the addressable devices in other fire/smoke compartments.

Each SLC shall support 125 addressable detector addresses and 125 module addresses. The SLC shall support 100% of all addressable devices in alarm and provide support for a 100% compliment of detector isolator bases. Initial circuit loading shall not exceed 80% in order to allow for future system expansion.

T-taps (branching) shall be permitted on Class B circuits. Where possible, the devices installed at the end of each branch should be easily accessible for troubleshooting, e.g. a pull station at normal mounting height.

The addressable device SLC module shall be UL Listed for use with code compliant, electrically sound existing wiring.

Each intelligent addressable device shall transmit information about its location with respect to other devices on the circuit. This information shall be used to create an "As-Built" wiring diagram as well as provide enhanced supervision of a device's physical location. The device message and programmed system output function shall be associated with the device's location on the SLC circuit location and not a device address.

The SLC module shall allow replacement of "same type" devices without the need to address and reload the "location" parameters on replacement device.

The SLC/Panels shall notify the user when programmed devices are detected on the SLC circuit. The SLC/Panels shall notify the user when the wrong device type is installed at a location configured for a different device type on the SLC circuit.

Should an SLC Controller CPU fail to communicate, the SLC circuit shall go into the stand-alone mode. The circuit shall be capable of producing a loop alarm if an alarm type device becomes active during stand-alone mode to enhance system integrity.

The addressable device signaling line circuit module shall be an EDWARDS 3-SDDC1 series.

2.2.5. NOTIFICATION APPLIANCE CIRCUITS

2.2.5.1. NOTIFICATION APPLIANCE CIRCUITS

General

All notification circuits shall be supervised, and power limited. Non-power limited circuits are not acceptable. All notification appliance circuits shall be Class B (Style "Y").

Initial circuit loading shall not exceed 80% in order to allow for future system expansion.

24 VDC Notification Appliance circuits

Notification appliance circuits shall have a minimum circuit output rating of 2 amps @ 24 VDC

24VDC NACs shall be polarized and provide both strobe synchronization and a horn silence signals on a single pair of wires.

Audio Notification Appliance Circuits

Audio notification appliance circuits shall be polarized and have a minimum circuit output rating of 50 watts @ 25V audio, and 35 watts @ 70V audio.

2.2.5.2. AUDIO AMPLIFIERS

Each audio power amplifier shall have integral audio signal de-multiplexers, allowing the amplifier to select any one of eight digitized audio channels as directed by system programming.

Audio amplifiers shall be power limited and protected from short circuits conditions on the audio circuit wiring. Each amplifier output shall provide a selectable 25/70 Vrms output, suitable for connection to emergency speakers.

To enhance system survivability in the event of a total loss of audio data communications, all amplifiers shall default to the local "EVAC" tone generator channel. If the local panel has an alarm condition, then all amplifiers will sound the EVAC message on their speaker circuits. In the event of a loss of the fully digitized, multiplexed audio riser data, the audio amplifiers shall automatically default to an internally generated alarm tone which shall sound a 3-3-3 temporal pattern.

<Provide a standby audio amplifier that shall automatically sense the failure of a primary amplifier, and automatically program themselves to select and de-multiplex the same audio information channel of the failed primary amplifier, and fully replace the function of the failed amplifier.>

Amplifiers shall also include a 24 VDC notification appliance circuit rated at 24Vdc @ 3.5A for connection of visible (strobe) appliances. This circuit shall be fully programmable.

Provide as minimum, one twenty (20) watt audio amplifier per paging zone. Initial amplifier loading shall not exceed 80% in order to allow for future system expansion. Calculations shall assume each speaker is connected at one (1) watt.

All NAC boosters and amplifier panels shall be combination NAC booster and amplifier panels contained in one cabinet and shall have a minimum of 100 Watts @ 25 Vrms for speaker circuits and 10A @ 24 Vdc for visible (strobe) appliance each.

Audio amplifiers shall be EDWARDS 3-ZA series devices.

2.2.6. INITIATING DEVICE CIRCUITS

2.2.6.1. INITIATING DEVICE CIRCUITS

Conventional (2-wire) initiating device circuits monitoring manual fire alarm stations, smoke and heat detectors, waterflow switches, valve supervisory switches, fire pump functions, and air pressure supervisory switches shall be Class B (Style "A" or "B").

Initiating device circuits shall be configurable for latched or non-latched operation and configurable to initiate alarm, supervisory or monitor events.

End-of-line resistors for conventional initiating device circuits shall be covered with insulated tubing, terminated with ring lugs and display a UL label.

2.2.7. OFF PREMISES COMMUNICATIONS

2.2.7.1. DACT

The system shall provide off premises communications capability using a Digital Alarm Communications Transmitter (DACT) for sending system events to multiple Central Monitoring Station (CMS) receivers over conventional telephone lines.

The system shall provide the CMS(s) with point identification of system events using 4/2, Contact ID ID (SIA DC-05) or SIA DCS protocols.

The dialer shall support up to 255 individual accounts and to send account information to eight (8) different receivers, each having a primary and secondary telephone access number. System events shall be capable of being directed to one or more receivers depending on event type or location as specified by the system design.

In the event of a fire alarm panel CPU failure during a fire alarm condition, the DACT degrade mode shall transmit a general fire alarm signal to the CMS.

The owner shall arrange for two (2) dedicated loop-start phone lines to be terminated using two RJ31X jacks within 5 ft of the main fire alarm control panel.

The DACT shall be an EDWARDS 3-MODCOM(P).

Provide a UL Fire Listed Sole Path Cellular Communicator for delivery of Alarm, Trouble, and Supervisory Signals.

2.3. REMOTE BOOSTER POWER SUPPLY

2.3.1. REMOTE BOOSTER POWER SUPPLY

Install Remote NAC Power Supplies (boosters) at the locations shown on the drawings, as required, to minimize NAC voltage drops. Remote NAC power supplies shall be treated as peripheral NAC devices and shall not be considered fire alarm control units.

The NAC power supplies shall be fully enclosed in a surface mounted steel enclosure with hinged door and cylinder lock and finished in red enamel. Door keys shall be the identical to FACP enclosure keys. The enclosure shall have factory installed mounting brackets for additional UL listed fire alarm equipment within its cabinet. Enclosures shall be sized to allow ample space for interconnection of all components and field wiring, and up to 10AH batteries. The enclosure shall have provisions for an optional tamper switch. All FACP addressable control modules required to initiate the required NAC power supply output functions shall be installed within the NAC power supply enclosure

Remote NAC power supply *input* circuits shall be configurable as Class B supervised inputs or for connection to any 6 to 45 VDC initiation source.

Remote booster power supplies shall provide four (4) synchronized Class B supervised or two (2) Class A, power limited, 24VDC filtered and regulated Notification Appliance Circuits (NACs). Each NAC output shall be configurable as a continuous 24Vdc auxiliary power output circuit. The booster power supply shall be capable of a total output of <6> 10 amps.

The power supply NACs shall be configurable to operate independently at any one of the following rates: continuous synchronized, or 3-3-3 temporal. It shall be possible to configure the NACs to follow the main FACP NAC or activate from intelligent addressable synchronized modules. All visible <audible> NACs within the facility shall be synchronized.

Upon failure of primary AC power, the remote power supply shall automatically switch over to secondary battery power without losing any system functions. It shall be possible to delay reporting of an AC power failure for up to 6 hours. All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately be announced as locally as battery trouble. All power supply trouble conditions (DC power failure, ground faults, low batteries, and IDC/NAC circuit faults) shall identify the specific remote power supply affected at the main FACP. All power supply trouble conditions except loss of AC power shall report immediately. Interconnecting NAC Booster power supplies in a manner which prevents identification of an individual power supply trouble shall not be considered as an equal.

The remote booster power supply shall be capable of recharging up to 24AH batteries to 70% capacity in 24 hours maximum. Batteries provided shall be sized to meet the same power supply performance requirements as the main FACP, as detailed elsewhere in this specification.

All AC power connections shall be to the building's designated dedicated emergency electrical power circuit. The power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside each remote NAC power supply the disconnect serves.

All NAC boosters and amplifier panels shall be combination NAC booster and amplifier panels contained in one cabinet and shall have a minimum of 100 Watts @ 25 Vrms for speaker circuits and 10A @ 24 Vdc for visible (strobe) appliances.

The remote NAC power supplies shall be EDWARDS model BPS/APS series devices.

2.4. ANNUNCIATORS

2.4.1. LOCAL OPERATING CONSOLES

Provide a UL864 listed surface mounted local operating consoles at the locations shown on the drawings.

The LOC shall utilize standard fire alarm user interface components to provide the ability to operate the Autonomous Control Unit/Fire Alarm Control Panel functions from alternate locations within the building. The LOC shall be capable of receiving the same event information and issuing the same system commands as the ACU/FACP to which it is connected, as specified in the functional matrix elsewhere in this specification. Functions shall include initiating all pre-recorded messages and live page messages.

The following common indicators and controls shall be provided on the LOC. The LOC shall include an integral LCD text annunciator. The LOC shall include an integral remote microphone for fire audio system paging. LOC Power, System Trouble, and Signal Silenced LEDs; System Reset, Silence, Trouble Silence, Drill and Lamp Test push buttons. **Provide a minimum of 12 Programmable Switches to be installed at each of the Local Operating Consoles (LOCs). Coordinate with Owner for programming and special function assignment of switches.**

The LOC shall be equipped with a key locked see-through door mounting. The LOC shall be powered by a battery backed up nominal 24 VDC power source.

The mass notification LOC remote annunciator shall be EDWARDS 3-ANN series.

2.5. PERIPHERAL COMPONENTS

2.5.1. ADDRESSABLE

2.5.1.1. DETECTORS

2.5.1.1.1. PHOTOELECTRIC DETECTOR

Provide analog/addressable photoelectric smoke detectors at the locations shown on the drawings.

When mounted in a sounder base, the detector shall initiate a temporal 3-3-3 when smoke is detected.

The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3 ft (0.91m) high and 3 ft (0.91m) wide with air velocities up to 4,000 ft/min. (0-25.39 m/sec) without requiring specific duct detector housings or supply tubes.

Each smoke detector shall be individually programmable to operate at any one of five (5) sensitivity settings. The detector shall also store pre-alarm and alternate pre-alarm sensitivity settings. Pre alarm sensitivity values shall be

configurable in 5% increments of the alarm and alternate alarm sensitivity settings respectively. The detector shall be able to differentiate between a long-term drift above the pre alarm threshold and fast rise above the threshold. The detector shall monitor the sensitivity of the smoke sensor. If the sensitivity shifts outside the UL limits, a trouble signal shall be sent to the panel. It shall be possible to automatically change the sensitivity of individual intelligent addressable smoke detectors for day and night (alternate) periods.

Each detector shall utilize an environmental compensation algorithm that shall automatically adjust for background environmental conditions such as dust, temperature, and pressure. The detector shall provide a maintenance alert signal when 80% (dirty) of the available compensation range has been used. The detector shall provide a dirty fault signal when 100% or greater compensation has been used.

The photoelectric smoke detector shall be an EDWARDS SIGA-PD.

2.5.1.1.2. DUCT SMOKE DETECTOR

Provide intelligent low-profile photoelectric duct smoke detectors / remote test switches at the locations shown on the drawings.

The intelligent duct smoke detector shall operate in ducts having from 100ft/min to 4,000ft/min air velocity. The detector shall be suitable for operation over a temperature range of -20 to 158F° and offer a harsh environment gasket option. The detector shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten (10) feet. Design of the detector shall permit sampling tube installation from either side of the detector and permit sampling tube installation in 45- degree increments to ensure proper alignment with duct airflow. Drilling templates and gaskets to facilitate locating and mounting the housing shall be provided.

The intelligent duct smoke detector shall obtain information from a photoelectric sensing element. The detector shall be able to differentiate between a long-term drift above the pre alarm threshold and fast rise above the threshold. The detector shall monitor the sensitivity of the smoke sensor. If the sensitivity shifts outside the UL limits, a trouble signal shall be sent to the panel

Each detector shall utilize an environmental compensation algorithm that shall automatically adjust for background environmental conditions such as dust, temperature, and pressure. The detector shall provide a maintenance alert signal when 80% (dirty) of the available compensation range has been used. The detector shall provide a dirty fault signal when 100% or greater compensation has been used.

The intelligent duct smoke detector shall provide a form "C" auxiliary alarm relay rated at 2amps @ 30Vdc. The position of the relay contact shall be supervised by the control panel software. Operation of the relay shall be controlled either by its respective detector processor or under program control from the control panel as required by the application. Detector relays not capable of programmed operation independent of the detector's state shall not be considered as equal. The detector shall be equipped with a local magnet-activated test switch.

Each duct detector shall be installed and testing in accordance with manufacturer's instructions, including pressure differential and, velocity testing. Test results shall be submitted to the owner.

Remote test switches/LED indicators shall be provided below the detector on the ceiling to indicate location of the detector in non-mechanical areas, at locations indicated on the drawings.

The Intelligent Photoelectric Duct Smoke Detector shall be an EDWARDS model SIGA-SD.

The remote key operated test switch / LED shall be a EDWARDS model SD-TRK

2.5.1.1.3. FIXED HEAT DETECTOR

Provide intelligent fixed temperature heat detectors at the locations shown on the drawings.

The detector shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The detector shall utilize a low mass thermistor heat sensor and operate at a nominal fixed temperature alarm point rating of 135°F (57°C). The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of thermistor data. Systems using central intelligence for alarm decisions shall not be considered as equal.

The heat detector shall be rated for ceiling installation at a minimum of 50 ft (15.24m) centers and also be suitable for wall mount applications.

The Intelligent fixed temperature detector shall be an EDWARDS SIGA-HFD.

2.5.1.1.4. RATE OF RISE DETECTOR

Provide intelligent combination fixed temperature / rate-of-rise heat detectors at the locations shown on the drawings.

The detector shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The detector shall utilize a low mass thermistor heat sensor and operate at a nominal fixed temperature alarm point rating of 135°F and at a temperature rate-of-rise alarm point of 15°F per minute. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of thermistor data. Systems using central intelligence for alarm decisions shall not be considered as equal.

The heat detector shall be rated for ceiling installation at a minimum of 50 ft centers and also be suitable for wall mount applications.

The Intelligent combination fixed temperature / rate-of-rise heat detector shall be an EDWARDS SIGA-HRD.

2.5.1.1.5. CO DETECTOR

Provide addressable carbon monoxide (CO) detectors at the locations shown on the drawings.

The CO detector shall provide a signal to the control panel for programming system responses. When mounted in a sounder base, the detector shall be capable of initiating a temporal 4-4-4-4 signal when CO is detected. The detector shall be listed under standard UL-2075.

The electro-chemical CO sensor shall generate a CO alarm in compliance with UL-2034 requirements. The sensor shall have a nominal six-year life. Performing a "sensitivity" check from the panel shall report the approximate number months of sensor life remaining. When the sensor approaches the end of its useful life, it shall transmit a maintenance condition to the control panel, indicating the CO sensor board replacement is required. Only when the sensor is no longer operational shall a trouble condition be sent to the control panel. Detectors that transmit a common trouble indication for both sensor end-of-life and other causes of detector trouble shall not be considered as equal.

Placing the CO detector in test mode shall facilitate the use of direct injection of small quantities of CO to check detector functionality.

The CO detector shall be an EDWARDS SIGA-COD.

2.5.1.1.6. STANDARD BASE

Provide standard detector bases suitable for mounting on either North American 1-gang, 3½ or 4-inch octagon box and 4-inch square box, European BESA or 1-gang box.

The bases shall utilize a twist-lock design and provide screw terminals for all field wiring connections.

The base shall contain no active electronics and support all Signature series detector types.

The base shall be capable of supporting a Remote Alarm LED Indicator. Provide remote LED alarm indicators where shown on the plans.

Removal of the respective detector shall not affect communications with other detectors.

The standard addressable detector base shall be an EDWARDS SIGA-SB or SB4.

The remote LED indicator shall be an EDWARDS SIGA-LED

2.5.1.2. MANUAL STATIONS**2.5.1.2.1. DOUBLE ACTION SINGLE STAGE**

Provide addressable double action, single stage fire alarm stations at the locations shown on the drawings.

The manual station shall be suitable for mounting on North American 2 ½ (64mm) deep 1-gang boxes and 1 ½ (38mm) deep 4 square boxes with 1-gang covers. If indicated as surface mounted, provide manufacturer's surface back box.

The fire alarm station shall utilize red polycarbonate construction with molded, raised-letter operating instructions in a contrasting color; shall show visible indication of operation and incorporate an internal toggle switch.

The manual pull station will have an addressable module integral to the unit.

The station reset key shall match the control panel key.

Manual pull stations that initiated an alarm condition when opening the unit are not acceptable.

The addressable double action, single stage manual fire alarm station shall be an EDWARDS SIGA-278.

2.5.1.3. MODULES

2.5.1.3.1. ONE INPUT MONITOR

Provide addressable single input multifunction modules at the locations shown on the drawings.

The module shall be suitable for mounting on North American 2½" (64mm) deep 1-gang boxes and 1½" (38mm) deep 4" square boxes with 1-gang covers.

Each module shall provide one (1) supervised Class B input circuit configurable as one of the following "personalities."

1. Normally-Open Alarm Latching (for alarm initiation applications)
2. Normally-Open Alarm Delayed Latching (for waterflow switch applications)
3. Normally-Open Active Non-Latching (for limit switch and monitor applications)
4. Normally-Open Active Latching (for tamper switch and supervisory applications)

Each module shall identify and report by device address, ground faults and opens associated with its initiating device circuit, to the control panel. Single function modules or without individual ground fault detection identification capability shall not be considered as equal.

The Intelligent Single Input Module shall be an EDWARDS SIGA-CT1.

2.5.1.3.2. TWO INPUT MONITOR

Provide addressable dual input multifunction modules at the locations shown on the drawings.

The module shall be suitable for mounting on North American 2½" (64mm) deep 1-gang boxes and 1½" (38mm) deep 4" square boxes with 1-gang covers.

Each module shall provide two (2) supervised Class B input circuit configurable as one of the following "personalities."

1. Normally-Open Alarm Latching (for alarm initiation applications)
2. Normally-Open Alarm Delayed Latching (for waterflow switch applications)
3. Normally-Open Active Non-Latching (for limit switch and monitor applications)
4. Normally-Open Active Latching (for tamper switch and supervisory applications)

Each module shall identify and report by device address, ground faults and opens associated with its initiating device circuits, to the control panel. Single function modules or without individual ground fault detection identification capability shall not be considered as equal.

The Addressable Dual Input Module shall be an EDWARDS SIGA-CT2.

2.5.1.3.3. NOTIFICATION CIRCUIT

Provide addressable notification appliance circuit modules at the locations shown on the drawings.

The module shall be suitable for mounting in North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes.

The addressable NAC module shall provide one (1) supervised Class B notification appliance circuit.

The NAC control module shall be configurable for the following operations:

- 24 VDC synchronized NAC circuit, 2 amps @ 24 VDC.
- Audio notification circuit 25Vrms @ 50 watts or 70 Vrms @ 35 watts
- Firefighter's Telephone control with ring tone

The addressable notification appliance circuit module shall be an EDWARDS SIGA-CC1(S) or MCC1(S)

2.5.1.3.4. RELAY

Provide addressable control relay modules at the locations shown on the drawings.

The module shall be suitable for mounting on a North American 2 ½" (64mm) deep 1-gang box or 1 ½" (38mm) deep

4" square box with 1-gang covers.

The module shall provide one (1) form C dry relay contacts rated at 24Vdc @ 2 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware. The relay coil shall be magnetically latched to reduce wiring and ensure 100% of the relays on the SLC can be energized at same time.

The addressable control relay module shall be an EDWARDS SIGA-CR or MCR.

2.5.2. NOTIFICATION APPLIANCES

2.5.2.1. LOW PROFILE

2.5.2.1.1. SPEAKER-CEILING

Provide low profile ceiling mounted speaker at the locations shown on the drawings.

Speakers shall mount in a North American 4" x 2 1/8" square electrical box, or a 960A-4RF round flush box, and protrude less than 1.6" from the finished ceiling. The word ALERT shall be prominently displayed on the housing.

The speaker output shall be switch selectable from the following available settings: 2W (91dBA), 1W (87dBA), 1/2W (84dBA), or 1/4W (80dBA) at 10 ft. when measured in reverberation room per UL-1480. Frequency response shall be 400 to 4,000Hz. The selected speaker wattage shall be visible when the speaker-strobe is in its installed position.

The speaker shall provide in and out screw terminals shall accommodate 18AWG to 12 AWG wiring and have captive hardware.

The low-profile ceiling mounted speaker shall be an EDWARDS Genesis GC series.

2.5.2.1.2. SPEAKER-WEATHERPROOF

Provide low profile weatherproof speakers at the locations shown on the drawings.

The weatherproof speaker shall mount in a North American 4" square 1 1/2" deep electrical box for indoor applications without a trim skirt and a 4" square 2 1/8" deep electrical box when used with a trim skirt. A factory supplied back box shall be supplied for weatherproof applications.

The speaker shall be suitable for wall or ceiling mount and operate in temperatures from -40 to 151 degrees F. The word ALERT shall be prominently displayed on the housing.

The speaker output shall be switch selectable from the following available settings:

Wattage	Switch Position	25Vrms	70Vrms
2W	T	90.0 dBA	89.7 dBA
1W	X	87.1 dBA	86.9 dBA
1/2 W	Y	84.0 dBA	83.9 dBA
1/4 W	Z	80.8 dBA	80.8 dBA

Output is at 10 ft. when measured in reverberation room per UL-464. Frequency response shall be 400 to 4,000Hz. The selected speaker wattage shall be visible when the speaker-strobe is in its installed position.

The speaker shall provide in and out screw terminals shall accommodate 18AWG to 12 AWG wiring and have captive hardware.

The weatherproof speaker shall be EDWARDS Genesis WG4 Series.

2.5.2.1.3. SPEAKER-STROBE-WALL

Provide low profile wall mounted speaker-strobes at the locations shown on the drawings.

The low-profile speaker-strobes shall mount in a North American 4" x 2 1/8" square electrical box, without trims or extension rings, and protrude less than 1" from the finished wall. The word ALERT shall be prominently displayed on the housing.

The speaker output shall be switch selectable from the following available settings: 2W (90dBA), 1W (87dBA), 1/2W (84dBA), or 1/4W (81dBA) at 10 ft. when measured in reverberation room per UL-464. Frequency response shall be

400 to 4,000Hz. The selected speaker wattage shall be visible when the speaker-strobe is in its installed position.

The strobe output shall be switch selectable as required by its application from the following available settings: 15cd, 30cd, 75cd & 110cd. Selected strobe rating shall be visible when the speaker-strobe is in its installed position. Amber lens strobes shall be available with outputs of 12/24/60/88cd. Light shall be evenly distributed throughout the required volume using cavity and mask "FullLight" technology to prevent hot spots. Strobes using specular reflectors shall not be considered as equal.

When multiple strobes are installed within view of each other, their outputs shall be synchronized within ten (10) milliseconds of each other for an indefinite period without the need for separate synchronization modules

Horn and strobe power, horn silencing, and strobe synchronization shall be accomplished over a single pair of wires. Both the speaker and strobe elements shall provide in and out screw terminals shall accommodate 18AWG to 12 AWG wiring and have captive hardware.

The low-profile wall mounted speaker-strobes shall be an EDWARDS G4 series.

2.5.2.1.4. SPEAKER-STROBE-CEILING

Provide low profile ceiling mounted speaker-strobes at the locations shown on the drawings.

Speaker-strobes shall mount in a North American 4" x 2 1/8" square electrical box, or a 960A-4RF round flush box, and protrude less than 1.6" from the finished ceiling. The word ALERT shall be prominently displayed on the housing.

The speaker output shall be switch selectable from the following available settings: 2W (91dBA), 1W (87dBA), 1/2W (84dBA), or 1/4W (80dBA) at 10 ft. when measured in reverberation room per UL-1480. Frequency response shall be 400 to 4,000Hz. The selected speaker wattage shall be visible when the speaker-strobe is in its installed position.

The strobe output shall be switch selectable as required by its application from the following available settings: 15cd, 30cd, 75cd & 95cd or 95cd, 115cd, 150cd, &177cd. Selected strobe rating shall be visible when the speaker-strobe is in its installed position. Amber lens strobes shall be available with outputs of 13/26/65/82cd or 82/100/130/155cd.

When multiple strobes are installed within view of each other, their outputs shall be synchronized within ten (10) milliseconds of each other for an indefinite period without the need for separate synchronization modules

Strobe power and synchronization shall be accomplished over a single pair of wires. Both the speaker and strobe elements shall provide in and out screw terminals shall accommodate 18AWG to 12 AWG wiring and have captive hardware.

The low-profile ceiling mounted speaker-strobes shall be an EDWARDS Genesis GC series.

2.5.2.1.5. SPEAKER-STROBE-WEATHERPROOF

Provide low profile weatherproof speaker-strobes at the locations shown on the drawings.

The weatherproof speaker-strobes shall mount in a North American 4" square 1 1/2" deep electrical box for indoor applications without a trim skirt and a and a 4" square 2 1/8" deep electrical box when used with a trim skirt. A factory supplied back box shall be supplied for weatherproof applications.

The speaker-strobe shall be suitable for wall or ceiling mount and operate in temperatures from -40 to 151 degrees F. The word ALERT shall be prominently displayed on the housing.

The speaker output shall be switch selectable from the following available settings:

Wattage	Switch Position	25Vrms	70Vrms
2W	T	90.0 dBA	89.7 dBA
1W	X	87.1 dBA	86.9 dBA
1/2 W	Y	84.0 dBA	83.9 dBA
1/4 W	Z	80.8 dBA	80.8 dBA

Output is at 10 ft. when measured in reverberation room per UL-464. Frequency response shall be 400 to 4,000Hz. The selected speaker wattage shall be visible when the speaker-strobe is in its installed position.

The strobe output shall be switch selectable as required by its application from the following available settings:

		Standard Candela Output Speaker-Strobes	High Candela Output Speaker-Strobes
--	--	--	--

Listing	Location	Strobe Switch Position							
		D	C	B	A	D	C	B	A
UL 1971	Indoor, Clear lens	15 cd	29 cd	70 cd	87 cd	102 cd	123 cd	147 cd	161 cd
UL 1971	Indoor, Amber lens	13 cd	25 cd	59 cd	62 cd	84 cd	101 cd	125 cd	130 cd
UL 1638	Outdoor, Clear lens	6 cd	12 cd	28 cd	35 cd	41 cd	50 cd	60 cd	65 cd
UL 1638	Outdoor, Amber lens	5 cd	10 cd	24 cd	25 cd	34 cd	41 cd	51 cd	52 cd

Selected strobe rating shall be visible when the speaker-strobe is in its installed position

When multiple strobes are installed within view of each other, their outputs shall be synchronized within ten (10) milliseconds of each other for an indefinite period without the need for separate synchronization modules.

Horn and strobe power, horn silencing, and strobe synchronization shall be accomplished over a single pair of wires. Both the speaker and strobe elements shall provide in and out screw terminals shall accommodate 18AWG to 12 AWG wiring and have captive hardware.

The weatherproof speaker-strobes shall be EDWARDS Genesis WG4 Series.

2.5.2.2. HIGH POWER SPEAKER ARRAYS

2.5.2.2.1. HIGH POWER SPEAKER ARRAYS

Provide dual cell high power speaker arrays (HPSA) at the locations shown on the drawings.

Locations of the HPSA sites shall be verified and recorded with GPS coordinates. Each HPSA site shall include a field-mounted local control unit, amplifier, standby batteries, charger, power supply, radio, mounting bracket and loudspeaker assembly for pole or building mounting.

Site coverage shall be designed using directional speaker characteristics to minimize the distortion of voice signals due to the interference from other HPSAs and to prevent the transmission of signals into environmentally sensitive areas on or off of the project site, as shown on the drawings.

Sound levels at any location where personnel may be located, including nearby buildings and underneath the HPSA, shall be at least 15dBA above ambient but not exceed 120 decibels (adjusted) (dBA) when measured on the A-scale of a standard sound level meter at slow response.

Speakers

The directional speaker arrays shall utilize powder coated spun aluminum, 400W re-entrant trumpet speakers featuring 90° horizontal dispersion. Speaker arrays shall be available with 90°, 180°, 270° and 360° horizontal dispersion. The directional speaker arrays shall have an output of 121 dBA @100ft. on the vertical axis.

The omni-directional speaker array shall consist of one or more stackable fiberglass 800 W speaker drivers and provide 360° horizontal dispersion. The omni-directional array shall have an output of 128 dBA @ 100ft on both the horizontal and vertical axis.

The HPSA control units

1. All local equipment for each HPSA speaker site shall be housed in modular cabinets suitable for the local environmental conditions, providing space heaters and ventilation fans, as appropriate. Enclosures shall protect the HPSA control unit from external temperatures ranging from -40° F to +140° F. The cabinet and power boxes shall be capable of being locked. A tamper switch shall signal the central control station that the HPSA enclosure door is open.
2. Each HPSA site shall contain from one to eight 800watt high efficiency switch-mode amplifiers. The amplifier shall have not more than 0.1 percent total harmonic distortion (THD). Amplifier frequency response shall be at least 200 Hz to 10,000 Hz. There shall be no more than 2 percent THD at the speaker at 1000 Hz. The amplifier shall be rated by the manufacturer for a minimum of two (2) hours of continuous operation.
3. The primary HPSA to CCS communication link shall be supervised and utilize TCP/IP protocol.
4. Each HPSA site shall be equipped with batteries to supply power for a minimum of 72 hours of electrical supervision following the loss of normal charging power, followed by a total of 60 minutes of full load operation at the end of the supervisory period.

5. Each HPSA site shall provide a charger/power supply that will accept alternating current (AC) input, backup electrical power generator input, battery input, or solar power cell input.
6. All metallic conductors entering or exiting the equipment cabinet shall be provided with UL Listed surge suppression devices.

Speakers shall be rated to operate between temperatures of -40° F to +140° F

HSPA Mounting

When not mounted to an existing building structure, an elevated supporting structure (e.g., pole, tower) shall be provided at the locations shown on the drawing.

The supporting structure and mount shall be designed to accommodate the static and dynamic loads produced by the sound systems and all attachments and designed to survive a wind speed of 100 miles per hour.

The minimum mounting height of the speakers on the support structure shall be based on the rated output of the speakers and shall prevent hearing damage to anyone directly below the speakers. The speaker mounting height shall not be less than 30 ft. nor greater than 60 ft. above ground level.

HPSA equipment cabinets mounted on the supporting structure shall be installed with the top of the enclosure no more than 10 ft. above ground level. HPSA equipment cabinets mounted on existing buildings shall be located as close as practical to the speaker to facilitate ease of maintenance.

PART 3 - EXECUTION

3.1. INSTALLATION

3.1.1. GENERAL

General

- A. The entire system shall be installed in a skillful manner in accordance with approved manufacturer's installation manuals, shop drawings and wiring diagrams.
- B. All work shall be performed in accordance with the requirements of NFPA 70 and NFPA 72.
- C. Coordinate locations of all devices with all other divisions' drawings and specifications.
- D. All fire alarm devices shall be accessible for periodic maintenance. Should a device location indicated on the contract drawings not meet this requirement, it shall be the responsibility of the installing contractor to bring it, in writing, to the attention of the Project Engineer.
- E. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.
- F. All systems and system components listed to UL864 Control Units for Fire Protective Signaling Systems may be installed within a common conduit raceway system, in accordance with the manufacture's recommendations. System(s) or system components not listed to the UL864 standard shall utilize a separate conduit raceway system for each of the sub-systems.
- G. No wiring except life safety system circuits and system power supply circuits shall be permitted in the control panel enclosures.
- H. Any low-voltage copper wiring that leaves the protection of a building shall be provided with a compatible UL 497B listed transient protection devices where the circuit leaves the building and where it enters the next building.
- I. Devices containing end-of-line resistors shall be appropriately labeled. Devices should be labeled such that removal of the device is not required to identify the EOL device.
- J. Fiber Optic Cable
 1. Only glass filament cable permitted. Plastic filament fiber optic cables are not acceptable.
 2. ST connectors shall be used at all equipment terminations.
- K. Concrete floors shall be X-rayed prior to core drilling on post tension slabs. Verify with engineer on type of slab prior to bid.

3.1.2. FA COMPONENTS

3.12.1 DEVICES

- A.. All devices and appliances shall be mounted to or in an approved electrical box.
- B. All wall mounted *control equipment* shall comply with requirements defined by the International Building Code and Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems (AC-156) using a seismic component importance factor of 1.5.
- C. Fire Alarm Control Panels
1. Mount the enclosure with the top of the cabinet 72" above the finished floor or center the cabinet at 63", whichever is lower.
 2. Label the fire alarm panels with the room number, electrical panel number and circuit breaker number feeding them.
 3. Paint the handles of the dedicated circuit breakers feeding fire alarm panels red and install handle locks.
 4. Within the panel, all non-power limited wiring must be properly separated from power limited circuits.
 5. Grounds shall comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- D. Remote Annunciator
1. Mount the panel; with the top of the panel 72" above the finished floor or center the panel at 63", whichever is lower.
- E. Remote power supplies and auxiliary fire alarm panels
1. Locate the panel or cabinet with the top of the panel 72" above the finished floor or center the panel at 63", whichever is lower.
 2. Do not locate these panels above ceilings or where inaccessible by a person standing on the finished floor of the space.
 3. Label the power supplies and auxiliary FACP's with the room number, electrical panel number and circuit breaker number feeding them.
 4. Paint the handles of the dedicated circuit breakers feeding fire alarm panels red and install handle locks.
 5. Within the panel, all non-power limited wiring must be properly separated from power limited circuits.
- F. Manual Pull Stations
1. Mount stations so that their operating handles are between 42" and 48" above the finished floor.
- G. Notification Appliances: Mount assemblies as follows:
1. All wall mounted audio/visual devices shall be mounted so the entire lens is between 80" and 96" above the finished floor. Where low ceilings exist, devices shall be mounted within 6" of the ceiling.
 2. Each speaker's (horn) output shall be set to the wattage value indicated for its specific location as shown on the drawings.
 3. Each strobe's output shall be set to the candela value indicated for its specific location as shown on the drawings.
 4. Each speaker (horn)-strobe's outputs shall be set to the wattage/candela value indicated for its specific location as shown on the drawings.
 5. Where ceiling height exceeds 30 feet, appliances shall be suspended from the ceiling to a height of 30 feet maximum above the finished floor.
 6. Appliances installed outdoors shall be UL listed for outdoor use.
- H. Smoke Detectors:
1. Smoke and heat detector **heads** shall not be installed until after construction clean-up is completed. Detector **heads** installed prior to construction clean-up shall be cleaned by the manufacturer or replaced.
 2. Detectors located on the wall shall have the top of the detector at least 4" and not more than 12" below the ceiling.
 3. On smooth ceilings, detectors shall not be installed over 30 ft. apart in any direction.
 4. Install smoke detectors no closer than 3 ft. from air handling supply air diffusers or return air openings.
 5. Locate detectors no closer than 12" from any part of a lighting fixture.
- I. Duct Smoke Detectors:
1. Install sampling tubes so they extend the full width of ducts exceeding 36".
 2. Detectors shall be located to facilitate ease of maintenance.
 3. All penetrations near detectors located on/in return ducts shall be sealed to prevent air entry.
- J. End-of-Line Resistors
1. Devices containing end-of-line resistors shall be appropriately labeled.
- K. Remote Status and Alarm Indicators:

1. Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

L. Heat Detectors

1. Heat detectors shall be installed in strict accordance with their UL listing and the requirements of NFPA 72.
2. Heat detectors installed in the elevator machinery room to meet ANSI A17.1 requirement for elevator power disconnect, shall be located adjacent to each sprinkler head. Coordinate temperature rating and location with sprinkler rating and location.

M. Addressable Control (relay) Modules

1. Install the module less than 3 feet from the device controlled.
2. Orient the device mounting for best maintenance access.
3. Label all addressable control modules as to their function.
4. Provide a dedicated 24VDC circuit to feed all auxiliary relays required for inductive loads (auxiliary relays, door holders). Circuits shall be supervised via an end-of-line relay and addressable input module. Auxiliary relays shall not derive their power from the starter or load being controlled.

END OF SECTION 283111

SECTION 284111 - FIRE FIGHTER COMMUNICATION SYSTEM

1. GENERAL

All new buildings, as well as all existing buildings undergoing substantial renovation, a change of occupancy, or the installation of a new fire alarm system shall have approved radio coverage for Fire Fighters within the building based upon the existing signal levels of the local Fire Department communication systems at the exterior of the building. This section shall not require improvement of the existing public safety communication systems.

Exceptions:

- A. Buildings that have sufficient levels of radio coverage to satisfy the requirements of this specification may request a waiver with the following constraints:
 - 1. A radio survey as described in this specification must be submitted and signed by a qualified radio vendor. *(Building must be substantially completed with all walls, windows, roof, interior partitions completed prior to the survey)*
 - 2. The survey shall be submitted with the waiver request.
 - 3. If approved, the waiver will only be valid for a 5-year period at which time a new radio survey must be submitted.
 - 4. If at any time it is determined that radio coverage does not meet this specification, the waiver will be withdrawn, and the property owner is then required to provide radio coverage as required by this specification.
- B. One and 2 family dwellings

- 1.1 Buildings and structures that cannot support the required level of radio coverage shall be equipped with a distributed antenna system and FCC-certified signal boosters, or systems otherwise approved to achieve the required adequate levels of radio coverage.
- 1.2 Existing buildings undergoing substantial renovation, a change of occupancy, or the installation of a new fire alarm system are required to provide radio coverage for fire fighters.
- 1.3 **Provide an allowance of \$55,000 for this system in the event the building does not meet current codes.**

2. SIGNAL STRENGTH

- 2.1 The in-building radio system is an integral component of the life safety equipment of a building or structure. The primary function is to provide reliable firefighter communications at the required signal strength within the specified areas.
- 2.2 Critical Areas such as emergency command center, fire pump room, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations and similar critical areas shall be provided with 100% floor area radio coverage.
- 2.3 General building areas shall be provided with 95% radio coverage.
- 2.4 In-building radio systems required by this ordinance must provide the following signal strengths:
Downlink - Minimum signal strength of -95 dBm throughout the coverage area.
Uplink - Minimum signal strength of -95 dBm received at the FD Radio System.

3. RADIO SURVEY

- 3.1 The building owner shall have the in-building radio system tested to ensure that two-way radio coverage on each floor of the building meets or exceeds the required levels.
- 3.2 Each floor of the building shall be divided into a grid of approximately twenty (20) equal areas. A maximum of one (1) area will be allowed to fail the test per floor. A spot located approximately in the center of a grid area will be selected for the test. Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted. Field strength testing instruments are to be recently calibrated (1 year) and of the frequency selective type incorporating a flexible antenna similar to the ones used on the hand-held transceivers.
- 3.3 RF plots indicating the enhanced coverage shall be submitted at the time of acceptance testing.
- 3.4 The FD is to be notified prior to any testing.
- 3.5 Unattended operation of the in-building radio system is not permitted until the completion of acceptance testing.

4. TECHNICAL SPECIFICATIONS AND COMPONENT INSTALLATION

- 4.1 Assembly and installation of all components of the Fire Fighter Communication System shall comply with all applicable sections of the National Electrical Code.

- 4.2 Survivability from attack by fire shall meet NFPA 72
- 4.3 The system must comply with all applicable sections of FCC rules. Signal booster shall have FCC certification prior to installation.
- 4.4 External filters or attachments or aftermarket modifications of the original equipment shall not be permitted.
- 4.5 Signal booster shall be contained in a NEMA4-type waterproof cabinet. All enclosures shall be painted red with a locking mechanism
- 4.6 The signal booster system shall include built-in automatic alarming of malfunctions of the signal booster and battery system as per NFPA1221 and NFPA 72, 2013 Edition, as applicable. Aftermarket equipment add-ons and modifications to comply with this specification will not be accepted.
- 4.7 Maximum Propagation delay of the signal booster system shall be 14us (microseconds)
- 4.8 Antenna isolation shall be maintained between the donor antenna and all inside antennas (D.A.S.) to a minimum of 20dB under all operating conditions.
- 4.9 The signal booster shall be designed to amplify the full 800MHz and 700MHz public safety frequency bands as follows:
Downlink frequency band: 851MHz – 860MHz and 763MHz – 775MHz
Uplink Frequency Band: 793MHz – 815MHz
Update frequencies to match AHJ jurisdiction **154.37000MHz.**
- 4.10 To reduce the possibility of unwanted out of band interference affecting the operation of the system, signal boosters shall have a minimum out of band rejection / attenuation of 50dB at +/- 1.5MHz from the edges of each passband.
- 4.11 Signal Boosters shall have oscillation prevention circuitry to protect the public safety radio system in case of signal booster malfunction.
- 4.12 Signal Booster shall be UL2524 listed
- 4.13 The cabinet shall be labeled (in bright yellow):

LOCAL FIRE DEPT. RADIO

Serviced by: vendor name and telephone number

5. SYSTEM MONITORING

- 5.1 The In-Building Radio system shall include automatic supervisory and trouble signals for malfunctions of the signal booster(s) and power supplies that are annunciated by the fire alarm system. Trouble signals must be immediately reported to the radio service provider.
- 5.2 The integrity of the circuit monitoring the signal boosters and power supplies shall comply with NFPA1221 and NFPA72.
- 5.3 System and Signal booster supervisory signals shall include Donor Antenna Malfunction and signal booster failure.
- 5.4 Power supply supervisory signals shall include loss of normal AC power, Failure of battery charger, and low battery capacity (alarming at 70% of battery capacity and 30% of the charge remaining).
- 5.5 A dedicated monitoring panel* shall be provided within the emergency command center to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each signal booster:
 - 1. Normal AC power
 - 2. Signal booster trouble
 - 3. Donor Antenna Failure
 - 4. Loss of normal AC power
 - 5. Failure of battery charger
 - 6. Low battery capacity
- 5.6 A sign will be located at the dedicated monitoring panel with the name and telephone number of the service provider.

6. DISTRIBUTED ANTENNA SYSTEM

- 6.1 The distributed antenna system may utilize a radiating cable, conventional cable, fixed antennas or a Combination of all three.
- 6.2 A secondary user of the distributed antenna system (DAS) must comply with all requirements of the Local Fire Department so as not to degrade the operational standards of the system. Notice will be made to the Local Fire Department as part of the permit application if the DAS will have non-fire department frequencies included.

7. POWER SUPPLY

- 7.1 At least 2 independent and reliable power supplies shall be provided.
- 7.2 The primary power source shall be supplied from a dedicated twenty (20) ampere branch circuit and comply with NFPA1221 and NFPA 72, National Fire Alarm Code, 2013 edition as applicable.

- 7.3 The emergency responder radio coverage system shall be equipped with a secondary source of power. The secondary source of power shall be a battery system with a dedicated battery charger powered by a separate, dedicated and independent electrical circuit of sufficient size. The secondary power supply shall supply power automatically when the primary power source is lost. The secondary source of power shall be capable of operating the emergency responder radio coverage system for a period of at least 24 hours. The battery system shall automatically charge in the presence of external power input. Battery charger and all other electronic components must be fully enclosed in a non-vented NEMA4 enclosure. Batteries shall be enclosed in a separate, vented NEMA3R rated enclosure.

8. **ACCEPTANCE TESTING**

- 8.1 Delivered audio quality (DAQ) testing will be conducted by FD radio personnel to ensure that two-way radio coverage, on each floor of the building, meets the minimum coverage requirements of Section 2.
- 8.2 The radio service vendor shall certify that the in-building radio system was installed and tested in accordance with the requirements of the current FD In-Building Radio Specification.
- 8.3 A radio service company shall certify that a maintenance contract is in effect that provides 24-hour by 7-day response within 2 hours of notification of a problem. This contract must be for a period of at least 1 year.
- 8.4 RF plotting (grid tests) results, gain values of all amplifiers, as built drawings which include BDA Manufacturer, Model #, Serial #, FCC Certification #, and a link budget must be submitted

9. **ANNUAL TEST**

- 9.1 The owner shall check all active components of the in-building radio system, including but not limited to amplifier, power supplies, and back-up batteries, a minimum of once every twelve (12) months.
- 9.2 Amplifiers shall be tested to ensure that the gain is the same as it was upon initial installation and acceptance. The original gain shall be noted and any change in gain shall be documented.
- 9.3 Back-up batteries and power supplies shall be tested under load to verify that they will operate during an actual power outage.
- 9.4 Active components shall be checked to determine that they are operating within the manufacturer's specifications for their intended purpose.
- 9.5 Documentation of the test shall be maintained on site and a copy forwarded by the radio service company to the Local Fire Department upon completion of the test.

10. **FIVE-YEAR TEST**

- 10.1 In addition to the annual test, a radio coverage test shall be conducted a minimum of once every five (5) years to ensure that the radio system continues to meet the requirements of this ordinance. The procedure set forth in Section 3 shall apply to such tests.

11. **RADIO SERVICE PROVIDER**

- 11.1 All tests shall be conducted, documented, and signed by a person in possession of FCC General General Radio Telephone Operators License.
- 11.2 All testing personnel shall be certified and authorized by the BDA manufacturer in the installation and operation of their equipment.
- 11.3 Must submit reports of annual test and 5-year tests.
- 11.4 FD shall be notified in writing at least thirty (30) days prior to cancellation of a maintenance contract.
- 11.5 FD shall be notified in writing upon the procurement of contractual agreements relating to in-building radios covered by this specification.

12. **MODIFICATIONS**

- 12.1 Any modification of an existing BDA System will require a written request to FD.
- 12.2 After completion of any modification to a BDA a full acceptance test as required in this specification will be conducted and submitted for review.

13. **FIRE DEPARTMENT INSPECTIONS**

- 13.1 Fire Department Radio personnel, after providing reasonable notice to the owner or their representative, shall have the right to enter onto the property to conduct field testing to be certain that the required level of radio coverage is present.

14. **PROPERTY OWNER RESPONSIBILITIES**

- 14.1** Upgrades to system as directed by the Local Fire Department.
- 14.2** Maintenance contract maintained with a qualified radio service contractor, who will provide a 24 hour by 7-day emergency response within two (2) hours after notification

END OF SECTION 284111

SCHOEL ENGINEERING

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Protection of existing trees and vegetation to remain.
 - 2. Removing trees and other vegetation.
 - 3. Clearing and grubbing.
 - 4. Topsoil stripping.
 - 5. Removing above-grade site improvements.
 - 6. Removing below-grade improvements.
 - 7. Disconnecting, capping or sealing, and abandoning site utilities in place.
 - 8. Disconnecting, capping or sealing, and removing site utilities.

- B. Related Sections:
 - 1. Section 312500 Erosion and Sedimentation Controls
 - 2. Section 312000 Earth Moving

1.2 DEFINITIONS

- A. Topsoil: Friable clay loam surface-soil found in depth not less than 4"; free of subsoil, clay, lumps, stones and objects larger than 2"; without weeds, roots, or other objectionable material.

1.3 MATERIAL OWNERSHIP

- A. Except for materials to be stockpiled or remain Owner's property, remove remainder from site.

1.4 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

- B. Record drawings per Contract Closeout Checklist.
 - 1. Identify and accurately locate capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.5 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements of specifications.

1.6 PROJECT CONDITIONS

- A. Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct public ways or other facilities without permission from Owner and authorities.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

- B. Improvements on Adjoining Property: Authority for performing indicated removal and alteration work on property adjoining Owner's property will be obtained by Owner before award of Contract.

- C. Notify utility locator service for area where Project is located before site clearing.

SCHOEL ENGINEERING

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 312000 Earth Moving.
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Provide erosion and sediment control measures to prevent soil erosion and discharge of runoff or airborne dust to adjacent properties and walkways.
- C. Locate and clearly flag trees and vegetation to remain or to be relocated.
- D. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

- A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within drip line.
 - 2. Do not permit vehicles, equipment, or foot traffic within drip line.
- B. Do not excavate within drip line of trees, unless otherwise indicated.
- C. Where excavation is within drip line, hand clear and excavate to minimize damage to root system. Use narrow-tine spades; comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.
 - 2. Support and protect roots until covered with soil.
 - 3. Coat cut face of roots with emulsified asphalt.
 - 4. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in manner approved by Engineer.
 - 1. Employ qualified arborist, licensed in jurisdiction of Project, to repair damage to trees and shrubs.
 - 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.3 UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities to be removed.
 - 1. Arrange to shut off indicated utilities with utility companies. Pay any required fees.

SCHOEL ENGINEERING

- B. Do not interrupt utilities serving occupied facilities unless permitted under following conditions and then only after arranging to provide temporary service as required.
 - 1. Notify Engineer two days before proposed interruption.
 - 2. Do not proceed without Engineer's written permission.
- C. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction; dig out stumps and grub roots.
 - 1. Protect trees, shrubs, and vegetation to remain or be relocated.
 - 2. Cut minor roots and branches of trees to remain in a clean and careful manner where obstructing new construction.
 - 3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18" below exposed subgrade.
 - 4. Use only hand methods for grubbing within drip line of trees.
- B. Fill depressions caused by clearing and grubbing with satisfactory soil material, unless further excavation or earthwork is indicated.
 - 1. Place fill in horizontal layers not exceeding 8" loose depth, and compact each layer to a density equal to adjacent original ground.

3.5 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, foundations, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.6 DISPOSAL

- A. No burning shall be permitted on site.
- B. Remove surplus soil, unsuitable topsoil, obstructions, demolished materials, trash and debris, and legally dispose of off site.

END OF SECTION

SCHOEL ENGINEERING

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes unclassified excavation, grading, and fill as shown or specified, all as part of Base Bid, and:
 - 1. Site excavation as shown or indicated, including removal of rock, rock deposits, boulders, organic material, soil or any other material to reach grade, subgrade, footing or trench bottom, or other condition indicated.
 - 2. Coordinate work with Owner's Geotechnical Engineer.
 - 3. Grade in stages if required to install new or modify existing utilities.
 - 4. Scarify, compact and test previously graded areas of site for acceptance before beginning work of this contract.
 - 5. Excavate and place embankments to required line, grade and elevation.
 - 6. Prepare low areas for fill placement, including disposal of muck, silt, wet or unsuitable material.
 - 7. Haul-in satisfactory fill material, if satisfactory material is not available on-site to provide site to line and grade shown.
 - 8. Haul-off excess excavation or unsatisfactory material, if material cannot be used on-site to provide line and grade shown.
 - 9. Prepare subgrades for slabs, walks, pavements, and landscaping.
 - 10. Provide base course for walks and pavements.
 - 11. Excavate and backfill for underground mechanical and electrical utilities and appurtenances.

1.2 RELATED WORK

- A. Section 312500 Erosion and Sedimentation Controls
- B. Section 311000 Site Clearing
- C. Section 334100 Storm Utility Drainage Piping

1.3 DEFINITIONS

- A. Backfill: Soil material used to fill an excavation.
- B. Base Course: Layer between subgrade, walks and paving.
- C. Bedding Course: Layer of select material underneath pipes.
- D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill when sufficient satisfactory soil not available on-site.
- E. Unclassified Excavation: Excavation is unclassified, which is defined as removal of any material encountered in reaching elevations or accomplishing the work shown on the drawings without regard to type or character; whether wet or dry; dark or light; dirt or rock; hard or soft; humus or no-humus; smelly or not smelly; heavy or light in weight.
- F. Fill: Soil material used to raise existing grades.
- G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

SCHOEL ENGINEERING

- H. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base, drainage fill, or topsoil materials.
- I. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

- A. Submit per Conditions of Contract
- B. Samples of:
 - 1. Proposed fill/backfill, 30-lb samples, sealed in airtight containers, from on-site or borrow sources.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of following with requirements indicated:
 - 1. Classification per ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve per ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.
- D. Blasting Plan: For record purposes approved by authorities having jurisdiction.
- E. Seismic Survey Report: For record purposes; from seismic survey agency.
- F. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.
- B. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code" and prepare a blasting plan reporting the following:
 - 1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
 - 2. Seismographic monitoring during blasting operations (minimum of four units to be included in project. Additional units required at direction of Owner or his representative).
- C. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
 - 1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures
Seismographic monitoring during blasting operations (minimum of four units to be included in project. Additional units required at direction of Owner or his representative).
- D. Owner will employ independent geotechnical testing agency qualified per ASTM E 329 to verify that soils meet requirements, perform required field and laboratory tests. The Contractor shall work with the testing agency to ensure that required testing and results are obtained.

1.6 PROJECT CONDITIONS

- A. Do not interrupt utilities serving Owner or others except when permitted in writing by Engineer and then only after acceptable temporary services are provided.

SCHOEL ENGINEERING

1. Provide minimum 48-hour notice to Owner and receive written notice to proceed before interrupting any utility.
 2. Contact utility-locator service before excavating.
- B. Demolish and remove from site underground utilities indicated to be removed. Coordinate with utility company to shutoff active lines.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Provide approved borrow material from off-site when sufficient approved material not available from on-site excavation.
- B. Satisfactory Soils: ASTM D 2487 classification CL, GW, GP, GM, ML, SM, SW, and SP; free of topsoil and organics, free of rock or gravel larger than 2 inches; with Plasticity Index of less than 25. liquid limit less than 50 and maximum dry density above 100 pcf.
- C. Unsatisfactory Soils: Material that will not readily compact, organic material, or material with Plasticity Index greater than 25, or unit weight less than or equal to 100 pcf. ASTM D 2487 MH, CH, OL, OH, and PT.
1. Unsatisfactory soils also include satisfactory soils not maintained within 2% of optimum moisture content at time of compaction.
- D. Provide engineered fill as required.
- E. Backfill and Fill Material: Satisfactory soil material.
- F. Base Material: Naturally or artificially graded mix of natural or crushed aggregate conforming to the requirements of ALDOT Standard Specifications for Highway Construction Section 825-Type "B".

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage by earthwork operation.
- B. Provide erosion and sediment control; prevent erosion or displacement of soils and discharge of soil-bearing water runoff or dust to adjacent properties. Erosion and sediment control is specified in Section 312500 Erosion and Sedimentation Controls.
- C. Tree protection is specified in Section 311000 Site Clearing.

3.2 DEWATERING

- A. Prevent surface or ground water from entering excavations, ponding on prepared subgrades, and from flooding site and surrounding area.
- B. Protect areas receiving fill, subgrades and foundation soils from softening and damage by rain or water accumulation.

3.3 EXPLOSIVES (If used)

- A. Explosives:

SCHOEL ENGINEERING

1. Comply with all laws, rules, and regulations of Federal, State, and local governments and insurer governing keeping, storage, use, manufacture, sale, handling, transportation, or other disposition of explosives. All operations involving handling, storage, and use of explosives shall be conducted under supervision of properly licensed individual. Take special precautions for proper use of explosives in order to prevent harm to human life and damage to surface structures, all utility lines, or other subsurface structures. Do not fire blasts until persons in vicinity have had ample notice and have reached positions of safety.
 2. Contractor shall indemnify and hold harmless Owner, Architect, Engineer, Owner's representative, and their agents and employees from any claim growing out of use of such explosives. Removal of any item of material of any nature by blasting shall be done in such a manner and such time as to avoid damage affecting integrity of design and to avoid damage to any new or existing structure included in or adjacent to work. It shall be the Contractor's responsibility to determine method of operation to ensure desired results and integrity of completed work.
 3. The Contractor shall submit a general blasting plan for review by the Architect and Geotechnical Engineer, to be approved, a minimum of two weeks before drilling. A pre-blast survey is to be included with the blasting plan. Pre-blast survey shall include as a minimum the items as described in Section 107.11 ALDOT Standard Specifications. Any damage to existing structures, utilities, etc. shall be repaired to pre-blast condition at no cost to the Owner.
 4. The Contractor's blasting shall not exceed the following limitations at any exposure, including nearby structures and occupied buildings.
 - a. Vibration levels and over pressure shall not exceed local government requirements. If no local requirements apply, vibration levels shall not exceed one half (1/2) inch per second and over pressure shall not exceed 0.0055 pounds per square inch or 100 db (decibels).
 - b. Depth of stemming shall be greater than the smallest dimension between holes.
 5. In addition to the above, blasting will not be permitted within 400 feet of concrete that has aged less than thirty-six (36) hours. After thirty-six (36) hours, the vibration level shall not exceed one-half (1/2) inch per second.
 6. The Contractor shall use suitable mats or other approved methods suitable to smother his blasts and eliminate any projectile "fly" rock.
 7. The Owner may employ a consultant to monitor certain blasts with seismograph and/or overpressure devices. The Contractor shall employ a blasting consultant to monitor all blasts and shall notify the Architect 24 hours in advance of such blasting to allow for monitoring to be scheduled.
 8. Logs of each blast shall be recorded by the Blasting Contractor and be kept on site at all times for review by the building inspector. Submit logs to the Architect and the Geotechnical Engineer.
 9. Review and comment by the Architect and Geotechnical Engineer of the Contractor's blasting plans and/or inspection of the performance of the work by the Architect and Geotechnical Engineer shall not relieve the Contractor of any liability for injuries and/or damages resulting from the blasting.
 10. All rock surfaces shall be free of loose, fractures, or broken rock to eliminate hazards to personnel and construction operations. After completion of the permanent rock faces, these surfaces shall be maintained in a condition satisfactory to the Architect and Geotechnical Engineer for the duration of the work.
- B. Coordination :
1. Any blasting activities by the Contractor must be coordinated in advance with the Owner. The Contractor must notify the Owner at least two weeks in advance of the commencement of any blasting activities on the site. The Contractor and the Owner will establish in advance a daily time window for any blasting activities to occur. This time window must have the specific approval of the Owner and must be strictly adhered to by the Contractor. The Contractor will notify any and all others that may be affected by the blasting.
 2. The Contractor is to notify and coordinate with the existing utility companies and have written approval from each affected utility before blasting operations commence.

SCHOEL ENGINEERING

3.4 EXCAVATION

- A. Excavation is unclassified and includes all excavation regardless of materials and obstructions encountered.

3.5 STABILITY OF EXCAVATIONS

- A. Comply with all Federal, State and local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.

3.6 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevation and dimension within $\pm .10"$. Extend excavation from structure to allow for placing and removing formwork, installing services and other construction, and inspections.
 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade before placing reinforcement. Trim bottom to required line and grade to leave solid base to receive other work.
 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Devices: Excavate to elevation indicated within $\pm .10"$. Do not disturb bearing surface.

3.7 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.8 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated slopes, lines, depths, and elevations.
 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trench to uniform width to provide 12" working clearance on each side of pipe or conduit. Excavate trench wall vertically from bottom to 12" above top of pipe or conduit, unless otherwise indicated.
- C. Trench Bottoms: Excavate and trench to provide uniform bearing and support of pipe and conduit. Shape subgrade to provide continuous support for bells, joints, barrels and fittings; avoid point loading, remove stones and sharp objects.
 1. For pipes or conduit less than 6" diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 2. For pipes and conduit 6" or larger diameter, shape trench bottom to support bottom 90° of pipe circumference. Fill depression with tamped sand backfill.
 3. Where encountering rock or other unyielding bearing, carry trench excavation 6" below invert elevation to receive bedding course.
 4. Sanitary and storm sewers shall receive a minimum of bedding of 4" of No. 57 stone to 30" pipe and 6" of No. 57 stone bedding for pipe sizes 36" and larger.

3.9 APPROVAL OF SUBGRADE

- A. Notify Engineer when excavations have reached required subgrade.
- B. When Geotechnical Engineer determines unsatisfactory soil is present, continue excavation and replace with compacted material as directed.
- C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.
- D. Reconstruct subgrades damaged by freeze, frost, rain, water, or construction activities, as directed by Engineer.

SCHOEL ENGINEERING

3.10 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering required top elevation. Use lean concrete when acceptable to Engineer.
 - 1. Fill unauthorized excavations under other construction as directed by Engineer.
- B. Where indicated width of utility trench is exceeded, provide stronger pipe, or special installation procedures, as required by the Engineer.

3.11 STORAGE OF SOIL MATERIALS

- A. Stockpile soil materials. Do not intermix. Place and shape stockpiles to drain surface water. Hydroseed and place erosion and sediment control fencing at base of stockpile. Cover to prevent wind-blown dust.
 - 1. Stockpile away from edge of excavations. Do not store within drip line of trees. If there is not sufficient area for onsite stockpiles, Contractor shall provide storage offsite at no additional cost to Owner.

3.12 BACKFILL

- A. Backfill excavations promptly, but not before:
 - 1. Acceptance of construction below finish grade including, dampproofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for record documents.
 - 3. Testing, inspecting, and approval of underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring and bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.13 UTILITY TRENCH BACKFILL

- A. Place and compact bed course on trench bottoms, on rock and other unyielding bearing, and to fill unauthorized excavations. Shape bed course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Use concrete backfill in trenches that extend below or pass under footings and that are excavated within 18" of footings. Place concrete to level of bottom of footings.
- C. Provide 4" concrete base slab support for piping or conduit less than 30" below surface of roads. After installation and testing, encase pipe or conduit in 4" of concrete before backfilling.
- D. Place and compact initial backfill of satisfactory soil or subbase material, free of particles larger than 1", to 12" over pipe or conduit.
- E. Where sewers, water lines, etc. are to be under paving or other improvements they shall be backfilled full depth with No. 57 stone. If sewer is located in fill and backfill is six feet or over from the top of pipe to finished subgrade backfill in accordance with Paragraph D above.
 - 1. Carefully compact material under pipe haunch and backfill evenly on both sides and along pipe or conduit to avoid damage or displacement of system.
- F. Coordinate backfilling with utilities testing.
- G. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.
- H. Place and compact final backfill of satisfactory soil material to final subgrade.

SCHOEL ENGINEERING

- I. Install warning tape directly above utilities, 12" below finished grade, except 6" below subgrade under pavements and slabs.

3.14 FILL

- A. Remove vegetation, topsoil, debris, wet, and unsatisfactory soil materials, obstructions, and deleterious materials from ground before placing fills. Areas receiving fill shall be proof rolled in the presence of the Geotechnical Engineer prior to fill placement. Areas identified as unacceptable by the Geotechnical Engineer shall be excavated (undercut) and backfilled prior to fill placement.
 - 1. Plow strip, or break up sloped surface steeper than 1 vertical to 4 horizontal so fill will bond with existing material.
- B. When subgrade or existing ground to receive fill has density less than required for fill, break up surface to depth required, pulverize, moisture-condition or aerate soil and recompact to required density.
- C. Place and compact fill in layers to required elevations as follows:
 - 1. Under grass, use satisfactory soil.
 - 2. Under walks and pavements, use subbase or base material, or satisfactory soil.
 - 3. Under steps and ramps, use subbase material.
 - 4. Under building slabs, use drainage fill over subgrade as shown and engineered fill to bring to subgrade.
 - 5. Under footings and foundations, use engineered fill.

3.15 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2% optimum moisture content.
 - 1. Do not place backfill or fill on muddy, frozen, or icy surface.
 - 2. Remove and replace, or scarify and air-dry soil too wet to compact as specified. Stockpile, or spread and dry removed material.

3.16 COMPACTION

- A. Place backfill/fill in 8" loose layers when compacted by heavy equipment; 4" loose layers when compacted by hand tamper.
- B. Place backfill/fill evenly on all sides of structures to required elevations. Place uniformly along full length of structure.
- C. Compact soil to not less than following percentage of maximum dry unit weight per ASTM D 698:
 - 1. Under structure, building slab, steps, and pavements, compact each layer of backfill or fill at 98%.
 - 2. Under walkways, compact each layer of backfill or fill material at 98%.
 - 3. Under lawn or unpaved areas, compact each layer of backfill or fill material at 95%.
- D. Embankment layers that are composed predominately of rock (approximately 70%) shall be rolled until firm to the satisfaction of the project's geotechnical engineer.

3.17 GRADING

- A. Uniformly grade areas to a smooth surface, free from irregular changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide smooth transition between existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to conform to required surface tolerances.
- B. Slope grade to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within following tolerances:

SCHOEL ENGINEERING

1. Lawn or Unpaved Areas: + .16'.
2. Walks: + .08'.
3. Pavements: \pm .04'.

C. Grading Inside Building Lines: Finish subgrade to tolerance of 1/2" when tested with 10' straightedge.

3.18 SUBSURFACE DRAINAGE

A. Drainage Piping: See Section 3340 00 Storm Drainage Utilities.

3.19 BASE COURSE

- A. Under pavements and walks, place base course material on prepared subgrades. Place base course material over subbases to pavements.
1. Compact the base to a minimum density of 100% at optimum moisture in accordance with ASTM D1557.
 2. Shape to required crown elevations and cross-slope grades.
 3. When thickness is 6" or less, place in single layer.
 4. When thickness exceeds 6", place in equal layers, with no layer more than 6" or less than 3" when compacted.

3.20 FIELD QUALITY CONTROL

- A. Testing Agency: The Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow test agency to inspect/test each subgrade and each fill or backfill layer. Do not proceed until tests for previous work verify compliance with requirements.
1. Test agency will test compaction of soils in place per ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method), or ASTM D 2937 (drive cylinder method), as applicable.
 - a. Field density tests may be performed by nuclear method per ASTM D 2922, provided calibration curves are adjusted to correlate to tests performed using ASTM D 1556 or ASTM D 2167. Check each calibration against curves furnished with moisture gages per ASTM D 3017.
 2. Footing Subgrade: At footing subgrades, perform at least one test of each soil stratum per 2,500SF to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on visual comparison of each subgrade with related tested strata when acceptable to Geotechnical Engineer.
 3. Paved Areas: At subgrade and at each compacted fill and backfill layer, perform at least one field in-place density test for every 5,000 sq ft or less of paved area or building slab, but in no case fewer than three tests.
 4. Foundation Wall Backfill: In each compacted backfill layer, perform at least one field in-place density test for each 50 feet or less of wall length, but no fewer than two tests along a wall face.
 5. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 200 feet or less of trench, but no fewer than two tests.
- C. When test agency reports subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace to depth required, recompact and retest until required density is obtained.

3.21 PROTECTION

- A. Protect graded areas from traffic and erosion, and free of trash and debris.
- B. Repair and re-establish grade to specified tolerance if eroded, rutted, settled, or compaction is lost due to construction or weather.

SCHOEL ENGINEERING

1. Scarify or remove and replace material to depth directed by Engineer; reshape and recompact at optimum moisture content to required density.
- C. Where settling occurs during warranty period, remove surface, backfill with additional approved material, compact, and reconstruct surface.
1. Restore appearance, quality, and condition of surface to match adjacent work; eliminate evidence of restoration.
- 3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS
- A. Legally dispose of soil and waste material off-site.

END OF SECTION

SCHOEL ENGINEERING

SECTION 312500 - EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work described in this section includes providing, establishing, and maintaining temporary erosion and sediment control work items which consist of measures indicated on drawings and as necessary during the life of the contract to control erosion and sedimentation on or beyond project limits.
- B. Related Work:
 - 1. Section 312000 Earth Moving.

1.2 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. General:
 - a. Current Federal, State, and City Standards apply to this Project.
 - b. Listings: Issues listed by reference, including revisions of issuing authority, form part of this Section to extent indicated. Issues listed are identified by number, edition, date, title, or other designation established by issuing authority. Issues subsequently referred to are by an issuing authority abbreviation and a basic designation.
 - c. Modifications: Modifications by Engineer to reference Standards, if any are noted with Standard.
 - 2. Alabama Department of Transportation (ALDOT), Standard Specifications for Highway Construction, Latest Edition.
 - 3. "Alabama Nonpoint Source Management Program" published by the Alabama Department of Environmental Management, April 1989.
 - 4. Local Codes, Ordinances, Regulations.
- B. Pre-Construction Meeting: Before proceeding with site clearing operations, review site features to remain and be protected at the site with Owner and Engineer.
- C. Site Damage: If any protection materials or measures are dismantled, removed or altered, even temporarily, or if areas of the site designated to remain are utilized in any manner without the Owner's written authorization, the Contractor agrees to pay the Owner five hundred dollars (\$500.00) per infraction, as determined by the Engineer, as fixed and liquidated damages.

PART 2 - PRODUCTS

2.1 HAY BALES

- A. Bales may be either hay or straw containing five cubic feet of material and weighing not less than 35 lbs.

2.2 SILT FENCE

- A. Silt fences approved by governing authorities, consist of a polymeric filter fabric mounted on posts with wire backing as shown on the drawings.

2.3 STRAW WATTLE

- A. Straw wattle cylinders consist of compressed agricultural straw wrapped in photodegradable synthetic netting as shown on the drawings.

PART 3 - EXECUTION

3.1 EROSION AND SEDIMENTATION CONTROL

- A. General: Employ erosion and sediment control management practices as required. The Contractor is responsible for obtaining all required permits for construction activity. The Contractor will be responsible for application and maintenance of all conditions required by the permits. The Contractor will be responsible for all requirements of the permits until acceptance of all work under this Contract.
1. Control and abate water pollution, erosion and sedimentation at its potential source; employ downstream sediment entrapment measures as a backup to primary control at the source.
 2. Take all reasonable precautions to prevent and suppress fires and other detrimental occurrence which may be caused by construction operations.
 3. Protect streams and drainage systems from contamination by siltation or other harmful materials.
 4. The Contractor, his employees and subcontractors must use conservation practices during the work:
 - a. Comply with all State and local laws, rules and regulations for prevention and suppressive action for forest fires and for the prevention of pollution of streams and drainage ways.
 - b. Protect and preserve soil and vegetation cover on the property and on adjacent lands. Any disturbance of soil and vegetation cover outside the project area will not be permitted under any circumstances. Special consideration will be given to the protection of adjacent areas.
 - c. Prevent and control soil erosion and gulleying within the property covered by the Contract and the lands immediately adjacent as a result of construction.
 - d. Do not deposit waste, loose soil or other materials in live streams, swales or drainage ways.
 - e. Do not allow fuels, oils, bitumen or other greasy or chemical substances originating from construction operations to enter or be placed where they may enter a live stream or drainage way. Service and repair equipment in selected areas as far as possible from streams and drainage ways.
 - f. Coordinate erosion and sedimentation control measures with the clearing and grubbing operation so both activities occur in the correct relation to one another.
 - g. Install and maintain erosion and sedimentation control measures (both temporary and permanent) as a continuing program until the site work is complete. This includes repairs, damage from storms, regular maintenance, removal and disposal of accumulated silt.
 - h. Protect downstream properties.
- B. Hay bales and straw wattles shall be anchored by use of stakes.
- C. Once installed, maintain silt fence and straw wattle until its capacity has been reached or erosion activity in the areas has been stabilized. When a silt fence or straw wattle has reached its capacity to function and need for a backup fence becomes evident, provide an additional line of silt fence or straw wattle. Repair of a damaged silt fence or straw wattle shall be accomplished by utilizing same type of materials used in original construction.
- D. Install and maintain erosion and sedimentation control measures as a continuing program until the site work is complete. This includes, repairs, damage from storms, regular maintenance and removal and disposal of accumulated silt.

3.2 MAINTENANCE

- A. Maintain erosion and sediment control features that have been installed. Maintenance of erosion and sediment control features will be considered as an incidental part of the work and no specific payment for this will be made.

END OF SECTION

SECTION 313116 - TERMITE CONTROL

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. Soil treatment.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each type of termite control product.
- C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
 - 1. Date and time of application.
 - 2. Moisture content of soil before application.
 - 3. Termiticide brand name and manufacturer.
 - 4. Quantity of undiluted termiticide used.
 - 5. Dilutions, methods, volumes used, and rates of application.
 - 6. Areas of application.
 - 7. Water source for application.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who is accredited by manufacturer.

1.6 FIELD CONDITIONS

- A. Soil Treatment:
 - 1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
 - 2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.7 WARRANTY

- A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites, including Formosan termites (*Coptotermes formosanus*). If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 SOIL TREATMENT

- A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.

1. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
 1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.
 1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
 2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
 3. Crawlspace: Soil under and adjacent to foundations. Treat adjacent areas, including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
 4. Masonry: Treat voids.
 5. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.
- B. Post warning signs in areas of application.
- C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 PROTECTION

- A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

3.5 MAINTENANCE SERVICE

- A. Continuing Maintenance Proposal: Provide from termite-control-treatment Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
 1. Include annual inspection for termite activity and effectiveness of termite treatment according to manufacturer's written instructions. **END OF SECTION 313116**

SCHOEL ENGINEERING

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of work is shown and includes hot-mixed asphalt paving over prepared sub-base.
- B. Verify grades and elevations before beginning. Notify Engineer of discrepancies.
- C. Engineer may make minor field adjustments without additional cost.
- D. Construct sub-grade per Section 312000 Earth Moving .

1.2 SUMMARY

- A. Section includes:
 - 1. Hot-mix asphalt paving.
 - 2. Hot-mix asphalt patching.
 - 3. Hot-mix asphalt overlays.
 - 4. Asphalt surface treatments:
 - a. Fog seals.
 - 5. Pavement-marking paint.
 - 6. Hot-mix asphalt curbs.
 - 7. Wheel stops.
- B. Related Sections:
 - 1. Section 311000 Site Clearing
 - 2. Section 312000 Earth Moving
 - 3. Section 321373 Concrete Paving Joint Sealants

1.3 SYSTEM DESCRIPTION

- A. Provide hot-mix asphalt pavement per requirements of Alabama Department of Transportation (ALDOT) "Standard Specifications for Highway Construction" latest edition.

1.4 SUBMITTALS

- A. Product Data: For each product specified. Include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for Work.
- C. Job-Mix Designs: For each job mix proposed for Work.
- D. Shop Drawings: Indicate pavement markings, lane separations, defined parking spaces and dedicated handicapped spaces with international graphics symbol.
- E. Samples: 12" x 12" of geotextile materials.
- F. Qualification Data: As required under "Quality Assurance".
- G. Material Test Reports: Indicate and interpret test results for compliance of materials with requirements indicated.

SCHOEL ENGINEERING

- H. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

1.5 QUALITY ASSURANCE

- A. Engage experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that required and with record of successful in-service performance.
- B. Engage firm experienced in manufacturing hot-mix similar to that required and with record of successful performance.
- C. Test Agency Qualification: Demonstrate to Architect's satisfaction, based on ASTM D 3666, that independent test agency has experience and ability to conduct testing indicated without delaying Work.
- D. Comply with State of Alabama Department of Transportation (ALDOT) "Standard Specifications for Highway Construction."
- E. Preinstallation Conference: Conduct at Project site to comply with "Project Meetings" Review methods and procedures:
 1. Review proposed source of paving material, including capabilities and location of plant that will manufacture hot-mix asphalt.
 2. Review condition of substrate and preparatory work performed by other trades.
 3. Review requirements for protecting paving, including restriction of traffic during installation and for remainder of construction.
 4. Review and finalize schedule for paving and related work. Verify availability of materials, paving Installer's personnel, and equipment required to execute Work without delays.
 5. Review inspection and test requirements, governing regulations, and proposed installation procedures.
 6. Review forecasted weather conditions and procedures for coping with unfavorable conditions.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking material in original packages with seal unbroken and bearing manufacturer's labels containing brand name, type of material, date of manufacture, and directions for storage.
- B. Store in clean, dry, protected location; per manufacturer's direction.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if following conditions are not met:
 1. Prime and Tack Coat: Minimum surface temperature 60°F.
 2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
 3. Asphalt Base Course: Minimum surface temperature of 40°F and rising at time of placement.
 4. Asphalt Surface Course: Minimum surface temperature of 40°F and rising, at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surface at minimum ambient or surface temperature of 40°F for oil-based material, 50°F for water-based, and not exceeding 95°F.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: Shall be in accordance with ALDOT Section 801.10.

SCHOEL ENGINEERING

- C. Fine Aggregate: Shall be in accordance with ALDOT Section 802.04.
 - 1. For hot-mix asphalt, limit natural sand to a maximum of 20% by weight of total aggregate mass.

- D. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material per ASTM D 242.

2.2 ASPHALT MATERIAL

- A. Asphalt Cement: Shall be in accordance with ALDOT Section 804.02.
- B. Aggregate Base Course: Crushed aggregate per requirements of ALDOT Section 301 (825-Type B). Place to width and depth shown.
- C. Plant Mix Bituminous Base (Black Base): Aggregate and bituminous material hot mixed in plant per ALDOT Section 327, Mix 1.
- D. Prime Coat: Bituminous treatment Type A, full width per requirements of ALDOT Section 401.02 (a) 1 and ASTM D 2027; medium-curing cutback asphalt; MC-30, MC-70.
- E. Binder Course: Bituminous Concrete binder layer in accordance with ALDOT Section 424.
- F. Tack Coat: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, per requirements of ALDOT Section 405.02.
- G. Wearing course: Bituminous Concrete wearing course in accordance with ALDOT Section 424.
- H. Water: Potable.

2.3 AUXILIARY MATERIAL:

- A. Herbicide: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide granular, liquid, or wet table powder form.
- B. Sand: ASTM D 1073, Grade Nos. 2 or 3.
- C. Paving Geotextile: Nonwoven polypropylene, specifically designed for paving applications, resistant to chemical attack, rot, and mildew. If required on drawings.
- D. Pavement-Marking Paint: Alkyd-resin type, ready-mixed, per FS TT-P-115, Type I, or AASHTO M-248, Type N.
 - 1. Color: As indicated.
 - 2. Color: White.
 - 3. Color: Yellow.
 - 4. Blue for handicapped markings.
- E. Glass Beads: In accordance with ALDOT Section 856.05.
- F. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, approximately 6" high, 9" wide, and 84" long. Provide chamfered corners, drainage slots, and anchorage holes.
 - 1. Dowels: Galvanized steel, 3/4" x 10".

2.4 MIXES

- A. Hot-Mix Asphalt: Provide dense, hot-laid, hot-mix asphalt plant mix meeting requirements of applicable sections of ALDOT "Standard Specifications for Highway Construction."
 - 1. Provide mix with history of satisfactory performance in area of Project.

SCHOEL ENGINEERING

- B. Bituminous Concrete Binder Layer: Plant mixed, bituminous concrete binder per requirements of ALDOT Section 424 (25% Max RAP).
- C. Bituminous Concrete Wearing Surface: Plant mixed, meeting requirements of ALDOT Section 424 (25% Max RAP).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.
- B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- C. Notify Architect in writing of any unsatisfactory conditions. Do not proceed until conditions have been satisfactorily corrected.

3.2 PATCHING AND REPAIRS

- A. Saw cut perimeter of patch and excavate existing pavement section to sound base. Recompact new subgrade. Excavate rectangular or trapezoidal patches, extending 12" into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.
 - 1. Tack coat faces of excavation and allow to cure before paving.
 - 2. Fill excavation with dense-graded, hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.
 - 3. Partially fill excavation with dense-graded, hot-mix asphalt base mix and compact while hot. Cover asphalt base course with compacted, hot-mix surface layer flush with adjacent surface.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
 - 1. Pump hot undersealing asphalt under rocking slabs until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
 - 2. Remove disintegrated or badly broken pavement. Prepare and patch with hot-mix asphalt.
- C. Leveling Course: Install and compact leveling course of dense-graded, hot-mix asphalt surface course to level sags and fill depressions deeper than 1" in existing pavements.
 - 1. Install leveling wedges in compacted lifts not exceeding 3" thick.
- D. Crack and Joint Filling: Remove existing filler material from cracks or joints to a depth of 1/4". Refill with asphalt joint-filling material to restore watertight condition. Remove excess filler that has accumulated near cracks or joints.
- E. Tack Coat: Apply uniformly to surface of previously constructed asphalt or portland cement concrete paving and to surfaces abutting or projecting into new, asphalt pavement; 0.05 to 0.15 gal/sq yd.
 - 1. Allow tack coat to cure undisturbed before paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 SURFACE PREPARATION

- A. Immediately before placing asphalt material, remove foreign material from substrate. Ensure that subgrade is ready to receive paving.
 - 1. Sweep loose aggregate from surface of unbound-aggregate base course. Do not dislodge aggregate in compacted base course.

SCHOEL ENGINEERING

- B. Herbicide Treatment: Apply herbicide per manufacturer's recommended rates and instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 - 1. Mix herbicide with prime coat when formulated by manufacturer for that purpose.
- C. Prime Coat: Apply uniformly over surface of compacted-aggregate base at a rate of 0.3 to 0.5 gal/sq yd.
 - 1. Comply with ALDOT, Section 401.03 (d)4.
 - 2. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure for 72 hours minimum.
 - 3. Protect primed substrate from damage until ready to receive paving.

3.4 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness, when compacted.
 - 1. Place hot-mix asphalt base course in lifts and thickness indicated.
 - 2. Place hot-mix asphalt surface course in single lift.
 - 3. Spread mix at minimum temperature of 250°F.
 - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
 - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears.
- B. Place paving in consecutive strips not less than 10' wide, except where edge strips of lesser width are required.
 - 1. After first strip is placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete asphalt base course for a section before placing asphalt surface course.
- C. Promptly correct irregularities in paving course behind paver. Use hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use hand tools to smooth surface.

3.5 JOINTS

- A. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat.
 - 2. Offset longitudinal joints in successive courses minimum of 6".
 - 3. Offset transverse joints in successive courses minimum of 24".
 - 4. Construct transverse joints by bulkhead method or sawed vertical face method as described in AI's "The Asphalt Handbook."
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to within 2% of specified course density.

3.6 COMPACTION

- A. Begin compaction as soon as paving will bear roller weight without excessive displacement. Compact paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185°F.
- B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surface by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevation.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while asphalt is hot enough to achieve specified density. Continue rolling until asphalt course is uniformly compacted to following density:

SCHOEL ENGINEERING

1. Average Density: 96% of reference laboratory density per ASTM D 1559, but not less than 94% nor greater than 100%.
 2. Average Density: 92% of reference maximum theoretical density per ASTM D 2041, but not less than 90% nor greater than 96%.
- D. Finish Rolling: Finish roll to remove roller marks while asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edge of pavement to proper alignment. Bevel edge while still hot. Compact thoroughly.
- F. Repairs: Remove areas that are defective or contaminated with foreign material. Remove paving course over area affected and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- I. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- J. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce thickness indicated within following tolerances:
1. Base Course: Plus or minus 1/2"
 2. Surface Course: Plus 1/4", no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within following tolerances as determined by using a 10' straightedge applied transversely or longitudinally to paved areas:
1. Base Course: 1/4".
 2. Surface Course: 1/8".
 3. Crowned Surface: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4".

3.8 PAVEMENT MARKING

- A. Comply with ALDOT, Section 701.03 (e)

3.9 WHEEL STOPS

- A. Securely attach wheel stops into pavement with not less than 2 galvanized steel dowels embedded in precast concrete at one-third points. Firmly bond each dowel to wheel stop and pavement.
1. Extend upper portion of dowel 5" into wheel stop and lower portion a minimum of 5" into pavement.

3.10 FIELD QUALITY CONTROL

- A. Test Agency: Owner will engage a qualified independent test agency to perform field inspections and tests and to prepare test reports.
1. Agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined per ASTM D 3549.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerance.

SCHOEL ENGINEERING

- E. In-Place Density: Samples of uncompacted paving mixture and compacted pavement will be secured by test agency per ASTM D 979.
 - 1. Reference laboratory density will be determined by averaging results from 4 samples of hot-mix asphalt-paving delivered daily to site, prepared per ASTM D 1559, and compacted per job-mix specifications.
 - 2. Reference maximum theoretical density will be determined by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 - 3. In-place density of compacted pavement will be determined by testing core samples per ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq yd or less of installed pavement, but in no case less than 3 cores.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate it does not comply with requirements.

END OF SECTION

SCHOEL ENGINEERING

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, apply to this Section.

1.2 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
 - 1. Driveways
 - 2. Parking lots.
 - 3. Curbs and gutters & curb inlets.
 - 4. Walkways.
 - 5. Cast in place inlets, headwalls, flumes, etc.
- B. Related Sections include the following:
 - 1. Section 312000 Earth Moving for subgrade preparation, grading, and subbase course.
 - 2. Section 321373 Concrete Paving Joint Sealants

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
- D. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
 - 1. Cementitious materials and aggregates.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Fiber reinforcement.
 - 4. Admixtures.
 - 5. Curing compounds.
 - 6. Applied finish materials.
 - 7. Bonding agent or adhesive.
 - 8. Joint fillers.

1.5 QUALITY ASSURANCE

- A. Industry Standards and Specifications: Issues listed (including modifications designated) form a part of this specification to extent indicated by reference thereto. Hereinafter, issues are referred to by basic numerical designation only, and revisions (if any) are noted herein.
 - 1. American Society for Testing and Materials:
 - C91 Masonry Cement, Spec. for

SCHOEL ENGINEERING

- C136 Sieve or Screen Analysis of Fine and Coarse Aggregate for Masonry Mortar, Spec. for
- C144 Aggregate for Masonry Mortar, Spec. for
- C150 Portland Cement, Spec. for
- C207 Hydrated Lime for Masonry Purposes, Spec. for
- C404 Aggregates for Masonry Grout, Spec. for

- B. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- D. Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program.
- E. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- F. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.
- G. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.
- H. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.
- I. Alabama Department of Transportation (ALDOT) Standard Specifications for Highway Construction, Latest Edition.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
 - 1. Use flexible or curved forms for curves of a radius 100 feet or less.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.1 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.
- C. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

SCHOEL ENGINEERING

- D. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60 (Grade 420). Cut bars true to length with ends square and free of burrs.
- E. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer coated wire bar supports.

2.3 CONCRETE MATERIALS

- A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.
- B. Portland Cement: ASTM C 150, Type I or II.
 - 1. Fly Ash: ASTM C 618, Class F or C.
 - 2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- C. Aggregate: ASTM C 33, uniformly graded, from a single source, with coarse aggregate as follows:
 - 1. Class: 4S.
 - 2. Class: 4M.
 - 3. Class: 1N.
 - 4. Maximum Aggregate Size: 1-1/2 inches (38 mm) nominal.
 - 5. Maximum Aggregate Size: 1 inch (25 mm) nominal.
 - 6. Maximum Aggregate Size: 3/4 inch (19 mm) nominal.
 - 7. Do not use fine or coarse aggregates containing substances that cause spalling.
- D. Water: ASTM C 94.

2.4 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

SCHOEL ENGINEERING

- D. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- E. Clear Solvent-Borne Liquid-Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- F. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- G. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.
- H. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
- I. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Evaporation Retarder:
 - a. Cimfilm; Axim Concrete Technologies.
 - b. Finishing Aid Concentrate; Burke Group, LLC (The).
 - c. Spray-Film; ChemMasters.
 - d. Aquafilm; Conspec Marketing & Manufacturing Co., Inc.
 - e. Sure Film; Dayton Superior Corporation.
 - f. Eucobar; Euclid Chemical Co.
 - g. Vapor Aid; Kaufman Products, Inc.
 - h. Lambco Skin; Lambert Corporation.
 - i. E-Con; L&M Construction Chemicals, Inc.
 - j. Confilm; Master Builders, Inc.
 - k. Waterhold; Metalcrete Industries.
 - l. Rich Film; Richmond Screw Anchor Co.
 - m. SikaFilm; Sika Corporation.
 - n. Finishing Aid; Symons Corporation.
 - o. Certi-Vex EnvioAssist; Vexcon Chemicals, Inc.
 - 2. Clear Solvent-Borne Liquid-Membrane-Forming Curing Compound:
 - a. AH Curing Compound #2 DR; Anti-Hydro International, Inc.
 - b. Res-X Cure All Resin; Burke Group, LLC (The).
 - c. RX Cure; Conspec Marketing & Manufacturing Co., Inc.
 - d. Day-Chem Rez Cure; Dayton Superior Corporation.
 - e. Kurez DR; Euclid Chemical Co.
 - b. Nitocure S; Fosroc.
 - c. #64 Resin Cure; Lambert Corporation.
 - d. L&M Cure DR; L&M Construction Chemicals, Inc.
 - e. 3100-Clear; W. R. Meadows, Inc.
 - f. Seal N Kure FDR; Metalcrete Industries.
 - g. Rich Cure; Richmond Screw Anchor Co.
 - h. Resi-Chem C309; Symons Corporation.
 - i. Horncure 30; Tamms Industries Co., Div. of LaPorte Construction Chemicals North America, Inc.
 - j. Uni Res 150; Unitex.
 - k. Certi-Vex RC; Vexcon Chemicals, Inc.
 - 3. Clear Waterborne Membrane-Forming Curing Compound:
 - l. AH Curing Compound #2 DR WB; Anti-Hydro International, Inc.
 - m. b. Aqua Resin Cure; Burke Group, LLC (The).
 - n. Safe-Cure Clear; ChemMasters.
 - o. W.B. Resin Cure; Conspec Marketing & Manufacturing Co., Inc.
 - p. Day Chem Rez Cure (J-11-W); Dayton Superior Corporation.
 - q. Nitocure S; Fosroc.
 - r. Aqua Kure-Clear; Lambert Corporation.
 - s. L&M Cure R; L&M Construction Chemicals, Inc.
 - t. 1100 Clear; W. R. Meadows, Inc.

SCHOEL ENGINEERING

- u. Resin Cure E; Nox-Crete Products Group, Kinsman Corporation.
- v. Rich Cure E; Richmond Screw Anchor Co.
- w. Resi-Chem Clear Cure; Symons Corporation.
- x. Horncure 100; Tamms Industries Co., Div. of LaPorte Construction Chemicals North America, Inc.
- y. Hydro Cure; Unitex.
- z. Certi-Vex Enviocure; Vexcon Chemicals, Inc.
- 4. White Waterborne Membrane-Forming Curing Compound:
 - aa. a. AH Curing Compound #2 WB WP; Anti-Hydro International, Inc.
 - bb. Aqua Resin Cure; Burke Group, LLC (The).
 - cc. W.B. Resin Cure; Conspec Marketing & Manufacturing Co., Inc.
 - dd. Thinfilm 450; Kaufman Products, Inc.
 - ee. Aqua Kure-White; Lambert Corporation.
 - ff. L&M Cure R-2; L&M Construction Chemicals, Inc.
 - gg. 1200-White; W. R. Meadows, Inc.
 - hh. White Pigmented Resin Cure E; Nox-Crete Products Group, Kinsman Corporation.
 - ii. Rich Cure White E; Richmond Screw Anchor Co.
 - jj. Resi-Chem High Cure; Symons Corporation.
 - kk. Horncure 200-W; Tamms Industries Co., Div. of LaPorte Construction Chemicals North America, Inc.
 - ll. Hydro White 309; Unitex.

2.6 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Pavement-Marking Paint: Alkyd-resin type; ready mixed; complying with FS TT-P-115, Type I, or AASHTO M 248, Type N.
- C. Glass Beads: AASHTO M 247.

2.7 CONCRETE MIXES

- A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.
 - 1. Do not use Owner's field quality-control testing agency as the independent testing agency.
- C. Proportion mixes to provide concrete with the following properties, unless otherwise noted on plans:
 - 1. Compressive Strength (28 Days): 3500 psi (24.1 MPa).
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - 3. Slump Limit: 3 inches (75 mm).
 - a. Slump Limit for Concrete Containing High-Range Water-Reducing Admixture: Not more than 8 inches (200 mm) after adding admixture to plant- or site-verified, 2- to 3-inch (50- to 75-mm) slump.
- D. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.
- E. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent.
 - 2. Combined Fly Ash and Pozzolan: 25 percent.
 - 3. Ground Granulated Blast-Furnace Slag: 50 percent.

SCHOEL ENGINEERING

4. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
- F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 2.5 to 4.5 percent.
- G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus or minus 1.5 percent:
 1. Air Content: 5.5 percent for 1-1/2-inch (38-mm) maximum aggregate.
 2. Air Content: 6.0 percent for 1-inch (25-mm) maximum aggregate.
 3. Air Content: 6.0 percent for 3/4-inch (19-mm) maximum aggregate.
- H. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m).
- I. Coloring Agent: Add coloring agent to mix according to manufacturer's written instructions.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.
 1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 MATERIALS REFERENCES

- A. Portland Cement: ASTM C150, of natural color.
 1. Type 1 non-staining and without air entrainment.
- B. Masonry Cement: ASTM C91, non-staining, except with 12% maximum air content by volume.
- C. Hydrated Lime: ASTM C207.
 1. Type N - Normal hydrated lime.
 2. Type S - Special hydrated lime, high-early-plasticity and high water retention.
- D. Aggregates: ASTM C144
- E. Aggregates for Masonry Grout: ASTM C404.
- F. Water: Clean, free from deleterious materials which would impair strength or bond.
- G. Masonry ties shall be rectangular galvanized steel, 3/16" diameter, C length as required for stone veneer over concrete unless otherwise noted on the drawings.

3.2 MORTAR MIXES

- A. Do not lower the freezing point of mortar by use of admixtures or anti-freeze agents. Do not use calcium in mortar or grout.
- B. Mortar: Comply with ASTM C270, Proportion Specification, except limit materials to those specified herein.
 1. Mortar Proportions:

SCHOEL ENGINEERING

Type	Portland Cement	Hydrated Lime Putty	Masonry Cement	Maximum Damp Loose Aggregate	Minimum Compression Strength 2" cubes in 28 days psi
M or	1	1/4	-	3	2500
	1	-	1	6	2500
S or	1	1/2	-	4-1/2	1800
	1/2	-	1	4-1/2	1800
N or	1	1	-	6	750
	-	-	1	3	750

The weight of one cubic foot of materials is considered to be: Portland Cement 94 lbs. (1 bag); hydrated lime, 40 lbs.; lime putty, 80 lbs.; dry sand, 80 lbs.' masonry cement, weight printed on bag.

For each type of mortar, the figures above the dotted line show proportions for Portland cement-lime mortar. Mortar made with masonry cement are shown below dotted line.

Damp, loose aggregate shall not be less than 2-1/4 times, nor more than three times the cementitious materials used.

3.4 PREPARATION

- A. Proof-roll prepared base surface to check for unstable areas and verify need for additional compaction. Proceed with pavement only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.
- B. Remove loose material from compacted base surface immediately before placing concrete.

3.5 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.
 - 1. Apply epoxy repair coating to uncoated or damaged surfaces of epoxy-coated reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

SCHOEL ENGINEERING

- E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap to adjacent mats.

3.7 JOINTS

- A. General: Construct construction, expansion, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
 - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.
 - 1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 - 2. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 - 3. Provide tie bars at sides of pavement strips where indicated.
 - 4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Expansion Joints: Form expansion joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 50 feet (15.25 m), unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler less than 1/2 inch (12 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
 - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to the following radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
 - a. Radius: 1/4 inch (6 mm).
 - b. Radius: 3/8 inch (10 mm).
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
- F. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.
 - 1. Radius: 1/4 inch (6 mm).
 - 2. Radius: 3/8 inch (10 mm).

3.8 CONCRETE PLACEMENT

SCHOEL ENGINEERING

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from base surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten base to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery, at Project site, or during placement.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
 - 1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer, or use bonding agent if approved by Engineer.
- I. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.
- J. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete.

If results are not approved, remove and replace with formed concrete.
- K. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.
 - 1. Compact base and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.
- L. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- M. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.

SCHOEL ENGINEERING

2. Do not use frozen materials or materials containing ice or snow.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- N. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.9 CONCRETE FINISHING

- A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.
1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
 2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

3.10 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

SCHOEL ENGINEERING

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.11 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 1. Elevation: 1/4 inch (6 mm).
 2. Thickness: Plus 3/8 inch (9 mm), minus 1/4 inch (6 mm).
 3. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/4 inch (6 mm).
 4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch (25 mm).
 5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch (6 mm).
 6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch (13 mm).
 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches (6 mm per 300 mm).
 8. Joint Spacing: 3 inches (75 mm).
 9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
 10. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.12 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.
- B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
 1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal. (0.72 kg/L).

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.
- B. Testing Services: Testing shall be performed according to the following requirements:
 1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C 172, except modified for slump to comply with ASTM C 94.
 2. Slump: ASTM C 143; one test at point of placement for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
 3. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.
 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
 5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
 6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m). One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.

SCHOEL ENGINEERING

7. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.
 9. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi (3.4 MPa).
- C. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as the sole basis for approval or rejection.
- E. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.14 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.
- B. Drill test cores where directed by Engineer when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SCHOEL ENGINEERING

SECTION 321373 – CONCRETE PAVING JOINT SEALANTS

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. This Section includes the following:
 - 1. Expansion and contraction joints within portland cement concrete pavement.
 - 2. Joints between portland cement concrete and asphalt pavement.
- B. Related Sections include the following:
 - 1. Section 321216 Asphalt Paving for constructing joints between concrete and asphalt pavement.
 - 2. Section 321313 Concrete Paving for constructing joints in concrete paving.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Product Certificates: Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Compatibility and Adhesion Test Reports: From joint sealant manufacturer indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backer materials have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- F. Product Test Reports: From a qualified testing agency indicating joint sealants comply with requirements, based on comprehensive testing of current product formulations.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency, based on testing current sealant formulations within a 36-month period.

SCHOEL ENGINEERING

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
 2. Test joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.
- D. Preconstruction Compatibility and Adhesion Testing: Submit to joint sealant manufacturer, for testing indicated below, samples of materials that will contact or affect joint sealants.
1. Use manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - a. Perform tests under environmental conditions replicating those that will exist during installation.
 2. Submit not fewer than nine pieces of each type of material, including joint substrates, joint-sealant backer materials, secondary seals, and miscellaneous material.
 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 4. For materials failing tests, obtain joint sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
 5. Testing will not be required if joint sealant manufacturer submits joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:
 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.
 2. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F (4.4 deg C).
 3. When joint substrates are wet.
- B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than that allowed by joint sealant manufacturer for application indicated.
- C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: Match Architect's samples.

SCHOEL ENGINEERING

- C. Colors of Exposed Joint Sealants: As indicated by referencing manufacturer's designations.
- D. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range for this characteristic.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Multicomponent Jet-Fuel-Resistant Sealant for Concrete: Pourable, chemically curing elastomeric formulation complying with the following requirements for formulation and with ASTM C 920 for type, grade, class, and uses indicated:
 - 1. Urethane Formulation: Type M; Grade P; Class 12-1/2; Uses T, M, and, as applicable to joint substrates indicated, O.
 - 2. Coal-Tar-Modified Polymer Formulation: Type M; Grade P; Class 25; Uses T and, as applicable to joint substrates indicated, O.
 - 3. Bitumen-Modified Urethane Formulation: Type M; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.
- B. Single-Component Jet-Fuel-Resistant Urethane Sealant for Concrete: Single-component, pourable, coal-tar-modified, urethane formulation complying with ASTM C 920 for Type S; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.
- C. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.
- D. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.
- E. Multicomponent Low-Modulus Sealant for Concrete and Asphalt: Proprietary formulation consisting of reactive petropolymer and activator components producing a pourable, self-leveling sealant.
- F. Available Products: Subject to compliance with requirements, cold-applied joint sealants that may be incorporated into the Work include, but are not limited to, the following:
- G. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Multicomponent Jet-Fuel-Resistant Sealant for Concrete:
 - a. Vulkem 202; Mameco International.
 - b. SEALTIGHT GARDOX; W.R. Meadows, Inc.
 - c. Urexpam NR-300; Pecora Corporation.
 - d. Sonomeric 2; Sonneborn Building Products Div., ChemRex, Inc.
 - 2. Single-Component Jet-Fuel-Resistant Urethane Sealant for Concrete:
 - a. Vulkem 200; Mameco International.
 - b. Sonomeric 1; Sonneborn Building Products Div., ChemRex, Inc.
 - 3. Type NS Silicone Sealant for Concrete:
 - a. Roadsaver Silicone-SL; Crafcro Inc.
 - b. 888; Dow Corning.
 - 4. Type SL Silicone Sealant for Concrete and Asphalt:
 - a. 890-SL; Dow Corning.
 - 5. Multicomponent Low-Modulus Sealant for Concrete and Asphalt:
 - a. SOF-SEAL; W.R. Meadows, Inc.

2.3 HOT-APPLIED JOINT SEALANTS

- A. Jet-Fuel-Resistant Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3569.

SCHOEL ENGINEERING

- B. Jet-Fuel-Resistant Sealant for Concrete and Tar Concrete: Single-component formulation complying with ASTM D 3581.
- C. Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3406.
- D. Sealant for Concrete and Asphalt: Single-component formulation complying with ASTM D 3405.
- E. Available Products: Subject to compliance with requirements, hot-applied joint sealants that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Jet-Fuel-Resistant Elastomeric Sealant for Concrete:
 - a. Superseal 444/777; Crafc0, Inc.
 - b. POLY-JET 3569; W.R. Meadows, Inc.
 - 2. Jet-Fuel-Resistant Sealant for Concrete and Tar Concrete:
 - a. SUPERSEAL 1614A; Crafc0 Inc.
 - b. POLY-JET 1614; W.R. Meadows, Inc.
 - c. POLY-JET 3406; W.R. Meadows, Inc.
 - d. POLY-JET 3569, W.R. Meadows, Inc.
 - 3. Elastomeric Sealant for Concrete:
 - a. Superseal 444/777; Crafc0, Inc.
 - b. POLY-JET 3406; W.R. Meadows, Inc.
 - 4. Sealant for Concrete and Asphalt:
 - a. ROADSAVER 221; Crafc0 Inc.
 - b. Product #9005; Koch Materials Company.
 - c. Product #9030; Koch Materials Company.
 - d. SEALTIGHT HI-SPEC; W.R. Meadows, Inc.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rod for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depths, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
- D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.

2.5 PRIMERS

- A. Primers: Product recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint- sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

SCHOEL ENGINEERING

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. **Surface Cleaning of Joints:** Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions.
- B. **Joint Priming:** Prime joint substrates where indicated or where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. **General:** Comply with joint sealant manufacturer's written installation instructions applicable to products and applications indicated, unless more stringent requirements apply.
- B. **Sealant Installation Standard:** Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. **Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.**
 - 1. Do not leave gaps between ends of backer materials.
 - 2. Do not stretch, twist, puncture, or tear backer materials.
 - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. **Install sealants by proven techniques to comply with the following and at the same time backings are installed:**
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses provided for each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. **Tooling of Nonsag Sealants:** Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealants from surfaces adjacent to joint.
 - 2. Use tooling agents that are approved in writing by joint sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. **Provide joint configuration to comply with joint sealant manufacturer's written instructions, unless otherwise indicated.**
- G. **Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.**

3.4 CLEANING

- A. **Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.**

3.5 PROTECTION

SCHOEL ENGINEERING

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

END OF SECTION

SECTION 323113 - CHAIN-LINK FENCES AND GATES

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. Chain-link fences.
 - 2. Coated Chain-link Infill Panels
 - 3. Gates: horizontal slide and hinged swing.
- B. Related Sections:
 - 1. Division 3 Section " Cast-in-Place Concrete for Sitework" for cast-in-place concrete post footings.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
 - 1. Minimum Post Size: Determine according to ASTM F 1043 for framework up to 12 feet (3.66 m) high, and post spacing not to exceed 6 feet for fabric.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.[Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.]
 - 1. Fence and gate posts, rails, and fittings.
 - 2. Chain-link fabric, reinforcements, and attachments.
 - 3. Accessories: Privacy slats.
 - 4. Gates and hardware.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
- C. Samples for Initial Selection: For components with factory-applied color finishes.
- D. Samples for Verification: Prepared on Samples of size indicated below:
 - 1. Polymer-Coated Components: In 6-inch (150-mm) lengths for components and on full-sized units for accessories.
- E. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Qualification Data: For qualified factory-authorized service representative.
- G. Product Certificates: For each type of chain-link fence, and gate, from manufacturer.
- H. Product Test Reports: For framing strength according to ASTM F 1043.
- I. Field quality-control reports.
- J. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
 - 1. Polymer finishes.
 - 2. Gate hardware.
- K. Warranty: Sample of special warranty.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
 1. Fabric Height: 6'-0" and/or sized to fit opening per drawings.
 2. Steel Wire Fabric: Wire with a diameter of 0.192 inch (4.88 mm).
 - a. Mesh Size: 2-1/8 inches (54 mm).
 - b. Polymer-Coated Fabric: ASTM F 668, Class 1 over-coated steel wire.
 - 1) Color: Black.
 - c. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.
 3. Selvage: Knuckled at both selvages.

2.2 FENCE FRAMING

- A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:
 1. Fence Height: 72 inches (2440 mm) and as indicated on Drawings.
 2. Heavy Industrial Strength: Material Group IA, round steel pipe, Schedule 40.
 - a. Line Post: 2.375 inches (60 mm) in diameter.
 - b. End, Corner and Pull Post: 2.375 inches (60 mm) in diameter.
 3. Horizontal Framework Members: Intermediate top and bottom rails complying with ASTM F 1043.
 - a. Top & Bottom Rails: 1.66 inches (42 mm) in diameter. Match side diameter when constructed in panels.
 4. Brace Rails: Comply with ASTM F 1043.
 5. Metallic Coating for Steel Framing:
 - a. Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating per ASTM A 653/A 653M.
 - b. Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
 - c. External, Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.
 - d. Type C, Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
 - e. Coatings: Any coating above.
 6. Polymer coating over metallic coating.
 - a. Color: Black, complying with ASTM F 934.

2.3 SWING GATES

- A. General: Comply with ASTM F 900 for gate posts and single and double swing gate types.
 1. Gate Leaf Width: as indicated on drawings.
 2. Gate Fabric Height: Match fence height.
- B. Pipe and Tubing:
 1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
 2. Gate Posts: Round tubular steel.
 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded.
- D. Hardware:
 1. Hinges: 180-degree outward swing.
 2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.

3. Cane Bolt for Inactive Leaf

2.4 FITTINGS

- A. General: Comply with ASTM F 626.
- B. Post Caps: Provide for each post.
 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
 1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches (152 mm) long.
 2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.
- E. Tension and Brace Bands: Pressed steel.
- F. Tension Bars: Steel, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
 - a. Hot-Dip Galvanized Steel: 0.148-inch- (3.76-mm-) diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.
- I. Finish:
 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g /sq. m) zinc.
 - a. Polymer coating over metallic coating.

2.5 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

- A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.
 1. Install fencing on established boundary lines inside property line.

3.4 CHAIN-LINK FENCE INSTALLATION

- A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- B. Post Setting: Set posts in concrete with mechanical anchors at indicated spacing.
 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

- C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
- D. Line Posts: Space line posts uniformly at 96 inches (2440 mm) o.c.
- E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
 - 1. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- F. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- G. Intermediate and Bottom Rails: Install and secure to posts with fittings.
- H. Panels: Where indicated as infill panels: Construct with equal dimension tube framing with welded connections. Mount fabric inside of framing with stretcher bars at four sides. All fastener heads to be oriented toward the exterior. All material with coated finish.
- I. Chain-Link Fabric: Where indicated as fencing: Apply fabric to outside of enclosing framework. Leave 1 inch (25.4 mm) between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (380 mm) o.c.
- K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.
- L. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.5 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet (450 m) except as follows:
 - 1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m).
 - a. Gates and Other Fence Openings: Ground fence on each side of opening.
 - 1) Bond metal gates to gate posts.
 - 2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.
- C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
- D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:
 - 1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
 - 2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.
- E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- F. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.7 FIELD QUALITY CONTROL

- A. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.
1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
 2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
 3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.8 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 323113

SCHOEL ENGINEERING

SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

- A. This Section includes the following utility materials and methods to complement other Division 33 Sections:
 1. Piping materials and installation instructions common to most piping systems.
 2. Concrete base construction requirements.
 3. Equipment nameplate data requirements.
 4. Nonshrink grout for equipment installations.
 5. Field-fabricated metal and wood equipment supports.
 6. Utility piping demolition.
 7. Cutting and patching.
 8. Touchup painting and finishing.
- B. Pipe and pipe fitting materials are specified in Division 33 piping Sections.
- C. Related Sections include the following:
 1. Section 312000 Earth Moving for excavating, trenching, and backfilling.
 2. Section 321313 Concrete Paving for bases and thrust restraints, etc.

1.3 DEFINITIONS

- A. Exposed Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

- A. Product Data: For identification materials and devices.
- B. Samples of color, lettering style, and other graphic representation required for each identification material and device.
- C. Shop Drawings: Detail fabrication and installation for metal and wood supports, and anchorage for utility piping materials and equipment.
- D. Coordination Drawings: Detail major elements, components, and systems of utility equipment and materials in relation to other systems, installations, and building components. Show space requirements for installation and access. Indicate whether sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 2. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 3. Equipment and accessory service connections and support details.
 4. Sizes and location of required concrete bases.
 5. Scheduling, sequencing, movement, and positioning of large equipment during construction.

SCHOEL ENGINEERING

- E. Welding Certificates: Copies of certificates indicating compliance of welding procedures and personnel with requirements specified in the "Quality Assurance" Article of this Section.

1.5 QUALITY ASSURANCE

- A. Qualify welding processes and operators for structural steel according to AWS D1.1, "Structural Welding Code--Steel."
- B. Qualify welding processes and operators for piping according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions of ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- D. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. If larger equipment is approved, no additional costs will be approved for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design requirements and commissioning requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate equipment installation with other components.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the Work.
- D. Coordinate connection of piping systems with other exterior underground and overhead utilities and services. Comply with requirements of authorities having jurisdiction, franchised service companies, and controlling agencies.
- E. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 33 Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

SCHOEL ENGINEERING

2.2 JOINING MATERIALS

- A. Refer to individual Division 33 Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metal: ASTM B 32.
 - 1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
 - 2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.
 - 3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.
 - 4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.
 - 5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.
- E. Brazing Filler Metals: AWS A5.8.
 - 1. BCuP Series: Copper-phosphorus alloys.
 - 2. BAg1: Silver alloy.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Flanged, Ductile-Iron-Pipe Gaskets, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.
- H. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
 - 1. Sleeve: ASTM A 126, Class B, gray iron.
 - 2. Followers: ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 536 ductile iron.
 - 3. Gaskets: Rubber.
 - 4. Bolts and Nuts: AWWA C111.
 - 5. Finish: Enamel paint.

2.3 PIPING SPECIALTIES

- A. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and to stop corrosion.
 - 1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types; and matching piping system materials.
 - 2. Insulating Material: Suitable for system fluid, pressure, and temperature.
 - 3. Dielectric Unions: Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
 - 4. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
 - 5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly; full-face or ring type. Components include neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
 - a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

SCHOEL ENGINEERING

6. Dielectric Couplings: Galvanized-steel coupling; with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
7. Dielectric Nipples: Electroplated steel nipple; with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.4 IDENTIFYING DEVICES AND LABELS

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 02 Sections. If more than one type is specified for application, selection is Installer's option, but provide one selection for each product category.
- B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment.
 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
 2. Location: An accessible and visible location.
- C. Snap-On Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap on, color-coded, complying with ASME A13.1.
- D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent-adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.
- E. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated.
 1. Fabricate in sizes required for message.
 2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
 3. Punch for mechanical fastening.
 4. Thickness: 1/16 inch (1.6 mm), unless otherwise indicated.
 5. Thickness: 1/8 inch (3.2 mm), unless otherwise indicated.
 6. Thickness: 1/16 inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) long; 1/8 inch (3.2 mm) for larger units.
 7. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.

2.5 GROUT

- A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout; nonstaining; noncorrosive; nongaseous; and recommended for interior and exterior applications.
 2. Design Mix: 5000 psig (34.5 MPa), 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 33 piping Sections specify unique piping installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.

SCHOEL ENGINEERING

- C. Install piping at indicated slopes.
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping free of sags and bends.
- F. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- G. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- H. Install fittings for changes in direction and branch connections.
- I. Install couplings according to manufacturer's written instructions.
- J. Sleeves are required for core drilled holes.
- K. Permanent sleeves are not required for holes formed by PE plastic removable sleeves.
- L. Verify final equipment locations for roughing-in.
- M. Refer to equipment specifications in other Division 33 Sections for roughing-in requirements.
- N. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping Sections:
 - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt, and debris from inside and outside pipe and fittings before assembly.
 - 3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
 - 4. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube."
 - 5. Soldered Joints: Construct joints according to CDA's "Copper Tube Handbook."
 - 6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 - c. Align threads at point of assembly.
 - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - e. Damaged Threads: Do not use pipe or pipe fittings with corroded or damaged threads. Do not use pipe sections that have cracked or open welds.
 - 7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- O. Piping Connections: Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping 2-inch NPS (DN50) and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS (DN50) or smaller threaded pipe connection or as shown on the drawings.
 - 2. Install flanges, in piping 2-1/2-inch NPS (DN65) and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.

SCHOEL ENGINEERING

3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Engineer.
- B. Install equipment level and plumb.
- C. Install equipment to facilitate service, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
- D. Install equipment giving right of way to piping systems installed at required slope.

3.3 LABELING AND IDENTIFYING

- A. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
 1. Lettering Size: Minimum 1/4-inch- (6.35-mm-) high lettering for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (12.7 mm) high for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
 2. Text of Signs: Provide name of identified unit. Include text to distinguish between multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- B. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches (150 mm) larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psig (20.7 MPa), 28-day compressive strength concrete and reinforcement as specified in Division 03 Section 03 30 00 Cast-in-Place Concrete.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports in location, alignment, and elevation to support and anchor utility piping materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code – Steel."

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor utility materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.7 DEMOLITION

SCHOEL ENGINEERING

- A. Disconnect, demolish, and remove work specified in Division 33 Sections.
- B. If pipe, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- C. Accessible Work: Remove indicated exposed pipe in its entirety.
- D. Work Abandoned in Place: Cut and remove underground pipe a minimum of 12 inches (50 mm) beyond face of adjacent construction. Cap and patch surface to match existing finish.
- E. Removal: Remove indicated equipment from Project site.
- F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.8 GROUTING

- A. Install nonmetallic, nonshrink grout for equipment-support bearing surfaces, pump and other equipment support plates, and anchors. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout on concrete bases to provide smooth bearing surface for equipment.
- F. Place grout around anchors.
- G. Cure placed grout according to manufacturer's written instructions.

END OF SECTION

SCHOEL ENGINEERING

SECTION 331100 - WATER UTILITY DISTRIBUTION PIPING

PART 1) - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

- A. This Section includes piping and specialties for potable-water service outside the building for combined water service and fire-service mains.
- B. This Section does not include tapping of utility company water main.
- C. Related Sections include the following:
 - 1. Section 31 2500 Erosion and Sedimentation Controls
 - 2. Section 31 2000 Earth Moving
 - 3. Section 32 1216 Asphalt Paving
 - 4. Section 32 1313 Concrete Paving

1.3 DEFINITIONS

- A. The following are industry abbreviations for plastic and rubber materials:
 - 1. NP: Nylon.
 - 2. PE: Polyethylene.
 - 3. PP: Polypropylene.
 - 4. PVC: Polyvinyl chloride.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressures: The following are minimum pressure requirements for piping and specialties, unless otherwise indicated:
 - 1. Potable-Water Service: 160 psig.
 - 2. Fire-Protection Water Service: 150 psig.
 - 3. Fire-Protection Water Service, Downstream from Fire Department Connections: 200 psig.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backflow preventers.
 - 2. Pipe and fittings.
 - 3. Flexible pipe fittings.
 - 4. Valves.
 - 5. Fire hydrants.
 - 6. Flushing hydrants.
 - 7. Fire department connections.
- B. Shop Drawings: For precast concrete structures. Include frames and covers and drains.
- C. Shop Drawings: For cast-in-place concrete structures. Include frames and covers and drains.
 - 1. Wiring Diagrams: For alarm devices.
- D. Coordination Drawings: For piping and specialties including relation to other services in same area. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

SCHOEL ENGINEERING

- E. Record Drawings: At Project closeout of installed water-service piping according to Division 01 Section Closeout Procedures."
- F. Test Reports: As specified in "Field Quality Control" Article in Part 3.
- G. Purging and Disinfecting Reports: As specified in "Cleaning" Article in Part 3.
- H. Maintenance Data: For specialties to include in the maintenance manuals specified in Division 1. Include data for the following:
 - 1. Backflow preventers.
 - 2. Valves.
 - 3. Fire hydrants.
 - 4. Flushing hydrants.

1.6 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water-service piping specialties and are based on specific types and models indicated. Other manufacturers' products with equal performance characteristics may be considered.
- B. Comply with requirements of utility supplying water. Include tapping of water mains and backflow prevention.
- C. Comply with standards of authorities having jurisdiction for potable water-service piping. Include materials, installation, testing, and disinfection.
- D. Comply with NSF 61, "Drinking Water System Components--Health Effects," for materials for potable water.
- E. Comply with standards of authorities having jurisdiction for fire-protection water-service piping. Include materials, hose threads, installation, and testing.
- F. Comply with NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances," for materials, installations, tests, flushing, and valve and hydrant supervision.
- G. Comply with NFPA 70, "National Electrical Code," for electrical connections between wiring and electrically operated devices.
- H. Provide listing/approval stamp, label, or other marking on piping and specialties made to specified standards.
- I. Listing and Labeling: Provide electrically operated specialties and devices specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.
 - 2. Protect valves against damage to threaded ends and flange faces.
 - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
 - 1. Do not remove end protectors, unless necessary for inspection; then reinstall for storage.

SCHOEL ENGINEERING

2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.

1.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Verify that water-service piping may be installed to comply with original design and referenced standards.
- C. Site Information: Reports on subsurface condition investigations made during design of Project are available for informational purposes only; data in reports are not intended as representations or warranties of accuracy or continuity of conditions between soil borings. Owner assumes no responsibility for interpretations or conclusions drawn from this information.

1.9 SEQUENCING AND SCHEDULING

- A. Coordinate connection to water main with utility company.
- B. Coordinate piping materials, sizes, entry locations, and pressure requirements with building water distribution piping.
- C. Coordinate piping materials, sizes, entry locations, and pressure requirements with building fire-protection water piping.
- D. Coordinate with other utility work.

PART 2) - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Drilling-Machine, Sleeves, and Corporation Stops:
 - a. Ford Meter Box Co., Inc.
 - b. Grinnell Corp.; Mueller Co.; Water Products Div.
 - c. Lee Brass Co.
 2. Bronze Corporation Stops and Valves:
 - a. Ford Meter Box Co., Inc.
 - b. Grinnell Corp.; Mueller Co.; Water Products Div.

SCHOEL ENGINEERING

- c. Lee Brass Co.
- d. Master Meter, Inc.
- e. McDonald: A.Y. McDonald Mfg. Co.
- f. Red Hed Manufacturing Co.
- g. Watts Industries, Inc.; James Jones Co.
- 3. Tapping Sleeves and Valves:
 - a. American Cast Iron Pipe Co.; Waterous Co.
 - b. East Jordan Iron Works, Inc.
 - c. Grinnell Corp.; Mueller Co.; Water Products Div.
 - d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa)
 - e. McWane, Inc.; Kennedy Valve Div.
 - f. United States Pipe & Foundry Co.
- 4. Gate Valves:
 - a. American AVK Co.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. American Cast Iron Pipe Co.; Waterous Co.
 - d. East Jordan Iron Works, Inc.
 - e. Grinnell Corp.; Grinnell Supply Sales Co.
 - f. Grinnell Corp.; Mueller Co.; Water Products Div.
 - g. Hammond Valve Corp.
 - h. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa)
 - i. McWane, Inc.; Kennedy Valve Div.
 - j. McWane, Inc.; Tyler Pipe; Utilities Div.
 - k. Milwaukee Valve Co., Inc.
 - l. Nibco, Inc.
 - m. Pratt: Henry Pratt Co.
 - n. Stockham Valves & Fittings, Inc.
 - o. United States Pipe & Foundry Co.
- 5. Relief Valves:
 - a. Bermad, Inc.
 - b. GA Industries, Inc.
 - c. MULTIPLEX Manufacturing Co.
 - d. Oceco, Inc.
 - e. Val-Matic Valve and Manufacturing Corp.
- 6. Water-Regulating Valves:
 - a. Ames Co., Inc.
 - b. Bermad, Inc.
 - c. Cla-Val Co.
 - d. GA Industries, Inc.
 - e. IMI Cash Valve, Inc.
 - f. OCV Control Valves.
 - g. Watts Industries, Inc.; Water Products Div.
- 7. Indicator Posts and Indicator Gate Valves:
 - a. American Cast Iron Pipe Co.; American Flow Control Div.
 - b. American Cast Iron Pipe Co.; Waterous Co.
 - c. Grinnell Corp.; Grinnell Supply Sales Co.
 - d. Grinnell Corp.; Mueller Co.; Water Products Div.
 - e. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa)
 - f. McWane, Inc.; Kennedy Valve Div.
 - g. Nibco, Inc.
 - h. Penn-Troy Machine Co.
 - i. Stockham Valves & Fittings, Inc.
 - j. United States Pipe & Foundry Co.
- 8. Dry-Barrel, Post Fire Hydrants:
 - a. American AVK Co.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. American Cast Iron Pipe Co.; Waterous Co.

SCHOEL ENGINEERING

- d. American Foundry & Mfg. Co.
 - e. East Jordan Iron Works, Inc.
 - f. Grinnell Corp.; Mueller Co.; Water Products Div.
 - g. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa)
 - h. McWane, Inc.; Kennedy Valve Div.
 - i. McWane, Inc.; M&H Valve Co. Div.
 - j. Penn-Troy Machine Co.
 - k. United States Pipe & Foundry Co.
9. Flushing Hydrants
- a. Gil Industries, Inc.
 - b. Kupferle: John C. Kupferle Foundry Co.
10. Water Meters:
- a. Badger Meter, Inc.
 - b. Carlon Meter Co.
 - c. Grinnell Corp.; Mueller Co.; Hersey Products Div.
 - d. Kent Meters, Inc.
 - e. Lee Brass Co.; Hays Div.
 - f. Schlumberger Industries, Inc.; Water Div.
 - g. Sensus Technologies, Inc.
 - h. Water Specialties Corp.
11. Detector-Type Water Meters:
- a. Badger Meter, Inc.
 - b. Grinnell Corp.; Grinnell Supply Sales Co.
 - c. Grinnell Corp.; Mueller Co.; Hersey Products Div.
 - d. Schlumberger Industries, Inc.; Water Div.
 - e. Sensus Technologies, Inc.
12. Detector Check Valves:
- a. Ames Co., Inc.
 - b. Grinnell Corp.; Mueller Co.; Hersey Products Div.
 - c. McWane, Inc.; Kennedy Valve Div.
 - d. Viking Corp.
 - e. Watts Industries, Inc.; Water Products Div.
13. Backflow Preventers:
- a. Ames Co., Inc.
 - b. Cla-Val Co.
 - c. CMB Industries; Febco Div.
 - d. Conbraco Industries, Inc.
 - e. Grinnell Corp.; Mueller Co.; Hersey Products Div.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
14. Keyed Couplings:
- a. McWane, Inc.; Tyler Pipe; Gustin-Bacon Div.
 - b. Victaulic Co. of America.
15. Protective Enclosures:
- a. Hot Box.
 - b. HydroCowl, Inc.
16. Drains:
- a. Enpoco, Inc.
 - b. Josam Co.
 - c. McWane, Inc.; Tyler Pipe; Wade Div.
 - d. Smith Industries, Inc.; Jay R. Smith Mfg. Co.
 - e. Watts Industries, Inc.; Ancon Drain Div.
 - f. Zurn Industries, Inc.; Hydromechanics Div.
17. Fire Department Connections:
- a. Elkhart Brass Mfg. Co., Inc.
 - b. Figgie International Co.; Badger Fire Protection.
 - c. Fire-End and Croker Corp.

SCHOEL ENGINEERING

- d. Firematic Sprinkler Devices, Inc.
 - e. Grinnell Corp.; Grinnell Supply Sales Co.
 - f. Guardian Fire Equipment, Inc.
 - g. Reliable Automatic Sprinkler Co., Inc.
 - h. Smith Industries, Inc.; Potter-Roemer Div.
18. Alarm Devices:
- a. Gamewell Co.
 - b. Grinnell Corp.; Grinnell Supply Sales Co.
 - c. Pittway Corp.; System Sensor Div.
 - d. Potter Electric Signal Co.
 - e. Reliable Automatic Sprinkler Co., Inc.
 - f. Victaulic Co. of America.
 - g. Watts Industries, Inc.; Water Products Div.

2.2 PIPES AND TUBES

- A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.
- B. Copper Tube: ASTM B 88 (ASTM B 88M), Type K, hard drawn, seamless water tube, annealed temper suitable for 250 psi working pressure.
- C. Ductile-Iron, Push-on-Joint Pipe: AWWA C151, A21.51 Class 50, with cement-mortar lining and seal coat according to AWWA C104 suitable for 250 psi working pressure. Include rubber compression gasket according to AWWA C111.
- D. Ductile-Iron, Mechanical-Joint Pipe: AWWA C151, A21.51 Class 50, with cement-mortar lining and seal coat according to AWWA C104 suitable for 250 psi working pressure. Include gland, rubber gasket, and bolts and nuts according to AWWA C111.

2.3 PIPE AND TUBE FITTINGS

- A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.
- B. Copper Fittings: ASME B16.22; wrought-copper, solder-joint pressure type.
- C. Ductile-Iron, Push-on-Joint Fittings: AWWA C110, ductile-iron; or AWWA C153, ductile-iron, compact type. Include cement-mortar lining and seal coat according to AWWA C104 and rubber compression gaskets according to AWWA C111.
- D. Ductile-Iron, Mechanical-Joint Fittings: AWWA C110, ductile-iron; or AWWA C153, ductile-iron, compact type. Include cement-mortar lining and seal coat according to AWWA C104 and glands, rubber gaskets, and bolts and nuts according to AWWA C111.
- E. Ductile-Iron, Flanged Fittings: AWWA C110, with cement-mortar lining and seal coat according to AWWA C104 or epoxy, interior coating according to AWWA C550. Include gaskets and bolts and nuts.
- F. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Units have 2 gasketed ball-joint sections and 1 or more gasketed sleeve sections. Include 250-psig minimum working-pressure rating; epoxy, interior coating according to AWWA C550; length for offset and expansion indicated; and glands, rubber gaskets, and bolts and nuts according to AWWA C111.
- G. Ductile-Iron, Deflection Fittings: Compound coupling fitting with sleeve and flexing sections, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include 250-psig (1725-kPa) minimum working-pressure rating; cement-mortar lining, interior coating according to AWWA C550;

SCHOEL ENGINEERING

deflection of at least 20 degrees (0.34 radians); and glands, rubber gaskets, and bolts and nuts according to AWWA C111.

- H. Ductile-Iron Expansion Joints: 3-piece assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include 250-psig (1725-kPa) minimum working-pressure rating; cement-mortar lining, interior coating according to AWWA C550; length for expansion indicated; and glands, rubber gaskets, and bolts and nuts according to AWWA C111.

2.4 JOINING MATERIALS

- A. General: Applications of the following piping joining materials are indicated in Part 3 "Piping Applications" Article.
- B. Refer to Section 33 05 00 Common Work Results for Utilities for commonly used joining materials.
- C. Ductile-Iron Piping: The following materials apply:
 - 1. Push-on Joints: AWWA C111 rubber gaskets and lubricant.
 - 2. Mechanical Joints: AWWA C111 ductile-iron or gray-iron glands, high-strength steel bolts and nuts, and rubber gaskets.
 - 3. Flanged Joints: AWWA C115 ductile-iron or gray-iron pipe flanges, rubber gaskets, and high-strength steel bolts and nuts.
 - (a) Gaskets: Rubber, flat face, 1/8 inch (3 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
 - (b) Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series.
- E. Solder Filler Metal: ASTM B 32, Alloy Sn95, Alloy Sn94, or Alloy E, with 0.10 percent maximum lead content.
- F. Pipe Couplings: Iron-body sleeve assembly, fabricated to match OD of pipes to be joined.
 - 1. Sleeve: ASTM A 126, Class B, gray iron.
 - 2. Followers: ASTM A 47 (ASTM A 47M), malleable iron; or ASTM A 536, ductile iron.
 - 3. Gaskets: Rubber.
 - 4. Bolts and Nuts: AWWA C111.
 - 5. Finish: Enamel paint.

2.5 PIPING SPECIALTIES

- A. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals to prevent galvanic action and corrosion.
 - 1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
 - 2. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig minimum working pressure at 180 deg F (82 deg C). Include insulating material isolating dissimilar metals and ends with inside threads according to ASME B1.20.1.
 - 3. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum pressure to suit system pressures.
 - 4. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.
 - 5. Dielectric Couplings: Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 deg F (107 deg C).

SCHOEL ENGINEERING

6. Dielectric Nipples: Electroplated steel nipples with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig working pressure at 225 deg F (107 deg C).

2.6 VALVES

- A. Nonrising-Stem, Metal-Seated Gate Valves, 3-Inch NPS (DN80) and Larger: AWWA C500, gray- or ductile-iron body and bonnet; bronze, double-disc gate, bronze gate rings, bronze stem with AO@ ring seals, and stem nut. Include 200-psig (1380-kPa) minimum working-pressure design; interior coating according to AWWA C550; and mechanical-joint ends, unless otherwise indicated. Valves shall open to the left.
- B. Nonrising-Stem, Resilient-Seated Gate Valves, 3-Inch NPS and Larger: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem with AO@ ring seals, and stem nut. Include 200-psig minimum working-pressure design, interior coating according to AWWA C550, and push-on- or mechanical-joint ends. Valves shall open to the left.
- C. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves, 3-Inch NPS (DN80) and Larger: AWWA C509, ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut. Include 250-psig minimum working-pressure design, interior coating according to AWWA C550, and push-on- or mechanical-joint ends. Valves shall open to the left.
- D. Nonrising-Stem Gate Valves, 4-Inch NPS and Larger: UL 262, FM approved, iron body and bonnet with flange for indicator post, bronze seating material, inside screw, 175-psig working pressure, and mechanical-joint ends. Provide with flanged ends for pit installation. Valves shall open to the left.
- E. Nonrising-Stem Gate Valves, 2-Inch NPS and Smaller: MSS SP-80; body and screw bonnet of ASTM B 62 cast bronze; with Class 125 threaded ends, solid wedge, nonrising copper-silicon-alloy stem, brass packing gland, PTFE-impregnated packing, and malleable-iron handwheel.
- F. Rising-Stem Gate Valves, 2-1/2-Inch NPS and Larger: UL 262, FM approved, iron body and bonnet, bronze seating material, OS&Y, 175-psig working pressure and flanged ends
- G. Rising-Stem Gate Valves, 2-inch NPS and Smaller: UL262, FM approved, bronze body and bonnet, OS&Y, bronze stem, 175-psig working pressure with threaded ends.
- H. Valve Boxes: Cast-iron box with top section and cover with lettering "WATER," bottom section with base of size to fit over valve and barrel approximately 5 inches (125 mm) in diameter, and adjustable cast-iron extension of length required for depth of bury of valve.
 1. Provide steel tee-handle operating wrench with each valve box. Include tee handle with one pointed end, stem of length to operate valve, and socket-fitting valve-operating nut.
- I. Indicator Posts: UL 789, FM-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of bury of valve.
- J. Ball Valves: AWWA C507, Class 250. Include interior coating according to AWWA C550.
- K. Butterfly Valves: UL 1091, with 175-psig (1200-kPa) working-pressure rating.
- L. Check Valves: UL 312, with swing clapper and 175-psig working-pressure rating.

2.7 SPECIALTY VALVES

- A. Pressure-Regulating Valves: Automatic, pilot-operated, cast-iron body with interior coating according to AWWA C550. Include 250-psig (1725-kPa) working-pressure design, bronze pressure-reducing pilot valve and tubing, and means for discharge pressure adjustment.

SCHOEL ENGINEERING

- B. Air-Release Valve: AWWA C512, hydromechanical device to automatically release accumulated air. Include 300-psig (2070-kPa) working-pressure design.

2.8 WATER METERS

- A. Water meter will be furnished and installed by The Birmingham Water Works Board with cost by the Contractor.
- B. Description: AWWA C700, displacement type, bronze main case. Register flow in gallons (Liters), unless cubic feet (cubic meters) are indicated.
- C. Description: AWWA C701, turbine type. Register flow in gallons (Liters), unless cubic feet (cubic meters) are indicated.
- D. Description: AWWA C702, compound type, bronze case. Register flow in gallons (Liters), unless cubic feet (cubic meters) are indicated.
- E. Description: AWWA C703, UL listed, FM approved, main line, proportional, detector type, 150-psig (1035-kPa) working pressure, with meter on bypass. Register flow in gallons (Liters), unless cubic feet (cubic meters) are indicated.
 - 1. Bypass Meter: AWWA C702, compound type, bronze case; size at least one-half nominal size of main-line meter.
 - 2. Bypass Meter: AWWA C701, turbine type, bronze case; size at least one-half nominal size of main-line meter.
- F. Description: AWWA C703, UL listed, FM approved, main-line turbine, detector type, 175-psig (1200-kPa) working pressure, with strainer, and meter on bypass. Register flow in gallons (Liters), unless cubic feet (cubic meters) are indicated.
 - 1. Bypass Meter: AWWA C701, turbine type, bronze case; at least 2-inch NPS (DN50).

2.9 WATER-METER BOXES

- A. Description: Cast-iron body and cover for disc-type water meter. Include lettering "WATER METER" in cover; and slotted, open-bottom base section of length to fit over service piping.
 - 1. Option: Base section may be cast-iron or Precast Concrete.
- B. Description: Cast-iron body and double cover for disc-type water meter. Include lettering "WATER METER" in top cover; separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.

2.10 PITS

- A. Description: Precast, reinforced-concrete pit, designed for A-16 load designation according to ASTM C 857, and made according to ASTM C 858.
- B. Ladder: ASTM A 36 (ASTM A 36M), steel or polyethylene-encased steel steps.
- C. Cast in place reinforced concrete having a compressive strength of 3000 psi in twenty-eight days with reinforcing being intermediate grade billet steel conform to ASTM A-615 for deformed bars as shown on drawings.

2.11 PROTECTIVE ENCLOSURES

- A. Description: Manufactured, weather-resistant enclosure designed to protect aboveground water piping equipment or specialties. Include size and dimensions indicated, but not less than those required for access and service of protected unit and the following:
 - 1. Housing: Reinforced-aluminum construction.

SCHOEL ENGINEERING

2. Housing: Reinforced-fiberglass construction.
3. Housing: Reinforced-aluminum or -fiberglass construction.
4. Drain opening for units with drain connection.
5. Access doors with locking devices.
6. Insulation inside housing.
7. Electric heating cable or heater with self-limiting temperature control.
8. Precast concrete base of dimensions required to extend at least 6 inches (150 mm) beyond edges of housing.
9. Anchoring devices to attach housing to base.

2.12 FREESTANDING FIRE HYDRANTS

- A. Fire hydrants shall meet all applicable parts of ANSI/AWWA-C502 and shall be Mueller Super Centurion 200 No. A-423 or approved equal and shall meet local standards and requirement. Verify with local Fire Department. Hydrants shall have a 6 inch mechanical joint connection, two 2 1/2" hose connections with National Standard threads and one 5 inch pumper. All working parts shall be bronze and hydrants shall open to the left.

2.13 DETECTOR CHECK VALVES

- A. Detector Check Valves: UL 312, galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends; designed for 175-psig working pressure. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
 1. Water Meter: AWWA C700, disc type, of size at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.
- B. Detector Check Valve: UL 312, FM-approved detector check, iron body, corrosion-resistant clapper ring and seat ring material, 175-psig working pressure, flanged ends, with connections for bypass and installation of water meter.

2.14 BACKFLOW PREVENTERS

- A. General: Manufactured backflow preventers, of size indicated for maximum flow rate and maximum pressure loss indicated.
- B. Working Pressure: 150 psig minimum, unless otherwise indicated.
- C. 2-Inch NPS and Smaller: Bronze body with threaded ends.
- D. 2-1/2-Inch NPS and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.
- E. Interior Lining: AWWA C550, epoxy coating for backflow preventers with cast-iron or steel body.
- F. Interior Components: Corrosion-resistant materials.
- G. Strainer on inlet if strainer is indicated.
- H. Reduced-Pressure-Principle Backflow Preventer: ASSE 1013, with OS&Y gate valves on inlet and outlet, and strainer on inlet. Include test cocks and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between 2 positive-seating check valves for continuous-pressure application.
- I. Reduced-Pressure-Principle Backflow Preventer: AWWA C511, with OS gate valves on inlet and outlet, and strainer on inlet. Include test cocks and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between 2 positive-seating check valves for continuous-pressure application.

SCHOEL ENGINEERING

- J. Double-Check Backflow Prevention Assemblies: ASSE 1015, with valves on inlet and outlet and strainer on inlet. Include test cocks with 2 positive-seating check valves for continuous-pressure application.
- K. Double-Check-Valve Assembly: AWWA C510, with OS&Y gate valves on inlet and outlet, and strainer on inlet.
- L. Double-Check-Valve Assembly: UL 312, FM approved. Assembly has two UL 312, FM-approved, iron-body, 175-psig working-pressure, flanged-end check valves, with two UL 262, FM-approved, iron-body, OS&Y, flanged, 175-psig working-pressure gate valves.
- M. Double-Check Detector Assembly Backflow Preventers: ASSE 1048, FM approved or UL listed, with OS&Y gate valves on inlet and outlet, and strainer on inlet. Include 2 positive-seating check valves and test cocks, and bypass with displacement-type water meter, valves, and double-check backflow preventer, for continuous-pressure application.

2.15 YARD HYDRANTS

- A. Yard Hydrants, Sanitary, Post Type: Nonfreeze, with nondraining chamber for storing water trapped downstream from inlet valve. Include 1-inch NPS (DN25) inlet, integral or field-installed vacuum breaker with outlet complying with ASME B1.20.7, 3/4-11.5NH threads for garden hose, brass or bronze casing, and other parts in contact with water, and are handle or key operated. Include body length required for installing storage chamber below frost line. Furnish 2 keys for each key-operated hydrant.
- B. Yard Hydrants, Post Type: Nonfreeze. Include 3/4-inch NPS (DN20) inlet, integral or field-installed vacuum breaker with outlet complying with ASME B1.20.7, 3/4-11.5NH threads for garden hose. Include bronze casing, cast-iron or cast-aluminum casing guard, tapped drain port in valve housing, and key operation. Include body length required for installing inlet valve below frost line. Furnish 2 keys for each hydrant.

2.16 ANCHORAGES

- A. Clamps, Straps, and Washers: ASTM A 506, steel.
- B. Rods: ASTM A 575, steel.
- C. Rod Couplings: ASTM A 197 (ASTM A 197M), malleable iron.
- D. Bolts: ASTM A 307, steel.
- E. Cast-Iron Washers: ASTM A 126, gray iron.
- F. Concrete Reaction Backing: Portland cement concrete mix, 3000 psig (20.7 MPa).
 - 1. Cement: ASTM C 150, Type I.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.

2.17 ALARM DEVICES

- A. Description: UL 753, FM approved, of types and sizes to mate and match piping and equipment.
- B. Supervisory Switches: SPDT, designed to signal valve in other than full open position.

2.18 IDENTIFICATION

SCHOEL ENGINEERING

- A. Refer to Section 31 20 00 Earth Moving for underground warning tape materials.
- B. Arrange for detectable warning tapes made of solid blue film with metallic core and continuously printed black-letter caption "CAUTION--WATER LINE BURIED BELOW."

PART 3) - EXECUTION

3.1 EARTHWORK

- A. Refer to Section 31 20 00 Earth Moving for excavation, trenching, and backfilling.
- B. Refer to Section 32 12 16 Asphalt Paving for cutting and patching of existing paving.
- C. Refer to Section 32 13 13 Concrete Paving for cutting and patching of paving.

3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications:
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.
- C. Do not use flanges or keyed couplings for underground piping.
 - 1. Exception: Piping in boxes and structures, but not buried, may be joined with flanges or keyed couplings instead of joints indicated.
- D. Flanges, keyed couplings, and special fittings may be used on aboveground piping.
- E. Potable Water-Service Piping: Use the following:
 - 1. 3/4- to 2-Inch NPS: Copper tube, Type K (Type A); copper fittings; and soldered joints.
 - 2. Option for 2-1/2- to 3-1/2-Inch NPS: 3- or 4-inch NPS ; ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed joints.
 - 3. Option for 2-1/2- to 3-1/2-Inch NPS: 3- or 4-inch NPS; ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
 - 4. 2-1/2- to 3-1/2-Inch NPS: Copper tube, Type K (Type A); copper fittings; and soldered joints.
 - 5. 4-Inch NPS: Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
 - 6. 6-Inch NPS: Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
 - 7. 8-Inch NPS: Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
- F. Fire-Protection Water-Service Piping: Use the following:
 - 1. 4- to 8-Inch NPS: Ductile-iron, push-on-joint pipe and gasketed joints.
 - 2. 4- to 8-Inch NPS: Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
 - 3. 10- and 12-Inch NPS: Ductile-iron, push-on-joint pipe and gasketed joints.
 - 4. 10- and 12-Inch NPS: Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
- G. Combined Potable-Water and Fire-Protection Water-Service Piping: Use the following:
 - 1. 6- to 12-Inch NPS (DN150 to DN300): Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.

SCHOEL ENGINEERING

3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Underground Valves, 3-Inch NPS and Larger: AWWA, gate valves, nonrising stem, with valve box.
 2. Underground Valves, 4-Inch NPS and Larger: UL/FM, gate valves, nonrising stem, with indicator post.
 3. Pit and Aboveground Installation Valves, 2-1/2-Inch NPS and Larger: UL/FM, OS&Y gate valves.
 4. Pit and Aboveground Installation Valves, 2-Inch NPS (DN50) and Smaller: UL/FM, OS&Y gate valves.

3.4 JOINT CONSTRUCTION

- A. Refer to Section 33 05 00 Common Work Results for Utilities for basic piping joint construction.
- B. Ductile-Iron Piping, Gasketed Joints: According to AWWA C600.
- C. Ductile-Iron Piping, Gasketed Joints for Fire-Service Piping: According to UL 194 and AWWA C600.
- D. Flanged Joints: Align flanges and install gaskets. Assemble joints by sequencing bolt tightening. Use lubricant on bolt threads.
- E. Threaded Joints: Thread pipes with tapered pipe threads according to ASME B1.20.1, apply tape or joint compound, and apply wrench to fitting and valve ends into which pipes are being threaded.
- F. Copper Tubing, Brazed Joints: According to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
- G. Copper Tubing, Soldered Joints: According to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube."
- H. Copper Tubing, Soldered Joints: According to CDA's "Copper Tube Handbook."
- I. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, OD, and system working pressure. Refer to "Piping Systems - Common Requirements" Article below for joining piping of dissimilar metals.

3.5 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.
- B. Install piping at indicated slope.
- C. Install components with pressure rating equal to or greater than system operating pressure.
- D. Install piping free of sags and bends.
- E. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- F. Install fittings for changes in direction and branch connections.
- G. Piping Connections: Unless otherwise indicated, make piping connections as specified below:

SCHOEL ENGINEERING

1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
3. Install dielectric fittings to connect piping of dissimilar metals.

3.6 SERVICE ENTRANCE PIPING

- A. Extend water-service piping and connect to water-supply source and building water piping systems 5 feet from outside face of building wall in locations and pipe sizes indicated.
 1. Terminate water-service piping 5 feet from building wall until building water piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building water piping systems when those systems are installed.
- B. Sleeves and mechanical sleeve seals are specified in Section 22 05 00 Common Work Results for Plumbing.
- C. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- D. Anchor service-entry piping to building wall.

3.7 PIPING INSTALLATION

- A. Water-Main Connection: Arrange for tap in water main, of size and in location indicated, from water utility.
- B. Comply with NFPA 24 for fire-protection water-service piping materials and installation.
- C. Install ductile-iron piping according to AWWA C600.
- D. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- E. Bury piping with depth of cover over top at least 36 inches, with top at least 12 inches (300 mm) below level of maximum frost penetration, and according to the following:
 1. Under Driveways: With at least 36 inches cover over top.
 2. Under Railroad Tracks: With at least 48 inches cover over top.
 3. In Loose Gravelly Soil and Rock: With at least 12 inches (300 mm) additional cover.
- F. Install piping under streets and other obstructions that cannot be disturbed, by tunneling, jacking, or combination of both.

3.8 ANCHORAGE INSTALLATION

- A. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 1. Gasketed-Joint, Ductile-Iron, Potable-Water Piping: According to AWWA C600.
 2. Gasketed-Joint, PVC Potable-Water Piping: According to AWWA M23.
 3. Fire-Service Piping: According to NFPA 24.
- B. Apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of installed ferrous anchorage devices.

3.9 VALVE INSTALLATION

- A. General Application: Use mechanical-joint-end valves for 3-inch NPS and larger underground installation. Use threaded- and flanged-end valves for installation in pits. Use nonrising-stem UL/FM

SCHOEL ENGINEERING

gate valves for installation with indicator posts. Use bronze corporation stops and valves, with ends compatible with piping, for 2-inch NPS and smaller installation.

- B. AWWA-Type Gate Valves: Comply with AWWA C600. Install underground valves with stem pointing up and with cast-iron valve box.
- C. UL/FM-Type Gate Valves: Comply with NFPA 24. Install underground valves and valves in pits with stem pointing up and with vertical cast-iron indicator post.
- D. Bronze Corporation Stops and Curb Stops: Comply with manufacturer's written instructions. Install underground curb stops with head pointed up and with cast-iron curb box.

3.10 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.
- C. AWWA-Type Fire Hydrants: Comply with AWWA M17.
- D. UL/FM-Type Fire Hydrants: Comply with NFPA 24.

3.11 WATER-METER INSTALLATION

- A. Install water meters, piping, and specialties according to utility company's written requirements.
- B. Water Meter: Install displacement-type water meters, 2-inch NPS (DN50) and smaller, in meter boxes with shutoff valve on water-meter inlet. Include valve on water-meter outlet and valved bypass around meter, unless prohibited by authorities having jurisdiction.
- C. Water Meter: Install compound-type water meters, 3-inch NPS (DN80) and larger, in meter pits. Include shutoff valves on water-meter inlet and outlet and valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.
- D. Water Meter: Install detector-type water meters according to AWWA M6 in meter pit. Include shutoff valves on water-meter inlet and outlet and full-size valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.

3.12 ROUGHING-IN FOR WATER METERS

- A. Rough-in piping and specialties for water-meter installation according to utility company's written instructions and requirements.

3.13 PIT CONSTRUCTION AND INSTALLATION

- A. Construct pits of cast-in-place concrete pits, with access frame and cover, ladder, and drain. Include sleeves with waterproof mechanical sleeve seals for pipe entry and exit. Refer to Section 32 13 13 Concrete Paving
- B. Install precast concrete pits according to ASTM C 891.
- C. Connect area drain outlet to storm drainage piping or as shown on Drawings. Refer to Section 33 40 00 Storm Drainage Utilities

SCHOEL ENGINEERING

3.14 DETECTOR CHECK VALVE INSTALLATION

- A. Install detector check valves in pits for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
- B. Support detector check valves, meters, shutoff valves, and piping on concrete piers.

3.15 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to plumbing and health department authorities having jurisdiction.
- B. Do not install reduced-pressure-principle type in pit.
- C. Do not install bypass around backflow preventer.
- D. Support backflow preventers, valves, and piping on concrete piers.

3.16 YARD HYDRANT INSTALLATION

- A. Install sanitary-type yard hydrants in pavement or with concrete anchor as indicated.
- B. Install post-type yard hydrants in pavement or with concrete anchor, and provide for drainage into dry well as indicated.

3.17 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install fire department connections of types and features indicated.
- B. Install ball drip valves at each check valve for fire department connection to mains.

3.18 ALARM DEVICE INSTALLATION

- A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with curb boxes do not require supervision.
- B. Supervisory Switches: Supervise valves in open position.
 - 1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
 - 2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
- C. Locking and Sealing: Secure unsupervised valves as follows:
 - 1. Valves: Install chain and padlock on open OS&Y gate valve.
 - 2. Post Indicators: Install padlock on wrench on indicator post.
- D. Connect alarm devices to building fire alarm system. Refer to Division 21 Fire Suppression for wiring and devices not specified in this Section.

3.19 IDENTIFICATION INSTALLATION

- A. Install continuous plastic underground warning tape during back-filling of trench for underground water-service piping. Locate 6 to 8 inches below finished grade, directly over piping.
- B. Attach nonmetallic piping label permanently to main electrical meter panel.

SCHOEL ENGINEERING

3.20 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than 1-1/2 times working pressure for 2 hours.
 - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to 0 psig. Slowly increase again to test pressure and hold for one more hour. No leakage will be allowed. Remake leaking joints with new materials and repeat test until leakage is within above limits.
- C. Prepare reports for testing activities.

3.21 CLEANING

- A. Clean and disinfect water distribution piping as follows:
 - 1. Purge new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by that authority, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
 - 3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities, use procedure described in AWWA C651 or as described below:
 - (a) Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine. Isolate system or part thereof and allow to stand for 24 hours.
 - (b) Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
 - (c) Following allowed standing time, flush system with clean, potable water until chlorine does not remain in water coming from system.
 - (d) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports for purging and disinfecting activities in accordance with the following:
 - 1. Disinfection report record:
 - a. Type and form of disinfectant used.
 - b. Date and time disinfectant injection start and time of completion.Test locations.
Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
Date and time of flushing start and completion.
Disinfectant residual after flushing in ppm for each outlet tested.
 - 2. Bacteriological report; record:
Date issued, project name, testing laboratory name, address, and telephone number.
Time and date of water sample collection.
Name of person collecting samples.
Test locations.
Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
Coliform bacteria test results for each outlet tested.

Certification that water conforms, or fails to conform, to bacterial standards.
Bacteriologist=s signature and authority.

END OF SECTION

SCHOEL ENGINEERING

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

- A. This Section includes storm drainage, piping and appurtenances from 5 feet outside the building to point of disposal.
- B. Related Sections include the following:
 - 1. Section 312500 Erosion and Sedimentation Controls
 - 2. Section 312000 Earth Moving

1.3 DEFINITIONS

- A. PE: Polyethylene plastic.
- B. PVC: Polyvinyl chloride plastic.
- C. RCP: Reinforced concrete pipe.
- D. HDEP: High Density Polyethylene pipe.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Stormwater disposal systems.
- B. Shop Drawings: Include plans, elevations, details, and attachments for the following:
 - 1. Precast concrete manholes and other structures, including frames, covers, and grates.
 - 2. Cast-in-place concrete manholes and other structures, including frames, covers, and grates.
- C. Coordination Drawings: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.
- D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

SCHOEL ENGINEERING

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic structures, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

- A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Engineer not less than 48 hours in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Engineer's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements,

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 PIPES AND FITTINGS

- A. Ductile-Iron Sewer Pipe: ASTM A 746, Class 52, for push-on joints.
 - 1 Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, for push-on joints.
 - 2 Compact-Pattern, Ductile-Iron Fittings: AWWA C153, for push-on joints.
 - 3 Gaskets: AWWA C111, rubber.
- B. Ductile-Iron Culvert Pipe: ASTM A 716, for push-on joints.
 - 1. Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, for push-on joints.
 - 2. Gaskets: AWWA C111, rubber.

SCHOEL ENGINEERING

- C. ABS Sewer Pipe and Fittings: ASTM D 2751, for solvent-cemented or gasketed joints.
 - 1. Wall Thickness for NPS 3 to NPS 6 (DN80 to DN150): SDR 35.
 - 2. Wall Thickness for NPS 8 to NPS 12 (DN200 to DN300): SDR 42.
 - 3. Gaskets: ASTM F 477, elastomeric seals.

- D. Corrugated PE Drainage Tubing and Fittings: AASHTO M 252, Type S, with smooth waterway for coupling joints.
 - 1. Soiltight Couplings: AASHTO M 252, corrugated, matching tube and fittings to form soiltight joints.
 - 2. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings to form silttight joints.

- E. Corrugated PE Pipe and Fittings: AASHTO M 294, Type S, with smooth waterway for coupling joints.
 - 1. Soiltight Couplings: AASHTO M 294, corrugated, matching pipe and fittings to form soiltight joints.
 - 2. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings to form silttight joints.

- F. Corrugated HDPE Pipe and Fittings: AASHTO M-252 and M-294
 - 1. Soiltight Coupling: Type III, Category 4 or 5, Grade P33 or P34, Class C per ASTM D-1248 with the applicable requirements define in ASTM D-1248.
 - 2. Pipe and fittings shall be Advanced Drainage Systems N-12 or equivalent.

- G. PVC Pressure Pipe: AWWA C900, Class 150, for gasketed joints.
 - 1. PVC Pressure Fittings: AWWA C907, for gasketed joints.
 - 2. Gaskets for PVC Piping: ASTM F 477, elastomeric seals.
 - 3. Ductile-Iron, Compact Fittings: AWWA C153, for push-on joints.
 - 4. Gaskets for Ductile-Iron Fittings: AWWA C111, rubber.

- H. VC Sewer Pipe and Fittings: According to the following:
 - 1. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.
 - a. Gaskets: ASTM F 477, elastomeric seals.
 - 2. PVC Sewer Pipe and Fittings, NPS 18 (DN450) and Larger: ASTM F 679, T-1 wall thickness, bell and spigot for gasketed joints.
 - a. Gaskets: ASTM F 477, elastomeric seals.

- I. PVC, Ribbed Drain Pipe: AASHTO M 304M, bell and spigot, with smooth waterway for bell-gasketed joints.
 - 1. Fittings: AASHTO M 304M or ASTM F 794 for bell-gasketed joints.
 - 2. Gaskets: ASTM F 477, elastomeric seals to form soiltight joints.

- J. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), Class 2, for gasketed joints.
 - 1. Gaskets: ASTM C 443 (ASTM C 443M), rubber.

SCHOEL ENGINEERING

- K. Concrete sewer pipe: Shall conform to ASTM Standard Specification C76, Latest Revision, for reinforced concrete pipe. Pipe smaller than 12 inches in diameter shall be non-reinforced. Pipe 12 inches and larger shall be reinforced. Pipe laid under proposed pavement and in streets shall be Class III unless otherwise noted on drawings. Certificates from manufacturer must be furnished which state that the pipe furnished was manufactured according to the above requirements. Concrete sewer pipe shall have standard tongue and groove type joints and shall be made water tight by use of a Portland cement mortar with a 1:2 cement-sand mixture and a minimum of water. Joints shall be made smooth inside and outside the pipe.
- L. Reinforced-Concrete Arch Pipe: ASTM C 506 (ASTM C 506M), latest revision.

2.4 SPECIAL PIPE COUPLINGS AND FITTINGS

- A. Sleeve-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes to be joined, for nonpressure joints.
 - 1. Sleeve Material for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.
 - 2. Sleeve Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
 - 3. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
 - 4. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.
 - 5. Bands: Stainless steel, at least one at each pipe insert.
- B. Bushing-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric bushing fabricated to mate with OD of smaller pipe and ID of adjoining larger pipe, for nonpressure joints.
 - 1. Material for Concrete Pipe: ASTM C 443 (ASTM C 443M), rubber.
 - 2. Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
 - 3. Material for Plastic Pipe: ASTM F 477, elastomeric seal.
 - 4. Material for Dissimilar Pipe: Compatible with pipe materials being joined.
- C. Pressure-Type Pipe Couplings: AWWA C219, iron-body sleeve assembly matching OD of pipes to be joined, with AWWA C111 rubber gaskets, bolts, and nuts. Include PE film, pipe encasement.
- D. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated. Include PE film, pipe encasement.

2.6 PRECAST MANHOLES

- A. Precast concrete manhole sections shall conform to the requirement of ASTM Specifications C-478, Latest Addition. The concrete when tested in compression shall not be less than 400 PSI and absorption shall not exceed 9%. Minimum wall thickness of manhole riser sections shall be as follows:

48" I.D. - 5" 60" I.D. - 6" 72" I.D. - 7"

SCHOEL ENGINEERING

- B. Cone sections shall have a minimum 5" wall at the bottom and 8" wall thickness at the top. The minimum thickness of the manhole bottoms shall be 6". Manholes shall have concentric cones.
- C. Joints between the manhole sections will be made with o-rings rubber gaskets or performed butyl section and shall meet the requirements of ASTM Specifications C-443, latest revision.
- D. Openings for inlet and discharge sewer pipes shall be provided in the manhole base section at the position shown on the plans.
- E. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch diameter frame and cover.
- F. Manhole steps shall be reinforced plastic complying with the requirements of ASTM-478. Para. 11 and shall be No. PSI-PF as manufactured by M.A. Industries or approved equal.
- G. Precast manholes shall be as manufactured by Sherman Industries or approved equal.
- H. Cast-in-Place Concrete Manholes: Construct of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
- I. Manhole Frames and Covers: ASTM A 48 Class 30, grey iron castings designed for heavy-duty service. Include indented top design with lettering "STORM SEWER" cast into cover. Castings shall be Vulcan Foundry Corp. No. V-1480-1 or approved equal.
- J. Cast-in-Place Concrete: Construct of reinforced concrete; designed according to ASTM C 890 for structural loading; of depth, shape, dimensions, and appurtenances indicated.
 - 1. Bottom, Walls, and Top: Reinforced concrete.
 - 2. Channels and Benches: Concrete.

2.6 STORMWATER INLETS

- A. Curb Inlets: Vertical curb opening, of materials and dimensions indicated.
- B. Grate Inlets: Horizontal opening, of materials and dimensions indicated. Include heavy-duty frames and grates.
- C. Yard Inlets: Vertical and horizontal openings, of materials and dimensions indicated. Include heavy-duty frames and grates.
- D. Frames and Grates: Dimensions, opening pattern, free area, and other attributes indicated.
 - 1. Material: ASTM A 48, Class 30 (ASTM A 48M, Class No. 200A) minimum, gray-iron casting.

SCHOEL ENGINEERING

2. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

2.7 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
 1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed steel.
- C. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water-cementitious ratio.
 1. Include channels (inverts) and benches in manholes.
 - a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - b. Benches: Concrete, sloped to drain into channel.
 2. Include channels in catch basins.
 - a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

2.8 PROTECTIVE COATINGS

- A. Description: One- or two-coat, coal-tar epoxy; 15-mil minimum thickness, unless otherwise indicated; factory applied to the following surfaces:
 1. Stormwater Inlet Frames and Grates: On entire surfaces.
 2. Stormwater Detention-Structure Manhole Frames and Covers: On entire surfaces.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 20 00 Earth Moving.

3.2 IDENTIFICATION

- A. Materials and their installation are specified in Section 31 20 00 Earth Moving. Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.
 1. Use warning tape or detectable warning tape over ferrous piping.

SCHOEL ENGINEERING

2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.3 PIPING APPLICATIONS

- A. General: Include watertight, silttight, or soiltight joints, unless watertight or silttight joints are indicated.

3.4 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.
- C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.
 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
 2. Install piping with 36-inch minimum cover.
- F. Extend storm drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

3.5 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. General: Join and install pipe and fittings according to installations indicated.
- B. ABS Pipe and Fittings: As follows:
 1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
 2. Install according to ASTM D 2321.
- C. PE Pipe and Fittings: As follows:
 1. Join pipe, tubing, and fittings with couplings for soiltight joints according to manufacturer's written instructions.

SCHOEL ENGINEERING

2. Install according to ASTM D 2321 and manufacturer's written instructions.
3. Install corrugated piping according to the Corrugated Polyethylene Pipe Association's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."

D. PVC Sewer Pipe and Fittings: As follows:

1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
2. Install according to ASTM D 2321.

E. Concrete Pipe and Fittings: Install according to ACPA's "Concrete Pipe Installation Manual."

F. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.

G. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.6 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Form continuous concrete channels and benches between inlets and outlet.

C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements and concrete. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.

D. Install precast concrete manhole sections with gaskets according to ASTM C 891.

E. Construct cast-in-place manholes as indicated.

3.7 CATCH-BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.8 STORM DRAINAGE INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

SCHOEL ENGINEERING

- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipators at outlets, as indicated.

3.9 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.10 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Structures: Excavate around structure as required and use one procedure below:
 - 1. Remove structure and close open ends of remaining piping.

3.11 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
 - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
 - 2. Place plug in end of incomplete piping at end of day and when work stops.
 - 3. Flush piping between manholes and other structures to remove collected debris.
- B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.

SCHOEL ENGINEERING

- C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate reports for each test.

END OF SECTION