

PROJECT MANUAL

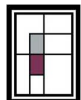
ADMINISTRATION & TRAINING CENTER TRI COUNTY BOARD OF RECOVERY & MENTAL HEALTH

1280 N. County Road 25-A
Troy, Ohio 45373

Project #1615.04

Rebid Specifications

May 12, 2021



FREYTAG & ASSOCIATES INC.
ARCHITECTS ENGINEERS

226 North Miami Avenue
P.O. Box 220
Sidney, Ohio 45365.

(937) 492-6983

Book 2 of 2
Division 21 – 33

(This page intentionally left blank)

SECTION 000001 - TABLE OF CONTENTS

000020	Notice to Bidders
000100	Instructions to Bidders
000200	Rebid Scope Changes
000300	Bid Proposal Form
000411	Bid Guarantee and Contract Bond
000480	Non-Collusion Affidavit
000481	Tax Compliance Affidavit
000600	Project Forms
000610	Contract Performance and Payment Bond
000800	Supplementary Conditions
000820	Certificate of Insurance
000900	CAD Agreement and Waiver
000950	Prevailing Wage Rates
003132	Geotechnical Data

DIVISION 1 - GENERAL REQUIREMENTS

011000	Summary
012100	Allowances
012300	Alternates
012500	Substitution Procedures
012600	Contract Modification Procedures
012900	Payment Procedures
013100	Project Management and Coordination
013200	Construction Progress Documentation
013300	Submittal Procedures
014520	Testing Laboratory Service
015000	Temporary Facilities and Controls
015713	Temporary Erosion & Sediment Control
016000	Product Requirements
017300	Execution - Construction Layout/Field Engineering
017329	Cutting & Patching
017400	Construction Cleaning
017419	Construction Waste Management
017700	Closeout Procedures
017823	Operation & Maintenance Data
017839	Project Record Documents
017900	Demonstration & Training

DIVISION 03 – CONCRETE

033000	Cast-in-Place Concrete
--------	------------------------

DIVISION 04 – MASONRY

040523	Masonry Accessories
042000	Unit Masonry
047200	Cast Stone Masonry

DIVISION 05 – METALS

051200	Structural Steel
053100	Steel Decking
054000	Cold-Formed Metal Framing
055000	Metal Fabrications

DIVISION 06 – WOOD, PLASTICS and COMPOSITES

061000	Rough Carpentry
--------	-----------------

061600	Sheathing
061753	Shop Fabricated Wood Trusses
062023	Interior Finish Carpentry
066511	Solid Surface Fabrications

DIVISION 07 – THERMAL and MOISTURE PROTECTION

072100	Thermal Insulation
072119	Spray Applied Polyurethane Foam Insulation (Closed Cell)
072139	Spray Applied Polyurethane Foam Insulation (Open Cell)
072500	Weather Barriers
072616	Underslab Vapor Barrier
074113	Standing Seam Metal Roof Panels
074213	Formed Metal Wall Panels
074243	Composite Wall Panels
074646	Fiber-Cement Siding & Soffit
074800	Rainscreen Attachment System
078413	Penetration Firestopping
079200	Joint Sealants

DIVISION 08 – OPENINGS

081113	Hollow Metal Doors and Frames
081416	Flush Wood Doors
081613	FRP Doors
083113	Access Doors & Frames
083613	Sectional Doors
084113	Aluminum-Framed Entrances and Storefronts
087100	Door Hardware
088000	Glazing

DIVISION 09 – FINISHES

092216	Non-Structural Metal Framing
092900	Gypsum Board
093000	Tiling
095113	Acoustical Panel Ceilings
096513	Resilient Base and Accessories
096519	Resilient Tile Flooring
096813	Tile Carpeting
097200	Vinyl Wall Coverings
098416	Acoustical Wall Treatment
099123	Painting and Finishing

DIVISION 10 – SPECIALTIES

101400	Signage
101426	Post and Panel Signage
102226	Operable Partitions
102600	Wall and Door Protection
102800	Toilet, Bath and Laundry Accessories
104413	Fire Extinguishers and Cabinets

DIVISION 12 – FURNISHINGS

122413	Roller Window Shades
123240	Casework

DIVISION 21 – FIRE SUPPRESSION

210001	Basic Fire Suppression Requirements
210004	Firestopping for Fire Suppression Systems
210519	Gauges
210529	Pipe Hangers & Supports
211100	Facility Fire-Suppression Water Service Piping

211313 Wet-Pipe Sprinkler Systems

DIVISION 22 – PLUMBING

220001	Basic Plumbing Requirements
220004	Firestopping for Plumbing Systems
220519	Meters and Gauges
220523	General Duty Valves
220529	Pipe Hangers and Supports
220530	Equipment Bases and Supports
220548	Vibration Control
220719	Pipe Insulation
221116	Domestic Water Piping
221119	Domestic Water Piping Specialties
221123	Domestic Water Pumps
221316	Sanitary Waste and Vent Piping
221319	Sanitary Waste Piping Specialties
221613	Interior Natural Gas Piping
223116	Water Softeners
223333	Electric Domestic Water Heaters
224200	Plumbing Fixtures

DIVISION 23 – HVAC

230001	Basic HVAC Requirements
230513	Electrical Requirements for HVAC Equipment
230519	Meters and Gauges
230523	General Duty Valves
230525	Flexible Pipe Connectors
230529	Pipe Hangers and Supports
230530	Equipment Basis and Supports
230548	Vibration Control
230553	Identification for HVAC Systems
230593	Testing, Adjusting and Balancing
230713	Duct Insulation
230716	Equipment Insulation
230719	Pipe Insulation
230913	Instruments and Control Devices
230914	Control Wiring
230923	Direct Digital Control System
230950	Variable Frequency Motor Controllers
231123	Interior Natural Gas Piping
231125	Exterior Natural Gas Piping
232113	Hydronic Piping
232114	Hydronic Specialties
232123	Hydronic Pumps
232300	Refrigerant Piping
232500	HVAC Water Treatment
233113	Ductwork
233300	Air Duct Accessories
233400	Fans
233600	Air Terminal Units
233713	Diffusers, Registers and Grilles
233723	Gravity Ventilators
235100	Breechings, Chimneys and Stacks
235216	Condensing Boilers
236200	Condensing Units
237313	Modular, indoor Air-Handling Units
238122	Split System Heat Pumps
238216	Air Coils – Hydronic, Electric, Steam, & Refrigerant
238239	Unit Heaters

DIVISION 26 – ELECTRICAL

260001	Basic Electrical Requirements
260004	Firestopping for Electrical Systems
260519	Low-Voltage Electrical Power Conductors and Cables
260526	Grounding and Bonding for Electrical Systems
260529	Hangers and Supports for Electrical Systems
260533	Raceway and Boxes for Electrical Systems
260543	Manholes, Underground Ducts and Raceways
260553	Identification for Electrical Systems
260923	Lighting Control Devices
262416	Panelboards
262726	Wiring Devices
262813	Fuses
262816	Enclosed Switches and Circuit Breakers
262913	Enclosed Motor Controllers
264313	Surge protective Devices (SPD) for Low Voltage Electrical Power Circuits
265113	Lighting Fixtures
265600	Exterior Area Lighting
266101	Digital Addressable Fire-Alarm System
267533	Raceway and Boxes for Communications Systems

DIVISION 27 – TECHNOLOGY

270500	Basic Communications Requirements
270503	Technology Systems Warrantee
270504	Communications Systems Submittals
270520	Basic Communications Materials and Methods
270525	Firestopping
270526	Grounding and Bonding for Communications Systems
270528	Pathways for Communications Systems
270529	Hangers and Supports for Communications Systems
270536	Cable trays for Communications Systems
270544	Sleeves and Seals for Communications Pathways
270553	Identification
270801	Communication Systems Cable Testing
270802	Documentation and Close Out for Tech & Security Systems
271100	Communications Equipment Room Fittings
271323	Communications Fiber Backbone Cabling
271513	Communications Copper Horizontal Cabling
272100	Data Communications Network Equipment
272133	Data Communications Wireless Access Points
273123	IP Telephone System
273244	Emergency Responder Testing
274118	Conference Room Audiovisual System
274119	Audiovisual Equipment

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

281300	Access Control System
281353	Door Entry Video Intercom System
282100	Video Surveillance Cameras
282300	Video Surveillance System

DIVISION 31 – EARTHWORK

311000	Site Clearing
312500	Erosion and Sediment Control

DIVISION 32 – EXTERIOR IMPROVEMENTS

321216	Asphalt Paving
321313	Concrete Paving

321373	Concrete Paving Joint Sealers
321723	Pavement Markings
329200	Turf and Grasses
329300	Plants

DIVISION 33 – UTILITIES

331000	Water Distribution Piping
331313	Sanitary Sewers
334100	Storm Drainage
334600	Subdrainage

(This page intentionally left blank)

DIVISION

21

FIRE SUPPRESSION

(This page intentionally left blank)

DIVISION 21 FIRE SUPPRESSION

21 0000 General Requirements for Fire Suppression Systems

- 21 0001 Basic Fire Suppression Requirements
- 21 0004 Firestopping for Fire Suppression Systems

21 0500 Common Work Results for Fire Suppression

- 21 0519 Gauges
- 21 0529 Pipe Hangers and Supports
- 21 0553 Identification for Fire Suppression Systems

21 1000 Water Based Fire Suppression Systems

- 21 1100 Facility Water Service
- 21 1313 Wet-Pipe Sprinkler Systems

This page left intentionally blank.

SECTION 21 0001 – BASIC FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes the following:
1. General Requirements
 2. Definitions
 3. Scope of Work
 4. Drawings and Specifications
 5. Reference Standards
 6. Allowances, Unit Prices and Alternates
 7. Site Visit
 8. Permits and Regulations
 9. Project Management and Coordination
 10. Workmanship
 11. Protection
 12. Painting
 13. Cleaning
 14. Equipment Selection
 15. Shop Drawings
 16. Final Inspection and Punch List
 17. Operation and Maintenance Manuals
 18. Record Drawings
 19. Warranties
 20. Project Closeout
 21. Operation and Adjustment of Equipment
 22. Operating Demonstration and Instruction

1.2 GENERAL REQUIREMENTS

- A. All provisions of Division 00 Front End Documents and Division 01 General Requirements apply to work specified in this Division.
- B. Specification provisions of other relevant Divisions shall apply where applicable work is required to be performed under this Fire Suppression work.
- C. A complete and functional Fire Suppression system installation shall be provided under this Division. Should overlap of work among trades become evident, this shall be called to the attention of the architect. In such event, none of the trades or their suppliers shall assume that he relieved of the work which is specified under his branch until instructions in writing are received from the Architect.
- D. The Fire Suppression, Plumbing, HVAC and Electrical drawings and specifications assign work (labor and/or materials) to be provided by the General, Fire Suppression, Plumbing, HVAC or

Electrical Contractor or their sub-contractors. Understanding that the contractors for mechanical and electrical work are sub-contractors to the (General) Contractor, such assignments are not intended to restrict the General Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior 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 SCOPE OF WORK

- A. The scope of the Fire Suppression work includes furnishing, installing, testing and warranty of all Fire Suppression work shown on the Fire Suppression drawings and specified herein, including Division 00, division 01, Division 21 and applicable provisions of other relevant Divisions.

1.5 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word “proved,” as used, shall mean “furnish and install.” If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.
- B. Make all necessary field measurements to insure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having pipe and fittings fabricated and delivered in advance of making actual measurements shall be sufficiently in advance as to

not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

- D. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties.
- E. Equipment, or piping shall not be installed or run above electrical switchgear or panelboards, nor in or above the access space in the immediate vicinity of the electrical switchgear/panelboards, in accordance with NEC Article 384.
- F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of ductwork, piping, etc., where conflict arises.
- G. Provides offsets in system runs, additional fittings, necessary drains and minor valves, traps, and devices required to complete the installation, or for the proper operation of the system. Each Contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.
- H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

1.6 REFERENCE STANDARDS

- A. Where standards (NFPA, NEC, ADTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

1.7 ALLOWANCES, UNIT PRICES AND ALTERNATES

- A. Refer to Sections 012100 Allowances, 012200 Unit Prices and 012300 Alternates.

1.8 SITE VISIT

- A. Refer to Sections 017300 Execution.
- B. Each bidder shall visit the project site to understand the existing conditions and compare the conditions with information shown on the drawings. Report immediately to the Architect any issues or discrepancies which are discovered that affect the bid. Changes to contract price will not be considered for site condition issues that are readily apparent from a thorough site review.

1.9 PERMITS, REGULATIONS AND INSPECTION

- A. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawing and specifications shall govern. Install no work contrary to minimum legal standards.
- B. The fire suppression contractor shall be responsible to prepare a permit set of documents to file for and obtain all required permits from the governing inspection agencies. Include payment of all permit and inspection fees applicable to the work in this Division.
- C. All work shall be subject to inspection and approval of Federal, State and local agencies as may be appropriate as well as the Architect and Engineer.
- D. Furnish for the Owner certificates of approval from the governing inspection agencies as a condition for final payment.

1.10 PROJECT MANAGEMENT AND COORDINATION

- A. Refer to Section 013100 Project Management and Coordination.

1.11 WORKMANSHIP

- A. Refer to Section 014000 Quality Requirements.
- B. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect shall have the right to stop the work if highest quality workmanship is not maintained.
- C. Fire suppression design and work shall be performed by licensed Fire Suppression Contractors in accordance with requirements of the jurisdiction.

1.12 PROTECTION

- A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.
- B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide plastic sheeting, drop cloths or similar barriers where dust and debris is generated, to protect adjacent areas.
- C. Contractor shall protect all equipment and materials from detrimental effects of weather or construction activity. All items shall be stored and secured in a protected location away from the daily work area. Equipment or materials shall be placed on raised skids to protect from surface moisture. Where appropriate, provide plastic sheeting or similar vapor barrier underneath the stored products to reduce the effects of ground moisture or curing concrete on the local humidity levels. Where unfinished ferrous products or finished ferrous products with raw edges

are stored, provide local, dry heat to maintain ambient relative humidity levels below 65% RH to prevent rust.

- D. All equipment shall retain the original packaging until required to be removed for installation or operation. Open ends of ducts, piping, conduit, etc. shall be capped or sealed and ventilation openings into equipment shall be wrapped and sealed in plastic sheeting to prevent dust or dirt entry both when stored and after installation but still open to the effects of construction activity. Stored items as well as installed equipment shall be covered with plastic sheeting at all times until placed in service or until dust generating activity in the area has ceased.

1.13 PAINTING

- A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 21:
 - 1. Ferrous metal which is no factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint.
 - 2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint.
 - 3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
- B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 Finishes. All rust must be removed before application of paint.
- C. Finish painting is included in the General Contract.

1.14 CLEANING

- A. Debris, dust, dirt, etc shall be removed daily, particular attention shall be paid to areas that the Owner is continuing to occupy or use; any mess created in corridors, stairwells and egress paths that are maintained during construction shall be cleaned immediately.
- B. The Owners dumpsters and trash receptacles shall not be used. If a dumpster is required, it shall be provided by the contractor and located where approved by the Owner. Coordinate dumpster requirements with other contractors.
- C. Before turning an area back over to the Owner, thoroughly clean the space to leave the area in a similar condition before the start of the project where finishes are to remain. The contractor shall also clean duct interiors and interior components of new or existing air handling system equipment if dirt, dust or debris have generated in the course of work have accumulated on these surfaces.

1.15 EQUIPMENT SELECTION

- A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer. The selection of materials and equipment to be furnished under this contract shall be governed by the following:
1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specifications, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturer's listed.
 2. Where the words "or approved equal:" appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
 3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.
- B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.
- C. Before bidding equipment, and again in the preparation of shop drawings the Contractor and his supplier shall verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.
- D. If extensive changes in pipe, duct or equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in the contract.

1.16 SHOP DRAWINGS

- A. Refer to Section 01600 Product Requirements.
- B. Shop drawings for equipment fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. Failure to do so may be cause for rejection of shop drawings.
- C. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

- D. Shop drawings for the following Fire Suppression equipment and materials shall be submitted
1. Pipe, fittings and joining methods for the various systems.
 2. Firestopping systems for pipe penetrations.
 3. Pipe hangers.
 4. Valves.
 5. Gauges.
 6. Sprinkler heads and accessories.
 7. Wet pipe and dry pipe components.
 8. Sprinkler system installation drawings per NFPA 13, applicable calculations and water supply flow curve.

1.17 FINAL INSPECTION AND PUNCH LIST

- A. Refer to Section 017700 Closeout Procedures.

1.18 OPERATING AND MAINTENANCE MANUALS

- A. Refer to Section 017823 Operation and Maintenance Data.
- B. All shop drawing and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required.
- C. These shall be assembled into three-ring loose lead binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.19 RECORD DRAWINGS

- A. Refer to Section 017839 Project Record Drawings.
- B. Each Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawing shall be turned over to the Architect.

1.20 WARRANTIES

- A. Refer to Section 017700 Closeout Procedures.
- B. This Contractor shall warrant all workmanship, equipment and material entering into this contract for a period of one year of date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner.

- C. This provision is intended specifically to cover deficiencies in contract completion or performance which are discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.
- D. This provision shall not be construed to include maintenance items such as replacing filters, re-tightening or repacking glands, greasing, oiling belt tightening and cleaning strainers after these have been done for final close-out.
- E. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.

1.21 PROJECT CLOSEOUT

- A. Refer to Section 017700 Closeout Procedures.

1.22 OPERATIONS AND ADJUSTMENT OF EQUIPMENT

- A. As the fire suppression systems are placed in operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing air and water systems, adjusting fan speeds, belts, pulleys, tightening packing glands, and adjusting all operating equipment.
- B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.
- C. Test relief valves, air vents and regulating valves to insure proper operation.

1.23 OPERATING DEMONSTRATION AND INSTRUCTIONS

- A. Refer to Section 017900 Demonstration and Training as well as individual Division 21 Sections for requirements.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION – NOT APPLICABLE

END OF SECTION 21 0001

SECTION 21 0004 – FIRESTOPPING FOR FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.2 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. E814 (ANSI/UL 1479) Fire Tests of Through-Penetration Fire Stops (minimum positive pressure of .01 inches of water column) and E119 (ANSI/UL 263) Fire Tests of Building Construction and Materials Time-Temperature Curve. Firestopping shall provide an “F” fire rating equal to that of the construction being penetrated. Firestop systems shall meet all requirements of the Ohio Building Code.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view or above ceilings in air return plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Firestopping materials shall be manufactured and/or supplied by:
 - 1. Hilti, Inc.
 - 2. Johns Manville.
 - 3. Nelson Firestop Products.
 - 4. Specified Technologies Inc.
 - 5. 3M; Fire Protection Products Division.
 - 6. Tremco; Sealant/Weatherproofing Division.

2.2 FIRESTOPPING

- A. Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

PART 3 - EXECUTION

3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.
- B. Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.
- C. Provide firestop system for every pipe at penetration of all fire resistance rated walls and horizontal assemblies.
- D. Provide rigid supports for pipes on both sides of the fire resistance rated wall or assembly where required as part of the fire stop assembly.
- E. Coordinate opening size and additional framing requirement with the General Contractor for each opening to meet the firestop installation requirements.

END OF SECTION 21 0004

SECTION 21 0519 - GAUGES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Gauges.
 - 2. Test plugs.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

- A. Pressure gauges, including compound gauges and vacuum gauges, shall be Bourdon tube type with 4-1/2" dial and cast aluminum case, equal to Trerice 600C Series. Accuracy shall be 1% at mid-range.
- B. A brass cock or bronze ball valve and a pressure snubber shall be furnished with each pressure gauge.
- C. Ranges of pressure gauges shall be selected to be consistent with anticipated pressures. Range shall be approximately twice the normal system working pressure at the gauge location.

2.2 TEST PLUGS

- A. Pressure-temperature test plugs for insertion of pressure gauge or thermometer shall be a brass fitting with neoprene or Nordel self-sealing insert and knurled brass cap with plastic capture tab. Fittings shall be equal to Peterson "PT". Furnish two thermometers and two pressure gauges with integral insertion stem appropriate for use with the test plugs.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Pressure gauges shall be installed where shown on the drawings, where required by applicable codes.
- B. Gauges shall be positioned to be read with unobstructed view from the floor. Pressure-temperature test plugs shall be installed where shown, located in a position to be most readable.

END OF SECTION 21 0519

SECTION 21 0529 – PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Steel pipe hangers and supports.
 2. Trapeze pipe hangers.
 3. Hanger Rods and Attachments.
 4. Pipe Riser Supports
 5. Base Mounted Pipe Supports

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 SUBMITTALS

- A. Product Data: For the following:
1. Steel pipe hangers and supports.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS

- A. Hangers and supports for piping shall be equal to the Anvil catalog numbers as follows:
1. Pear shaped band hanger with adjustable swivel ring type per NFPA standards, lock nut and rod attachment, carbon steel with galvanized finish, Anvil fig. 69.

2.2 HANGER RODS AND ATTACHMENTS

- A. Hanger rods shall be solid steel, threaded-end or all-thread rod, of diameter listed below. A hanger attachment device (for attachment to the structure) and locking nut at the hanger attachment shall be provided on each hanger.

<u>Pipe Size</u>	<u>Min. Rod Dia.</u>
4" and smaller	3/8"
5" to 6"	1/2"

- B. Hanger rod attachment devices for attachment to the structure shall be:
 - 1. Side beam bracket for wood construction equal to Anvil Fig. 206.
 - 2. Channel support system equal to Unistrut or Hilti.

2.3 PIPE RISER SUPPORTS

- A. Riser clamps shall be:
 - 1. Carbon steel, epoxy coated or galvanized finish- Anvil Fig. 261.

2.4 BASE MOUNTED PIPE SUPPORTS

- A. Base mounted pipe supports shall be factory or shop prime coat painted equal to Anvil Fig. numbers as follows:
 - 1. Adjustable pipe saddle support and yoke– Fig. 265.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Spacing of hangers shall be as follows:
 - 1. Vertical:
 - a. At the base and 15 ft. maximum spacing unless otherwise shown.
 - 2. Horizontal:
 - a. 2" size and smaller – 8 ft. intervals
 - b. 2-1/2" thru 6" – 10 ft. intervals
 - c. 8" and larger – 12 ft.. intervals.
 - d. 1-1/2" thru 2" – 8 ft.. intervals
 - e. 2-1/2" and larger – 10 ft. intervals
- B. In piping systems with rolled or cut groove end pipe and mechanical joint couplings, pipe hangers shall be provided on horizontal piping at normal specified intervals and, in addition, so that no pipe shall be left unsupported between any two couplings nor left unsupported whenever a change in direction takes place. Added supports may be omitted on "rigid" couplings such as Victaulic Style 07 Zero-Flex. Vertical piping shall be supported at normal specified intervals or every other pipe length, which ever is more frequent. The base of the riser or base fitting shall be supported.
- C. Attachment of pipe hangers to the structure shall be with:
 - 1. Side beam bracket in wood construction, secured to the wood joist with lag screws set in drilled pilot holes.

2. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical.
- D. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.
- E. Pipe hangers shall be adjusted to proper elevation and all hanger rods set in a vertical position.
- F. Extended legs of pipe riser clamps shall be shortened as needed to maintain concealment of the clamp within finished spaces. Insure that adequate support is still maintained.

END OF SECTION 21 0529

(This page intentionally left blank)

SECTION 211100 - FACILITY WATER-SERVICE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fire-suppression water-service piping and related components from water service through floor provided by site utility contractor in the building to outlet alarm check and various accessories.
- B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.
- C. Related Sections:
 - 1. Division 21 Section 21 1313 "Wet-Pipe Sprinkler Systems" for wet-pipe fire-suppression sprinkler systems inside the building.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements of utility company supplying water.
 - 2. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with the "Approval Guide," published by FM Global, or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.

1.4 COORDINATION

- A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to piping schedule on the Drawings for piping material and applications.

2.2 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 GATE VALVES

- A. UL-Listed or FM-Approved Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American AVK Company; Valve & Fittings Division.
 - b. American Cast Iron Pipe Company; American Flow Control Division.
 - c. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - d. Clow Valve Company; a division of McWane, Inc.
 - e. Crane Co.; Crane Valve Group; Jenkins Valves.
 - f. Crane Co.; Crane Valve Group; Stockham Division.
 - g. East Jordan Iron Works, Inc.
 - h. Hammond Valve.
 - i. Kennedy Valve; a division of McWane, Inc.
 - j. M&H Valve Company; a division of McWane, Inc.
 - k. Milwaukee Valve Company.
 - l. Mueller Co.; Water Products Division.
 - m. NIBCO INC.
 - n. Shurjoint Piping Products.
 - o. Troy Valve; a division of Penn-Troy Manufacturing, Inc.
 - p. Tyco Fire & Building Products LP.
 - q. United Brass Works, Inc.
 - r. U.S. Pipe.
 - s. Watts Water Technologies, Inc.
2. 175-psig, UL-Listed or FM-Approved, Iron, Nonrising-Stem Gate Valves:
 - a. Description: Iron body and bonnet, bronze seating material, and inside screw.
 - b. Standards: UL 262 and "Approval Guide," published by FM Global, listing.
 - c. Pressure Rating: 175 psig minimum.
 - d. End Connections: Mechanical or push-on joint.
 - e. Indicator-Post Flange: Include on valves used with indicator posts.
3. 175-psig, UL-Listed or FM-Approved, Iron, OS&Y, Gate Valves:

- a. Description: Iron body and bonnet and bronze seating material.
- b. Standards: UL 262 and "Approval Guide," published by FM Global, listing.
- c. Pressure Rating: 175 psig minimum.
- d. End Connections: Flanged or grooved.

2.4 BACKFLOW PREVENTERS

A. Double-Detector Check Backflow-Prevention Assemblies

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Size: 3/4" to 3", as required to match connected piping or as noted on drawings.
6. Body: Bronze for 2" and smaller; stainless steel for 2-1/2" and larger.
7. End Connections: Threaded for 2" and smaller; flanged for 2-1/2" and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of 2" and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of 2-1/2" and larger.

B. Backflow-Preventer Test Kits

1. Manufacturers Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 ALARM DEVICES

- A. General: UL 753 and "Approval Guide," published by FM Global, listing, of types and sizes to mate and match piping and equipment.
- B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psig working pressure; designed for horizontal or vertical installation; with two single-pole, double-throw circuit switches to provide 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 when cover is removed.
- C. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Comply with NFPA 24 for fire-service-main piping materials and installation.
- B. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- C. Extend fire-suppression water-service piping and connect to water-supply source and building fire-suppression water-service piping systems at locations and pipe sizes indicated.
 - 1. Terminate fire-suppression water-service piping at building floor slab until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire-suppression water-service piping systems when those systems are installed.
- D. Comply with requirements in Division 21 Sections for fire-suppression-water piping inside the building.
- E. Comply with requirements in Division 22 Section "Domestic Water Piping" for potable-water piping inside the building.

3.2 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure rating same as or higher than systems pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in tubing NPS 2" and smaller.
- C. Install flanges, flange adaptors, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2" and larger end connections.
- D. Ream ends of tubes and remove burrs.

- E. Remove scale, slag, dirt, and debris from outside and inside of pipes, tubes, and fittings before assembly.
- F. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
- G. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts.
- H. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with bolts according to ASME B31.9.
- I. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.3 VALVE INSTALLATION

- A. UL-Listed or FM-Approved Gate Valves: Comply with NFPA 24. Install valves with stem pointing up.
- B. Support valves and piping, not direct buried, on concrete piers. Comply with requirements for concrete piers in Division 03 Section "Cast-in-Place Concrete."

3.4 ALARM DEVICE INSTALLATION

- A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box 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. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
- D. All wiring to be done by Div 26.

3.5 FIELD QUALITY CONTROL

- A. Use test procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described below.
- B. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

- C. Hydrostatic Tests: Test at not less than one-and-one-half times the working pressure for two 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. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- D. Prepare test and inspection reports.

3.6 IDENTIFICATION

- A. Permanently attach equipment nameplate or marker indicating plastic fire-suppression water-service piping or fire-suppression water-service piping with electrically insulated fittings, on main electrical meter panel. Comply with requirements for identifying devices in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.7 CLEANING

- A. Clean fire-suppression water-service piping as follows:
 - 1. Purge new 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 authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate 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 three hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains 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 of purging and disinfecting activities.

3.8 PIPING SCHEDULE

- A. Refer to piping schedule on the Drawings for piping material and applications.

3.9 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

- B. Standard-pressure, vault fire-suppression water-service shutoff valves NPS 3” and larger shall be 175-psig, UL-listed or FM-approved, iron, OS&Y gate valves.

END OF SECTION 21 1100

(This page intentionally left blank)

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Fire-department connections.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Pressure gages.

1.2 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.3 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Design sprinkler system(s), by a State certified designer, using performance requirements and design criteria indicated.
 - 1. Water supply data: The Fire Suppression Contractor is responsible for conducting a flow test to obtain current water supply data from the water distribution system for use in the hydraulic calculations.
 - 2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
- C. System shall conform to the requirements of NFPA 13 and OBC chapter 9 and other requirements of the authority having jurisdiction.
- D. Sprinkler system design shall be approved by authorities having jurisdiction.

1.4 SUBMITTALS

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

- B. Approved Sprinkler Piping Drawings and Calculations: Working plans and hydraulic calculations, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- C. Welding certificates.
- D. 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."
- E. Field quality-control reports.
- F. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Design Responsibility: Preparation of working plans, calculations, and field test reports by a certified sprinkler designer.
 - B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
 - C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
 - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to piping schedule on the Drawings for piping material and applications.

2.2 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.

2. Minimum Pressure Rating: 175 psig.
 3. Acceptable Manufacturers: Subject to compliance with requirements:
 - a. Anvil International, Inc.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Stockholm Valve and Fittings.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.
 - f. Watts Water Technologies, Inc.
- B. Check Valves 2 1/2” and larger:
1. Standard: UL 312.
 2. Type: Swing check.
 3. Body Material: Cast iron.
 4. Disc Material: Bronze
 5. End Connections: Flanged or grooved.
- C. Check Valves 2” and smaller:
1. Standard: UL 312.
 2. Type: Swing check.
 3. Body Material: Bronze.
 4. Disc Material: Composition faced
 5. End Connections: Threaded.
- D. OS&Y Gate Valves 2” and smaller:
1. Standard: UL 262.
 2. Body Material: Bronze.
 3. End Connections: Threaded.
- E. OS&Y Gate Valves: 2 1/2” and larger
1. Standard: UL 262.
 2. Body Material: Cast or ductile iron.
 3. End Connections: Flanged or grooved.
- F. Indicating-Type Butterfly Valves:
1. Standard: UL 1091.
 2. Pressure Rating: 175 psig minimum.
 3. Valves 2” and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
 4. Valves 2-1/2” and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.

- c. End Connections: Flanged, grooved, or wafer.

G. Trim and Drain Ball Valves:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Body Material: Bronze.
3. End Connections: Threaded.

2.3 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.
6. Acceptable manufacturers:
 - a. Globe Fire Sprinkler Corporation.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - e. Viking Corporation.

B. Alarm Valves:

1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

C. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175 psig minimum.
3. Type: Automatic draining, ball check.
4. Size: 3/4".
5. End Connections: Threaded.

2.4 FIRE-DEPARTMENT CONNECTIONS

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

1. Elkhart Brass Mfg. Company, Inc.
2. Fire-End & Croker Corporation.

3. Guardian Fire Equipment, Inc.
 4. Kidde Fire Fighting.
 5. Potter Roemer.
 6. Reliable Automatic Sprinkler Co., Inc.
- B. Description: Freestanding, with cast-bronze body, 5” stortz inlet and matching local fire-department requirements. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- high brass sleeve; and round escutcheon plate.
- C. Standard: UL 405.
- D. Connections: One 5” stortz inlet and one 4” outlet.
- E. Finish Including Sleeve: Rough chrome plated.
- F. Escutcheon Plate Marking: "AUTO SPKR."

2.5 SPRINKLER SPECIALTY PIPE FITTINGS

- A. Flow Detection and Test Assemblies:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating: 175 psig .
 3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
 4. Size: Same as connected piping.
 5. Inlet and Outlet: Threaded.
 6. Acceptable Manufacturers
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
- B. Branch Line Testers:
1. Standard: UL 199.
 2. Pressure Rating: 175 psig minimum.
 3. Body Material: Brass.
 4. Size: Same as connected piping.
 5. Inlet: Threaded.
 6. Drain Outlet: Threaded and capped.
 7. Branch Outlet: Threaded, for sprinkler.
 8. Acceptable Manufacturers:
 - a. Elkhart Brass Mfg. Company, Inc.
 - b. Fire-End & Croker Corporation.
 - c. Potter Roemer.
- C. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.
6. Acceptable Manufacturers:
 - a. Tyco Fire & Building Products LP.
 - b. Victaulic Company.
 - c. Viking Corporation.

2.6 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Acceptable Manufacturers:
 - a. Globe Fire Sprinkler Corporation.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - e. Viking Corporation.

B. Automatic Sprinklers:

1. Early-Suppression Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Quick-response type with nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

C. Sprinkler Finishes: Refer to drawings for finishes and placement.

D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications.

1. Exposed Pendent Sprinklers: Chrome -plated steel, one piece, flat.
2. Concealed Recessed Sprinklers: White -plated steel, two piece, with 1-inch vertical adjustment and a flat cover plate.
3. Sidewall Mounting: Chrome -plated steel one piece, flat.

2.7 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: 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.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.
7. Manufacturers:
 - a. ADT Security Services, Inc.
 - b. McDonnell & Miller; ITT Industries.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 - e. Viking Corporation.
 - f. Victaulic Company.

C. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. Manufacturers:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.

2.8 PIPE ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated finish with set-screws.
- C. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.
- D. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.9 SLEEVES

- A. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.

PART 3 - EXECUTION

3.1 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Division 21 Section "Facility Water-Service."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.[Comply with requirements for backflow preventers in Division 21 Section "Facility Water-Service."]

3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Locate sprinkler piping in areas protected from freezing.
- C. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes 2" and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having 2-1/2" and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install alarm devices in piping systems. All wiring to be done by Div 26.
- J. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- K. 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 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.

- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Fill sprinkler system piping with water.

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- D. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- E. 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:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated.
- G. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- H. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

- C. Install backflow preventer in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.5 SPRINKLER INSTALLATION

- A. Refer to the drawing for the locations of various types of sprinklers.
- B. Install sprinklers in suspended ceilings in center of acoustical ceiling panels or at the quarter points along the long axis for rectangular panels.

3.6 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install free-standing, fire-department connections. Location to be approved by local Fire Department.
- B. Piping from building to fire department connection shall be pitched for drainage towards the fire department connection.
- C. Install automatic (ball drip) drain valve at in manhole section as detailed on drawings.
- D. Anchor fire department connection in 18" x 18" 6" concrete pad

3.7 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, and walls.
- B. Sleeves are not required for core-drilled holes in cast walls or floors.
- C. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- D. Install sleeves in new partitions, slabs, and walls as they are built.
- E. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- F. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- G. Seal space outside of sleeves in concrete slabs and walls with grout.

- H. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.8 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Coordinate with fire-alarm tests. Operate as required.
 - 5. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Turn spare sprinklers, wrench and cabinet over to owner

3.10 CLEANING

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

END OF SECTION 211313

(This page intentionally left blank)

22

PLUMBING

DIVISION

(This page intentionally left blank)

SECTION 22 0001 – BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes the following:
1. General Requirements
 2. Definitions
 3. Scope of Work
 4. Drawings and Specifications
 5. Reference Standards
 6. Allowances, Unit Prices and Alternates
 7. Site Visit
 8. Permits, Regulations and Inspections
 9. Project Management and Coordination
 10. Temporary Utilities
 11. Workmanship
 12. Protection
 13. Painting
 14. Cleaning
 15. Miscellaneous Equipment Connections
 16. Equipment Selection
 17. Shop Drawings
 18. Final Inspection and Punch List
 19. Operation and Maintenance Manuals
 20. Record Drawings
 21. Warranties
 22. Project Closeout
 23. Operation and Adjustment of Equipment
 24. Operating Demonstration and Instruction

1.2 GENERAL REQUIREMENTS

- A. All provisions of Division 00 Front End Documents and Division 01 General Requirements apply to work specified in this Division.
- B. Specification provisions of other relevant Divisions shall apply where applicable work is required to be performed under this Plumbing work.
- C. A complete and functional Plumbing system installation shall be provided under this Division. Should overlap of work among trades become evident, this shall be called to the attention of the architect. In such event, none of the trades or their suppliers shall assume that he relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

- D. The Fire Suppression, Plumbing, HVAC and Electrical drawings and specifications assign work (labor and/or materials) to be provided by the General, Fire Suppression, Plumbing, HVAC or Electrical Contractor or their sub-contractors. Understanding that the contractors for mechanical and electrical work are sub-contractors to the (General) Contractor, such assignments are not intended to restrict the General Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior 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 SCOPE OF WORK

- A. The scope of the Plumbing work includes furnishing, installing, testing and warranty of all Plumbing work shown on the Plumbing drawings and specified herein, including Division 00, Division 01, Division 22 and applicable provisions of other relevant Divisions..

1.5 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word “provide,” as used, shall mean “furnish and install.” If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.
- B. Make all necessary field measurements to insure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having pipe and fittings fabricated and delivered in advance of making actual measurements shall bet be sufficiently in advance as to

not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

- D. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties.
- E. Equipment or piping shall not be installed or run above electrical switchgear or panelboards, nor in or above the access space in the immediate vicinity of the electrical switchgear/panelboards, in accordance with NEC Article 384.
- F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of ductwork, piping, etc., where conflict arises.
- G. Provides offsets in system runs, additional fittings, necessary drains and minor valves, traps, and devices required to complete the installation, or for the proper operation of the system. Each Contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.
- H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

1.6 REFERENCE STANDARDS

- A. Where standards (NFPA, NEC, ADTM, UL, ASPE, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

1.7 ALLOWANCES, UNIT PRICES AND ALTERNATES

- A. Refer to Sections 01200 Allowances, 012200 Unit Prices and 012300 Alternates.

1.8 SITE VISIT

- A. Refer to Section 017300 Execution.
- B. Each bidder shall visit the project site to understand the existing conditions and compare the conditions with information shown on the drawings. Report immediately to the Architect any issues or discrepancies which are discovered that affect the bid. Changes to contract price will not be considered for site condition issues that are readily apparent from a thorough site review.

1.9 PERMITS, REGULATIONS AND INSPECTION

- A. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawing and specifications shall govern. Install no work contrary to minimum legal standards.
- B. Except where the permit application is made by the Architect or the Engineer, the Plumbing contractor shall be responsible to file for and obtain all required permits from the governing inspection agencies for the plumbing work. Where the Architect of Engineer is the Architect or Engineer of record, they will furnish sealed and signed drawings and specifications required by the permit authorities.
- C. Include payment of all permit and inspection fees applicable to the work in this Division.
- D. All work shall be subject to inspection and approval of Federal, State and local agencies as may be appropriate as well as the Architect and Engineer.
- E. Furnish for the Owner certificates of approval from the governing inspection agencies as a condition for final payment.

1.10 PROJECT MANAGEMENT AND COORDINATION

- A. Refer to Section 013100 Project Management and Coordination.

1.11 TEMPORARY UTILITIES

- A. Refer to Section 015000 – Temporary Facilities and Controls for division of responsibilities for temporary utilities.
- B. Install new water service and piping from the new service as soon as practicable to facilitate water supply for construction purposes. Provide a water meter, piping and hoses bibbs with vacuum breaker at the site as directed by the General Contractor. Protect meter and piping from physical damage and freezing.
- C. Cost of water use for construction is not included in Division 22.
- D. Remove construction water meter and piping when no longer required.

1.12 WORKMANSHIP

- A. Refer to Section 014000 Quality Requirements.
- B. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect shall have the right to stop the work if highest quality workmanship is not maintained.
- C. Plumbing work shall be performed by licensed Plumbing Contractors in accordance with requirements of the jurisdiction.

1.13 PROTECTION

- A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.
- B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide plastic sheeting, drop cloths or similar barriers where dust and debris is generated, to protect adjacent areas.
- C. Contractor shall protect all equipment and materials from detrimental effects of weather or construction activity. All items shall be stored and secured in a protected location away from the daily work area. Equipment or materials shall be placed on raised skids to protect from surface moisture. Where appropriate, provide plastic sheeting or similar vapor barrier underneath the stored products to reduce the effects of ground moisture or curing concrete on the local humidity levels. Where unfinished ferrous products or finished ferrous products with raw edges are stored, provide local, dry heat to maintain ambient relative humidity levels below 65% RH to prevent rust.
- D. All equipment shall retain the original packaging until required to be removed for installation or operation. Open ends of piping, conduit, etc. shall be capped or sealed and ventilation openings into equipment shall be wrapped and sealed in plastic sheeting to prevent dust or dirt entry both when stored and after installation but still open to the effects of construction activity. Stored items as well as installed equipment shall be covered with plastic sheeting at all times until placed in service or until dust generating activity in the area has ceased.

1.14 PAINTING

- A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 22:
 - 1. Ferrous metal which is no factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint.
 - 2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint.
 - 3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
- B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 9 of the Specifications. All rust must be removed before application of paint.

- C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and Patching paragraph in this Section for finishing requirements

1.15 RECORD DRAWINGS

- A. Refer to Section 017839 Project Record drawings.
- B. Each Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawing shall be turned over to the Architect.

1.16 CLEANING

- A. Debris, dust, dirt, etc shall be removed daily, particular attention shall be paid to areas that the Owner is continuing to occupy or use; any mess created in corridors, stairwells and egress paths that are maintained during construction shall be cleaned immediately.
- B. The Owners dumpsters and trash receptacles shall not be used. If a dumpster is required, it shall be provided by the contractor and located where approved by the Owner. Coordinate dumpster requirements with other contractors.
- C. Before turning an area back over to the Owner, thoroughly clean the space to leave the area in a similar condition before the start of the project where finishes are to remain.

1.17 MISCELLANEOUS EQUIPMENT CONNETIONS

- A. Certain categories of fixtures and equipment, including kitchen equipment, sterilizers, washers, laundry and laboratory equipment, require piping connections and duct connections as shown on the drawings. Equipment will be furnished and set in places by the equipment supplier.
- B. Make all final connections to these fixture and equipment, as indicated and in accordance with the manufacturer's recommendations. All piping connections shall be valved and final connections made with unions.
- C. Fixtures and equipment, unless otherwise noted, will be furnished complete with the basic plumbing supply and waste trim. The trim will generally be furnished "loose" and shall be installed under this work. Countertop sinks furnished "loose" shall also be installed by the Plumbing Contractor.
- D. Provide supplies, supply stops, traps, shut-off valves, fixture drains, continuous wastes and indirect wastes. Provide a water-hammer arrestor on the system side of each automatic (quick-closing) valve on water supply lines. Items not specifically described elsewhere in these specifications shall be of the same manufacturer as similar items specified in conjunction with the plumbing fixtures.
- E. Supply piping and devices connecting to equipment, where exposed to view in the finished space, shall be chrome plated and insulation shall be omitted.

- F. Roughing-in drawings shall be obtained for the various fixtures and items of equipment as the time approaches when such information is required; allow a reasonable period, from the time of notice to obtain this information.
- G. Connections to equipment shall be in accordance with manufacturer's installation guidelines. Any additional accessories recommended by the manufacturer such as gauges, shut-off valves, unions at connection points, etc., shall be provided by this Contractor.

1.18 EQUIPMENT SELECTION

- A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.
- B. The selection of materials and equipment to be furnished under this contract shall be governed by the following:
 - 1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specifications, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
 - 2. Where the words "or approved equal: appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
 - 3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.
- C. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.
- D. Before bidding equipment, and again in the preparation of shop drawings the Contractor and his supplier shall verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.
- E. If extensive changes in pipe, or equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in the contract.

1.19 SHOP DRAWINGS

- A. Refer to Section 016000 Product Requirements.

- B. Shop drawings for equipment fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. Failure to do so may be cause for rejection of shop drawings.
- C. The review of shop drawings by the Architect or Engineer shall not relieve the Contactor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.
- D. Shop drawings for the following Plumbing equipment and materials shall be submitted:
 - 1. Pipe, fittings and joining methods for the various systems.
 - 2. Firestopping systems for pipe penetrations.
 - 3. Pipe hangers and saddles.
 - 4. Valves.
 - 5. Gauges.
 - 6. Pipe insulation
 - 7. Equipment insulation.
 - 8. Supply system specialties.
 - 9. Backflow preventers
 - 10. Drainage system specialties
 - 11. Plumbing fixtures and trim
 - 12. Water softening equipment
 - 13. Water heating equipment
 - 14. Domestic hot water return balance report

1.20 OPERATING AND MAINTENANCE MANUALS

- A. Refer to Section 017823 Operation and Maintenance Data.
- B. All shop drawing and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required.
- C. These shall be assembled into three-ring loose lead binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.21 RECORD DRAWINGS

- A. Refer to Section 017839 Project Record Drawings.
- B. Each Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawing shall be turned over to the Architect.

1.22 WARRANTIES

- A. This Contractor shall warrant all workmanship, equipment and material entering into this contract for a period of one year of date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner.
- B. This provision is intended specifically to cover deficiencies in contract completion or performance which are discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.
- C. This provision shall not be construed to include maintenance items such as replacing filters, and cleaning strainers after these have been done for final close-out.
- D. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.

1.23 PROJECT CLOSEOUT

- A. Refer to Section 017700 Closeout Procedures.

1.24 OPERATIONS AND ADJUSTMENT OF EQUIPMENT

- A. As each piping system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing the domestic hot water return system,
- B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.
- C. Test relief valves, air vents and regulating valves to insure proper operation.

1.25 OPERATING DEMONSTRATION AND INSTRUCTIONS

- A. Refer to Section 017900 Demonstration and Training as well as individual Division 22 Sections for requirements.
- B. The Contractor shall set the various systems into operation and demonstrate to the Owner and Architect that the systems function properly and that the requirements of the Contract are fulfilled.
- C. The Contractor shall provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

- D. A minimum of 1 hour shall be allowed for instructions to personnel selected by the Owner. Instructions shall include not less than the following:
1. Show locations of items of equipment and their purpose.
 2. Review binder containing instructions and equipment and systems data.
 3. Coordinate written and verbal instructions so that personnel understand each.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION– NOT APPLICABLE

END OF SECTION 22 0001

SECTION 22 0004 – FIRESTOPPING FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes through-penetration firestopping systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.2 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Firestopping assemblies shall be tested and rated in accordance with ASTM E814 (ANSI/UL 1479) Fire Tests of Through-Penetration Fire Stops (minimum positive pressure of .01 inches of water column) and E119 (ANSI/UL 263) Fire Tests of Building Construction and Materials Time-Temperature Curve. Firestopping shall provide an “F” fire rating equal to that of the construction being penetrated. Firestop systems shall meet all requirements of the Ohio Building Code.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 - 2. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view or above ceilings in air return plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Firestopping materials shall be manufactured and/or supplied by:
1. Hilti, Inc.
 2. Johns Manville.
 3. Nelson Firestop Products.
 4. Specified Technologies Inc.
 5. 3M; Fire Protection Products Division.
 6. Tremco; Sealant/Weatherproofing Division.

2.2 FIRESTOPPING

- A. Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

PART 3 - EXECUTION

3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.
- B. Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.
- C. Provide firestop system for every pipe at penetration of all fire resistance rated walls and horizontal assemblies.
- D. Provide rigid supports for ducts on both sides of the fire resistance rated wall or assembly where required as part of the fire stop assembly.
- E. Coordinate opening size and additional framing requirement with the General Contractor for each opening to meet the firestop installation requirements.

END OF SECTION 22 0004

SECTION 22 0005 – EXCAVATION, BACKFILL AND SURFACE RESTORATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Excavating and backfilling for utility trenches.

1.2 DEFINITIONS

- A. Backfill: Soil material used to fill an excavation.
1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- E. Fill: Soil materials used to raise existing grades.
- F. 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.
- G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below topsoil materials.
- H. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1.4 GENERAL

- A. Excavate for all in-grade, under-floor piping, underground, exterior piping, and incidental work which are included in the Plumbing contract. Backfill to finish grade or to levels consistent with the General Contractor's and Site Contractor's activities. Cut existing drive and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered.
- B. Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in this contract.
- C. Contact the Ohio Utilities Protection Service (1-800-362-2764) well in advance of the start of any excavation to determine if any of the utility companies or departments have underground utilities in or near the project area.
- D. Contact local water and sewer departments, gas company, electric company, telephone company, etc., regarding the possibility of encountering existing utilities. The integrity of all existing utilities shall be respected.
- E. Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by the Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Bedding Course: Naturally or artificially graded natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- B. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

PART 3 - EXECUTION

3.1 EXCAVATION FOR UTILITY TRENCHES

- A. Trenches for interior and exterior piping shall be over-excavated and the pipe shall be laid on 6” minimum depth sand bed.
- B. Backfilling of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with graded pea gravel, graded coarse sand or compacted, crushed limestone, 3/4” maximum size, to prevent undue settlement. Backfill material for plastic piping shall be pea gravel or sand. Other excavations and trenches shall be backfilled with similar materials up to 18” above the top of the piping. The remainder shall be with similar materials or with excavated material having no large clods, stones or rocks.
- C. Maintain in place adequate barricades, guards, planking, plating signage, warning lights, etc., at and around excavations.
- D. Backfill shall be mechanically compacted in layers not over 6” deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of as directed by the General Contractor. Refer to Division 31 Earthwork for compaction requirements.
- E. All exterior underground piping shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6’ wide with black letters identifying the piping service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18’ above and on the centerline of the pipe.

END OF SECTION 22 0005

(This page intentionally left blank)

SECTION 22 0519 - METERS AND GAUGES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Thermometers.
 - 2. Gauges.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 THERMOMETERS

- A. Thermometers shall be 9" blue reading organic spirit filled tube column type with cast aluminum case with epoxy finish, acrylic window, aluminum scale with white background and black markings, 1% accuracy, adjustable angle hinge assembly and 3.5" aluminum insertion stem, equal to Terice BX91403.
- B. Thermometers shall be 5" diameter dial face bi—metallic type with adjustable angle hinge, stainless steel insertion stem and recalibration feature, equal to Terice B85604.
- C. Provide a separable socket insertion thermowell shall be furnished with each thermometer. An extension neck, with appropriate increase in thermometer stem length, shall also be furnished where insulation thickness exceeds 2".
- D. Ranges of thermometers shall be selected from standard Fahrenheit scales to be consistent with anticipated temperatures, typically 0 deg.F.- 160 deg.F.

2.2 PRESSURE GAUGES

- A. Pressure gauges, including compound gauges and vacuum gauges, shall be Bourdon tupe type with 4-1/2" dial and cast aluminum case, equal to Terice 600C Series. Accuracy shall be 1% at mid-range.
- B. Pressure gauges for low pressure application, calibrated in inches of water gauge, ounces peer sq. in. or 0-5 psi, as appropriate, shall be equal to Terice 860.

- C. Pressure gauges at pumps shall be liquid filled Bourdon tube type with 4” dial and stainless steel case and internals, equal to Trerice 700 Series.
- D. A brass cock or bronze ball valve and a pressure snubber shall be furnished with each pressure gauge.
- E. Ranges of pressure gauges shall be selected to be consistent with anticipated pressures. Range shall be approximately twice the normal system working pressure at the gauge location.

2.3 TEST PLUGS

- A. Pressure-temperature test plugs for insertion of pressure gauge or thermometer shall be a brass fitting with neoprene or Nordel self-sealing insert and knurled brass cap with plastic capture tab. Fittings shall be equal to Peterson “PT”. Furnish two thermometers and two pressure gauges with integral insertion stem appropriate for use with the test plugs.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Thermometers shall be installed where shown on the drawings and also at:
 - 1. Hot water outlet of water heater.
 - 2. Outlet side of hot water recirculation pump.
- B. Pressure gauges shall be installed where shown on the drawings, where required by applicable codes and also at:
 - 1. Outlet of domestic water service backflow preventer,
 - 2. Inlet and outlet of each natural gas regulator.
- C. Thermometers and gauges shall be positioned to be read with unobstructed view from the floor. Pressure-temperature test plugs shall be installed where shown, located in a position to be most readable.
- D. Install thermometer wells in piping tees in the vertical position. Fill the well with oil or graphite and secure the thermometer in position

END OF SECTION 22 0519

SECTION 22 0520 – COMMON PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Piping Systems - Common Requirements.
7. Equipment installation requirements common to equipment sections.

1.2 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- B. Welders shall be qualified and fully certified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- C. Welding procedures and testing shall comply with ANSI Standard B31.1.0 Standard Code for Pressure Piping, Power piping and The American Welding Society Welding Handbook.
- D. All pressure piping systems regulated by the Ohio Pressure Piping Systems Code, Chapter 4101:8 shall conform to applicable requirements of the Code. Welders shall carry a current State of Ohio, Pressure Piping Board Certification. Each welder shall submit a copy of their signed performance qualification record to the Engineer for approval prior to beginning work on any pressure piping system.
- E. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 DIELECTRIC CONNECTORS

- A. A dielectric connector shall be incorporated at each connection between ferrous and copper piping. Connectors shall be:
 - 1. Dielectric coupling with non-conductive polymer liner, Lochinvar Corp. “V-line” Dielectric fitting on services 180 degrees and less.
 - 2. Dielectric flange with non-metallic bolt hole grommets and gasket.
 - 3. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F .

2.2 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Plastic. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 SLEEVES

- A. Schedule 40 black steel pipe or 18 gauge galvanized steel poured concrete floors, walls and roof decks.
- B. 26 gauge galvanized sheet or Schedule 40 clack steel pipe in the other than poured concrete.

2.4 ESCUTCHEONS

- A. Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished rooms and areas where pipes penetrate walls, floors, ceilings or overhead structure.

2.5 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. 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.
- B. Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with N.E.C. Article 384.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Install piping to permit valve servicing.
- H. Install piping adjacent to equipment and specialties to permit servicing and maintenance.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install piping to allow application of insulation.
- L. Select system components with pressure rating equal to or greater than system operating pressure.
- M. Install escutcheons for penetrations of walls, ceilings, and floors.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor slabs.
- O. Verify final equipment locations for roughing-in.

3.2 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping 2” and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping 2-1/2” and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.3 PIPE SLEEVES

- A. Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all floor slabs, poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and allow for expansion, contraction and normal movement of the pipe. Sleeves are also required for all existing piping related to the various trades in new walls, partitions, floors and roof slabs, same as for new piping.
- B. Sleeves are not required in the following:
1. In floor slabs on grade.
 2. In stud and gypsum board or plaster walls and partitions which are not fire rated.
 3. For uninsulated pipe passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions.
- C. Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1” above finished floor. Pipe sleeves shall be sized to allow insulation to pass thru the sleeve, for insulation requiring continuous vapor barrier (domestic cold water, chilled water refrigerant, etc.). Where vapor barrier continuity is not needed, the sleeve may be sized to pass the pipe only or the insulation as well.
- D. Pipe sleeves which are part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.
- E. Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed with caulking to retard the passage of smoke.
- F. Where uninsulated pipes requiring no pipe sleeves pass thru non-fire rated floor, wall or partition, the annular space shall be closed with material and methods compatible with the wall or partition material (Type M masonry grout, drywall joint compound, plaster, etc.).

3.4 Mechanical Seals

- A. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- B. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 22 0520

(This page intentionally left blank)

SECTION 22 0523 – GENERAL DUTY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Check valves.
3. Gate valves.
4. Balancing-Shutoff valves.

B. Related Sections:

1. Division 22 Plumbing piping Sections for specialty valves applicable to those Sections only. Section 22 0553 "Identification for Plumbing Systems" for valve tags and schedules.
2. Valves for natural gas, compressed air vacuum systems are specified in the system specification. See appropriate Division 22 specification.

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- C. Sweat end valves of equal construction and features are acceptable in lieu of those specified with screwed ends. Valves of equal construction and features with ends compatible with mechanical joint couplings are acceptable on such systems, and may be manufactured by the coupling system manufacturer. Grooved end valves shall conform to ANSI/AWWA Standard C-606.
- D. Ball valves in piping which is to be insulated shall have extended shaft necks to accommodate the insulation.
- E. All valve for Domestic potable water systems (cold, hot hot return, etc.) shall be “lead free” in accordance with the Federal Safe Water Act (S3874) definition and NSF/ANSI-61 approved

PART 2 - PRODUCTS

- 2.1 Refer to valve schedule on the Drawings for piping material and applications.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Drain valves shall be the same as for the shut-off service. Provide a ¾” hose thread adapter on the outlet of each drain valve that is not piped to a drainage point. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.
- B. Internals shall be removed and the remaining elements of sweat end valves shall be protected against heat damage during soldering or brazing
- C. Valves shall be installed with the stem at or above the centerline of the pipe. Valves shall be located to be accessible for operation, servicing and/or removal.
- D. Packing glands shall be tightened before placing the valves in service.

END OF SECTION 22 0523

SECTION 22 0529 – PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Hanger Rods and Attachments.
 - 5. Pipe Riser Supports

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS

- A. Hangers and supports for piping shall be equal to the Anvil catalog numbers as follows:
 - 1. General service - clevis type - Fig. 260.

2. Uninsulated copper tubing - copper plated clevis type - Fig. CT-65 (or plastic coated clevis, or fiberglass construction).
 3. Where the length of the hanger rod between the top of the hanger and the attachment is 3" or less, clevis type hangers with rollers, Fig. 181, shall be used to allow for expansion travel
- B. Hangers on insulated horizontal piping shall be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, the following shall be provided at each hanger:
1. Pipe 2" and smaller – Anvil Fig. 168 18 ga. sheet metal rib-lock shield with belled ends, 12" long.
 2. Pipe 2-1/2" and larger – wood blocking to prevent crushing insulation, with Anvil Fig. 168 18 ga. Sheet metal rib-lock shield with belled ends, 12" long.
- C. The first two hangers on piping connecting to motor driven equipment shall be fitted with a steel spring and neoprene vibration isolation section similar to Mason Industries, No. 30N.

2.2 TRAPEZE HANGERS

- A. Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with pipe rollers (to allow for expansion travel) and spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension.

2.3 HANGER RODS AND ATTACHMENTS

- A. Hanger rods shall be solid steel, threaded-end or all-thread rod, of diameter listed below or matching manufacturer's provisions. A hanger attachment device (for attachment to the structure) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis hanger.

<u>Pipe Size</u>	<u>Min. Rod Dia.</u>
1" and smaller	1/4"
1-1/4" to 3"	3/8"
4" to 6"	1/2"

- B. Hanger rod attachment devices for attachment to the structure shall be:
1. Side beam bracket for wood construction equal to Anvil Fig. 206.
 2. Channel support system equal to Unistrut or Hilti.

2.4 PIPE RISER SUPPORTS

- A. Riser clamps on cold service insulated piping shall be:
1. Insulated Pipe size 1-1/2" and smaller shall be factory (Pipe Shields E1000) or shop fabricated assembly Fig. 261 with high density calcium silicate insulation and galvanized steel jacket.
 2. Insulated Pipe size 2" and greater shall be factory fabricated assembly Pipe Shields, Inc. E1000.
 3. Un-insulated copper tubing – Anvil Fig CT-121 or CT-121C
 4. Un-insulated steel piping – Anvil Fig. 261.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Spacing of hangers shall be as follows:
1. Steel pipe - Vertical:
 - a. At the base and 15 ft. maximum spacing unless otherwise shown.
 2. Steel pipe - Horizontal:
 - a. 2" size and smaller – 8 ft. intervals
 - b. 2-1/2" thru 6" – 10 ft. intervals
 3. Cast iron pipe - Vertical
 - a. At the base and 15 ft. maximum spacing unless otherwise shown.
 4. Cast iron pipe – Horizontal
 - a. At 10 ft. intervals.
 - b. Support each length of pipe not more than 18" from the joint.
 - c. Support terminal ends of horizontal runs and branches and each change in direction.
 5. Copper Tubing - Vertical
 - a. At the base and 10 ft. maximum spacing unless otherwise shown.
 6. Copper Tubing – Horizontal
 - a. 1-1/4" size and smaller – 6 ft. intervals
 - b. 1-1/2" thru 2" – 8 ft.. intervals
 - c. 2-1/2" and larger – 10 ft. intervals
 7. Plastic pipe
 - a. Per manufacturer's recommendations.
- B. In piping systems with mechanical joint couplings, pipe hangers shall be provided on horizontal piping at normal specified intervals and, in addition, so that no pipe shall be left unsupported

between any two couplings nor left unsupported whenever a change in direction takes place. Vertical piping shall be supported at normal specified intervals or every other pipe length, which ever is more frequent. The base of the riser or base fitting shall be supported.

- C. Attachment of pipe hangers to the structure shall be with:
 - 1. Side beam bracket in wood construction, secured to the wood joist with lag screws set in drilled pilot holes.
 - 2. Unistrut channels with spring and nut rod connection may be utilized where a number of pipes are run parallel. Channel shall be attached to the structure with inserts or clamps.
- D. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.
- E. Pipe hangers shall be adjusted to proper elevation and all hanger rods set in a vertical position before pipe insulation is installed.
- F. Extended legs of pipe riser clamps shall be shortened as needed to maintain concealment of the clamp within the pipe chase. Insure that adequate support is still maintained.
- G. Hanger assemblies which will remain exposed on completion of the project shall be painted before installation.

END OF SECTION 22 0529

SECTION 22 0530- EQUIPMENT BASES AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Concrete Bases
 - 2. Equipment Supports
- B. See Division 22 Section "Vibration Control" for vibration isolation devices.

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- B. Design seismic-restraint equipment support and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Equipment hangers and supports.
 - 2. Equipment bases.
 - 3. Support Curbs.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 CONCRETE BASES

- A. Concrete bases and pads with anchor bolts cast-in-place. Bases shall be formed on all sides and hand troweled to a smooth, dense finish with neatly chamfered corners. Large concrete pads on grade shall be constructed with reinforcing steel or reinforcing roadway mesh.

2.2 STEEL SUPPORTS

- A. Structural steel angles, beams or channels, unistrut type channels or pipe. Supports shall be fabricated into a rigid framework with welded or bolted connections and cross-bracing or sway bracing. Supports shall be set on slab with base plates, or attached to the building structure as required. Brackets for relatively lightweight equipment may be attached to the wall. Equipment shall be set on and attached to the framework.
- B. Solid steel hanger rods supported from the structure above similar to pipe hangers. Provide sway bracing for equipment supported in this manner.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- B. Field Welding: Comply with AWS D1.1.
- C. Concrete bases for plumbing equipment are included in the Plumbing Contract. The Plumbing Contractor shall coordinate exact dimensions, locations and other details for the specific equipment provided. The Plumbing Contractor shall set anchor bolts as required for the equipment.

END OF SECTION 22 0530

SECTION 22 0548 - VIBRATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:

1. Vibration Isolators

1.2 PERFORMANCE REQUIREMENTS

1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Spring Hanger
1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 2. Housings: Neoprene in shear or double deflection LDS rubber upper and lower elements.
 3. Mason Industries Series “30N”
- B. Neoprene in Shear Hanger
1. Element: Double deflection LDS rubber isolator color coded for load carrying capacity.
 2. Mason Industries Series “HD”.

2.2 MANUFACTURERS

- A. Mason Industries.
- B. Kinetics Noise Control
- C. Amber Booth

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow manufacturer's instructions in setting and adjusting isolators. Insure that no direct hard surface to surface contact occurs. Fasten device to floor as recommended by the isolation supplier.
- B. Where electrical connections are to be made to equipment mounted on isolators, inform the Electrical Contractor to connect to the equipment with flexible conduits.
- C. See Specification Section 23 0529 Pipe Hangers and Supports for spring hanger locations and hanger installation requirements.
- D. Adjust isolators after piping system is at operating weight.
- E. Adjust active height of spring isolators.

END OF SECTION 22 0548

SECTION 22 0719 - PIPE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Fiberglass.
 - b. Flexible Elastomeric.

1.2 SUBMITTALS

A. Product Data:

1. For each type of product indicated.
2. Thickness and covering table.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
- B. Thicknesses shall be in compliance with ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 INSULATION GENERAL

- A. Refer to insulation schedule on the Drawings for piping material and applications.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be done by tradesmen specializing in insulation work in strict accordance with manufacturer's recommendations.
- B. Overlap and seal all longitudinal joints. Staples and adhesive may be used as stated above. Tape and seal cross joints. Vapor barrier shall be continuous on insulation of all cold services. Vapor barrier type mastic shall be used where needed to maintain a vapor seal.
- C. Where insulation is terminated, insulation shall be beveled at 45 degrees and the beveled surface sealed with vapor barrier mastic. PVC caps over straight cut ends which have been vapor sealed may be used in lieu of beveling.
- D. Mechanical joint fittings and couplings shall be considered as a part of the pipe line and shall be insulated. Bidders on the insulation work are cautioned to verify during the bidding period the extent of this work.
- E. Insulation on cold service piping shall be run through floor and wall sleeves to maintain vapor barrier continuity. Insulation on other services may likewise be run continuous when sleeve size permits. Refer to Section 22 0529 for non-compressible insulation or blocking material and sheet metal saddles required at pipe hangers. Coordinate with the contractor on the furnishing, installation and detailed requirements of these. Provide insulation and vapor barrier on and around supports for pipe risers of services which require vapor seal so as to prevent sweating.
- F. Re-insulate piping where insulation has been damaged in the performance of work in this project.
- G. Verify that piping has been tested before applying insulation materials and that piping surfaces are clean and dry, with foreign material removed.
- H. Fittings, valves, flanges and other devices, both exposed and concealed, requiring insulation shall be covered same thickness as pipe insulation with:
 - 1. Factory molded fitting insulation cover with PVC one-piece fitting cover.
 - 2. Miter-cut segments of pipe insulation, held in place with adhesive and/or wire, filled with insulating cement smoothed to shape and covered with PVC one-piece fitting cover.
 - 3. Fiberglass blanket insulation, held in place and covered with PVC one-piece fitting cover.

END OF SECTION 22 0719

SECTION 22 1116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Valves Schedules
3. Unions and Flanges.
4. Dielectric Connectors.
5. Pipe Sleeves
6. Escutcheons.

1.2 SUBMITTALS

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

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

1.3 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.
- C. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIAL

- A. Refer to piping and valve schedules on the Drawings for piping materials, valves, and applications.

2.2 UNIONS AND FLANGES

- A. Unions on copper tubing, all bronze construction 150 lb., solder ends.

- B. Unions on steel pipe 2” and smaller, malleable iron with ground seat, bronze to steel, 300 lbs., screwed ends.
- C. Flanges on steel pipe with welded or screwed joints, 2-1/2” and larger. Gaskets shall be 1/16” thickness full face compressed sheet suitable for temperature and pressure ranges of the application.
- D. Mechanical joints associated with grooved end pipe are acceptable in lieu of unions and flanges.

2.3 DIELECTRIC FITTINGS

- A. Refer to Division 22 Section "Common Piping Materials and Methods" for dielectric fitting requirements.

2.4 PIPE SLEEVES

- A. Refer to Division 22 Section "Common Piping Materials and Methods" for sleeve requirements.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Refer to Division 22 Section "Common Piping Materials and Methods" for basic piping installation requirements.
- B. Piping shall be pitched for drainage. The low points shall be fitted with a 3/4” drain valve (with hose thread adapter if not piped to a floor drain) except that on piping 1-1/4” and smaller where a drain valve is not shown, a drain plug is acceptable. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.
- C. Piping shall be installed consistent with good piping practice and run concealed wherever possible. Coordinate with other trades to attain a workmanlike installation.
- D. Piping shall be supported as specified in Section 22 0529 Pipe Hangers. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before insulation is applied and the system accepted.
- E. Internals of sweat end valves shall be removed when damage or warping could occur due to applied heat of soldering. Where silver brazing is specified, solder connection of valves shall be used to reduce the danger of damage. Close open ends of piping during installation to keep interior of the pipe clean.
- F. Unions and flanges shall be installed at pipe connections to fixtures and equipment and as required for erection purposed.
- G. Refer to Division 22 Section "Common Piping Materials and Methods" for dielectric fitting requirements.

- H. Refer to Division 22 Section "Common Piping Materials and Methods" for sleeve requirements.
- I. Refer to Division 22 Section "Pipe Hangers and Supports" for basic hanger and support requirements
- J. Refer to Division 22 Section "Common Piping Materials and Methods" for escutcheon requirements.
- K. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for equipment and piping labeling requirements.

3.2 FIELD QUALITY CONTROL

A. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Domestic water piping – hydrostatic at 125 psig for 6 hours at the low point of the system. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

C. Domestic water piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 PIPE CLEANING

- A. Before placing each water piping system in operation, the piping system shall be thoroughly flushed out with clean water.

3.4 DISINFECTION OF PIPING

- A. All new domestic water piping shall be disinfected by a company or personnel regularly engaged in the performance of this service.
- B. Disinfection shall be performed in accordance with AWWA C651- 86 Standards. Disinfection shall be means of a chlorine solution injected into the water system near the source. Outlets throughout the system shall be tested to prove presence of minimum chlorine concentration. Flush out the system with clean water until the residual chlorine content is not greater than .2 parts per million or until approved by the Health Department.
- C. Disinfection procedures shall be witnessed by the Architect, Engineer or other qualified representative.

3.5 DOMESTIC HOT WATER RETURN SYSTEM BALANCING

- A. The domestic hot water return shall be balanced and or adjusted to provide proper operation or function in accordance with the drawings, specifications and manufacturer's recommendations.
- B. Submit balance report. Report to include:
 - 1. Project name and location.
 - 2. Architect's name and address.
 - 3. Engineer's name and address.
 - 4. Contractor's name and address.
 - 5. Report date.
 - 6. Location and information data for each recirculation pump.
 - 7. Location and information data for each balancing valve.
 - 8. Pump design and final pump performance settings.
 - 9. Balance valve design and final valve settings.
 - 10. Notes to explain why final data varies from indicated values.

END OF SECTION 22 1116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Backflow preventers.
 - 2. Water pressure-reducing valves.
 - 3. Temperature-actuated water mixing valves.
 - 4. Strainers.
 - 5. Hose bibbs.
 - 6. Wall hydrants.
 - 7. Drain valves.
 - 8. Water hammer arresters.
 - 9. Trap-seal primer valves.
- B. See Division 22 Section "Domestic Water Piping" for water meters.
- C. See Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.
- D. See Division 22 Section "Domestic Water Filtration Equipment" for water filters in domestic water piping.

1.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: As noted on drawings.
5. Body: Bronze.
6. End Connections: Union, solder joint.
7. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Size: 3/4" to 3", as required to match connected piping or as noted on drawings.
6. Body: Bronze for 2" and smaller; or FDA approved stainless steel for 2-1/2" and larger.
7. End Connections: Threaded for 2" and smaller; flanged for 2-1/2" and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of 2" and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of 2-1/2" and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Backflow-Preventer Test Kits

1. Manufacturers Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.2 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Point of Use Thermostatic Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation
 - b. Lawler Manufacturing Company, Inc.
 - c. Leonard Valve Company.
 - d. Powers; a Watts Industries Co.
 - e. Symmons Industries, Inc.
 - f. Caleffi Hydronics Solutions
2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Exposed-mounting, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, thermometer on outlet, temperature-control handle.
8. Tempered-Water Setting: 105 deg F .
9. Tempered-Water Design Flow Rate: 0.5 gpm minimum.
10. Valve Finish: Chrome plated.
11. Piping Finish: Chrome plated.

2.3 STRAINERS FOR DOMESTIC WATER PIPING

2.4 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.

- b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Woodford Manufacturing Company.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for concealed -outlet, self-draining wall hydrants.
 3. Pressure Rating: 125 psig .
 4. Operation: Loose key.
 5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
 6. Inlet: 3/4”.
 7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
 8. Box: Deep, flush mounting with cover.
 9. Box and Cover Finish: Polished nickel bronze.
 10. Include operating key with each key operated hose bibb

2.5 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves.

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: 3/4”.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.6 WATER HAMMER ARRESTERS

A. Water Hammer Arresters :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. PPP Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products Inc.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.7 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. (Insert manufacturer.)
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: 1/2" threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: 1/2" threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

- E. Install water hammer arresters on each quick closing valve in water piping according to PDI-WH 201.
- F. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- G. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Reduced-pressure-principle backflow preventers.
- H. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.2 FIELD QUALITY CONTROL

- A. Test reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard and prepare test reports.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.3 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 1119

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic hot-water recirculation:
 - 1. Close-coupled, in-line, seal less centrifugal pumps.
- B. See Division 22 Section "Domestic-Water Packaged Booster Pumps" for booster systems.

1.2 SUBMITTALS

- A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
- B. Operation and maintenance data.

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

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE, SEALLESS CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, single-stage, close-coupled, in-line, sealless centrifugal pumps as defined in HI 5.1-5.6.
 - 1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge-type unit with motor and impeller on common shaft and designed for installation with pump and motor shaft mounted horizontally.
 - 2. Casing: Bronze, with threaded companion-flange connections.
 - 3. Impeller: Corrosion-resistant material.
 - 4. Motor: Single speed, unless otherwise indicated. Comply with requirements in Division 22 Section "Electrical Requirements for Plumbing Equipment."
- B. Capacities and Characteristics: Refer to drawings.

- C. Acceptable Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett Domestic Pump; ITT Industries.
 - 3. Grundfos Pumps Corp.
 - 4. Taco, Inc.

2.2 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
 - 1. Type: Water-immersion sensor, for installation in hot-water circulation piping.
 - 2. Range: 65 to 200 deg F.
 - 3. Operation of Pump: On or off.
 - 4. Transformer: Provide if required.
 - 5. Power Requirement: 120 V, ac.
 - 6. Settings: Start pump at 115 deg F and stop pump at 120 deg F.
 - 7. Acceptable Manufacturers:
 - a. Honeywell International, Inc.
 - b. Square D.
 - c. White-Rodgers Div.; Emerson Electric Co.
- B. Timers: pump to be controlled thru the building Automation system

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Install in-line, seal less centrifugal pumps with motor and pump shafts horizontal.
- E. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 22 Section "Vibration Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- F. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- G. Install piping adjacent to pumps to allow service and maintenance.

- H. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."
 - 1. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.
 - 2. Install test plugs for pressure gage at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and test plugs.
 - 3. Install thermometer at suction of pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometer.
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- K. Connect timers to pumps that they control.

END OF SECTION 22 1123

(This page intentionally left blank)

SECTION 22 1316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following soil and waste, sanitary drainage and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Plastic piping and components shall comply with NSF 14, "Plastics Piping Systems Components and Related Materials,". Include marking with "NSF-DWV" for plastic drain, waste, and vent piping; and "NSF-drain" for plastic drain piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to piping schedule on the Drawings for piping material and applications.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

- A. Basic piping installation requirements are specified in Division 22 Section ""Common Piping Materials and Methods. "
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section " Common Piping Materials and Methods."
- D. Piping suspended 18” or more shall be provided with sway bracing as required by CISPI’s "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- E. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping smaller than 3” and; 1 percent downward in direction of flow for piping 3” and larger.
 - 2. Vent Piping: slope down toward vertical fixture vent or toward vent stack.
- H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- I. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- J. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- K. Refer to Division 22 Section "Common Piping Materials and Methods" for sleeve requirements.
- L. Refer to Division 22 Section "Pipe Hangers and Supports" for basic hanger and support requirements
- M. and Methods" for escutcheon requirements.

- N. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for equipment and piping labeling requirements.

3.2 JOINT CONSTRUCTION

- A. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.3 CONNECTIONS

- A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code or indicated on the drawings.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections 2-1/2" and larger.

3.4 FIELD QUALITY CONTROL

- A. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- B. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- C. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- D. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- E. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.
 - 1. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 2. Prepare reports for tests and required corrective action.

3.5 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Plugs the ends of uncompleted piping at end of day and when work stops.

3.6 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 22 1316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
1. Cleanouts.
 2. Floor drains.
 3. Roof flashing assemblies.
 4. Miscellaneous sanitary drainage piping specialties.
 5. Flashing materials.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

1.3 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 FLOOR DRAINS

- A. Floor drains shall be as indicated on the drawings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Wade Manufacturing Company Division of Tyler Pipe

2.2 CLEANOUTS

- A. Exposed Cast-Iron Cleanouts:
1. Manufacturer shall be same as floor drains.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Floor Cleanouts:

1. Manufacturer shall be same as floor drains.
2. Standard: ASME A112.36.2M for adjustable housing cast-iron soil pipe with cast-iron ferrule threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Inside caulked.
8. Closure: Plastic plug.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze,.
11. Frame and Cover Shape: Round Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts

1. Manufacturer shall be same as floor drains.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk drilled-and-threaded plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.

- B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch- thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Maintenance Device:

1. Description: Device inserted into the drain body or adjustable strainer that opens to allow water to pass thru and closes to prevent sewer gases from entering the room from the drainage system.
2. Must conform to ASSE 1072 .
3. Size: Same as floor drain outlet.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

2.5 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft, 0.0625-inc thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft, 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Solder: ASTM B 32, lead-free alloy.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to 4". Use 4" for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping 4" and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install floor-drain, trap-maintenance devices on inlet to floor drains as noted on drawings.
- H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- K. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 1319

(This page intentionally left blank)

SECTION 22 1613 – INTERIOR NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 100 psig minimum unless otherwise indicated.
- B. All gas piping work shall be in accordance with Gas Company requirements. Verify materials selected are in conformance before installation.
- C. Intermediate natural gas piping shall run between the Gas company meter setting and the building at an intermediate pressure of 2 psi. At the building the pressure shall be regulated down to 7" w.c. which shall enter the building and be distributed to each item needing natural gas.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Welding certificates.
- C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Materials and installation shall conform to standards and requirements of the Gas Company and the Ohio Building Code including the referenced International Fuel Gas Code.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to piping schedule on the Drawings for piping material and applications.

2.2 PIPING SPECIALTIES

- A. Gas Pressure Regulators:
 - 1. Gas pressure regulator shall be self-operating spring loaded type. Valve body shall be cast iron, 125 psi construction with screwed or flanged connections. Spring and diaphragm casings shall be aluminum. Regulator shall have an internal relief valve assembly, tapped vent connection with removable screen on the spring casing and an external pilot operator to afford a 5% maximum droop. Over-pressure protection shall be ten times the inlet pressure (or higher as may be required by the gas company).
 - 2. Regulator shall be Fisher Type S102 or S202 or equal by Sprague or Equimeter. Refer to the drawings for size, capacity, inlet and outlet pressures and installation detail.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Piping Materials and Methods."
- B. Outdoor Piping
 - 1. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
 - 2. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
 - 3. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
 - 4. Install underground, PE, natural-gas piping according to ASTM D 2774.
 - 5. Steel Piping with Protective Coating:
 - a. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - c. Replace pipe having damaged PE coating with new pipe.
 - 6. Install fittings for changes in direction and branch connections.

7. Exterior-Wall Pipe Penetrations: Seal penetrations using steel or cast-iron 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.
8. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
9. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 22 Section "Meters and Gages.
10. Piping installed above ground and outdoors shall be painted to protect it from corrosion.
11. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for equipment and piping labeling requirements.

C. Indoor Piping Installation

1. Valves, unions and threaded joints are not permitted in inaccessible locations. Valve shall not be located in ceiling air plenums and or other air plenums or ducts.
2. Comply with Gas Company for installation and purging of natural-gas piping.
3. A shutoff valve and dirt and moisture leg with screwed end cap shall be provided on the pipe drop to each item of equipment.
4. Gas pressure regulators shall be installed in accordance with the manufacturer's instructions. Provide valved gauge taps upstream and downstream of the regulator and a pressure gauge on the downstream side. Provide pilot regulator piping and miscellaneous valves, devices and piping to complete the installation.
5. Vent piping shall be extended individually from each regulator and gas venting device to outside the building in an approved location.
6. Piping installed above ground and outdoors shall be painted to protect it from corrosion.
7. Unions and flanges shall be installed at pipe connections to fixtures and equipment and as required for erection purposed.
8. Refer to Division 22 Section "Common Piping Materials and Methods" for sleeve requirements.
9. Refer to Division 22 Section "Pipe Hangers and Supports" for basic hanger and support requirements
10. Refer to Division 22 Section "Common Piping Materials and Methods" for escutcheon requirements.
11. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for equipment and piping labeling requirements.

3.1 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.1 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance.
- B. Install regulator with maintenance space adequate for servicing and testing.

3.2 CONNECTIONS

- A. Connect to utility's gas service according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

- E. Dirt Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.3 FIELD QUALITY CONTROL

- A. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction. Test pressure shall be 3 psi or 1.5 times the working pressure whichever is greater.
- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 22 1613

(This page intentionally left blank)

SECTION 22 3116 - WATER SOFTENERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes commercial water softeners.
 - 1. Chemicals.
 - 2. Water testing kits.

1.2 SUBMITTALS

- A. Product Data: For each type of water softener and water testing kit indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and connections to piping systems.
 - 1. Include wiring diagrams.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

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.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within specified warranty period.
 - 1. Water Softener, Warranty Period: Five years from date of Substantial Completion.

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. Salt for Brine Tanks: Furnish same form as and at least four times original load, but not less than 200 lb. Deliver on pallets in 40- or 50-lb packages.
2. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

PART 2 - PRODUCTS

2.1 SOFTENER TANK(S)

- A. System shall include one (1) tank. Each The sideshell height shall be sufficient to allow for proper freeboard space above the resin bed for adequate expansion of the resin during backwashing.
- B. Tank shall be manufactured of polyester reinforced by a continuous roving glass filament overwrap. The top opening will be 4" threaded and the tank bottom will be supported on a molded structural base.
- C. The upper distribution system shall be of the single point diffuser type to dispense water laterally to avoid channeling within the resin bed.
- D. The lower distribution system shall be of the single point distributor type, constructed of PVC pipe and a fine slotted strainer to provide even flow distribution through the resin bed. The distribution system shall be embedded in a subfill of washed inorganic material to support the resin bed.
- E. The ion exchange resin shall be virgin high capacity "standard mesh" of sulfonated polystyrene type stable over the entire pH range with good resistance to bead fracture from attrition or osmotic shock. Each cubic foot of resin will be capable of removing 30,000 grains of hardness as calcium carbonate when regenerated with 15 lbs. of salt. The resin shall be solid, of the proper particle size of 20-50 mesh, U.S. standard screen and will contain no agglomerates, shells, plates or other shapes that might interfere with the normal function of the water softener. The resin shall be manufactured to comply with the food additive regulation 21 CFR 173.25 as set forth by the USFDA.

2.2 MAIN OPERATING VALVE

- A. The main operating valve shall be of a top mount design constructed of all plastic inlet and outlet water pipe connections.
- B. The main operating valve will be of the motor driven, electronically activated design with six (6) positions to accomplish the regeneration steps of backwash, brine draw/rinse, fast rinse, brine refill and stand-by, in addition to the service position.
- C. The main operating valve shall incorporate self adjusting flow regulators to control the rate of flow and prevent resin loss during backwash regardless of system pressure fluctuations between 30 and 100 psi.
- D. The main operating valve will be fitted with a fixed orifice eductor

2.3 CONTROLS

- A. The main operating valve will be controlled by a single electrically controlled timer to control the regeneration and to alternate the tank in service. The timer will activate a motor drive which will shift the stand-by tank into the service position, perform the regeneration functions on the exhausted tank and return it to the stand-by position. The timer will permit individual adjustment of the backwash, brine-rinse, fast rinse and brine refill cycles.
- B. No external alternating devices will be acceptable. The alternating function must be contained in the sequencing controller. Simultaneous regenerations shall not be possible.

2.4 FLOW METER

- A. The main operating valve will include one (1) mechanical turbine-type meter on the outlet side of the water softener. The meter will be directly connected to the cycle timer by a cable. The meter provided shall be the same size as the outlet of the softener. The operating temperature/pressure range of the meter shall be 34°F - 110°F at 120 psi max.

2.5 EXCHANGE RESIN

- A. The ion exchange resin shall be virgin high capacity “standard mesh” of sulfonated polystyrene type stable over the entire pH range with good resistance to bead fracture from attrition or osmotic shock. Each cubic foot of resin will be capable of removing 30,000 grains of hardness as calcium carbonate when regenerated with 15 lbs. of salt. The resin shall be solid, of the proper particle size of 20-50 mesh, U.S. standard screen and will contain no agglomerates, shells, plates or other shapes that might interfere with the normal function of the water softener. The resin shall be manufactured to comply with the food additive regulation 21 CFR 173.25 as set forth by the USFDA.

2.6 BRINE SYSTEM

- A. Provide a complete brine system consisting of a plastic tank, salt platform, salt dosage brine well, an automatic brine valve and all necessary fittings for operation with the water softening system. The system shall consist of a combined brine measuring and salt storage tank with salt platform.
- B. The brine tank will be equipped with a float operated non-corrosive field serviceable brine float valve for automatic control of brine withdrawal and fresh water refill.
- C. The brine valve will automatically open to admit brine to the resin tank during eduction and close automatically providing positive shut-off to prevent air from entering the system. The brine valve will also regulate the flow of soft water into the brine tank during refill. The brine valve works with the timed fill feature of the main operating valve controls to admit the correct volume of fresh water to the brine tank in accordance with the salt dosage setting on the controls. The brine valve will include a float operated safety shut-off valve as a back up to the timed refill from the main operating valve control to prevent brine tank overflow.

2.7 ACCEPTABLE MANUFACTURERS

- A. Culligan.
- B. Kinetico
- C. Aqua Systems
- D. Marlo Incorporated
- E. Watts

PART 3 - EXECUTION

3.1 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for commercial water softeners. Refer to Division 22 Section "Common Work Results for Plumbing."

3.2 WATER SOFTENER INSTALLATION

- A. Install household water softeners on floor.
- B. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
- C. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.
- D. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
- E. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."
- D. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank.

1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 2. Exception: Water softeners with factory-installed shutoff valves at locations indicated.
- E. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."
1. Exception: Water softeners with factory-installed pressure gages at locations indicated.
- F. Install valved bypass water piping around water softeners.
1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
 3. Water piping is specified in Division 22 Section "Domestic Water Piping."
- G. Install drains as indirect wastes to spill into open drains or over floor drains.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

3.5 STARTUP SERVICE

- A. Add water to brine tanks and fill with salt.
- B. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
1. ASTM D 859, "Test Method for Silica in Water."
 2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
 3. ASTM D 1068, "Test Methods for Iron in Water."
 4. ASTM D 1126, "Test Method for Hardness in Water."

5. ASTM D 1129, "Terminology Relating to Water."
6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water softeners. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 22 3116

SECTION 22 3333 - ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Light-commercial electric water heaters.
 - 2. Water heater accessories.

1.2 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.
- D. Warranty.

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. ASHRAE/IESNA-90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:

- a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period(s): From date of Substantial Completion:
 - a. .
 - b. Commercial Electric Water Heaters: Five years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 LIGHT-COMMERCIAL ELECTRIC WATER HEATERS

- A. Description: Comply with UL 174 for household, storage electric water heaters.
 1. Storage-Tank Construction: Steel, vertical arrangement.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
 2. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1-2010.
 - e. Jacket: Steel with enameled finish.
 - f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - g. Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation, unless otherwise indicated.
 - h. Temperature Control: Adjustable thermostat for each element.
 - i. Safety Control: High-temperature-limit cutoff device or system.
 - j. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
 3. Special Requirements: NSF 5 construction with legs for off-floor installation.
 4. Refer to the drawings for capacity and characteristics.
 5. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:

- a. American Water Heater Company.
- b. Bradford White Corporation.
- c. Lochinvar Corporation.
- d. Rheem Water Heater Div.; Rheem Manufacturing Company.
- e. Ruud Water Heater Div.; Rheem Manufacturing Company.
- f. Smith, A. O. Water Products Company.
- g. State Industries, Inc.

2.3 WATER HEATER ACCESSORIES

- A. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.
- B. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
- C. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than 3/4".
- D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1-2010.
- E. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig- maximum outlet pressure, unless otherwise indicated.
- F. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install commercial water heaters on concrete bases.
 - 1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
 - 2. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial, water-heater, relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

- D. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
- E. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- F. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- G. Fill water heaters with water.

3.2 CONNECTIONS

- A. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial electric water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 22 3300

SECTION 22 4200 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Faucets for lavatories and/ sinks.
 - 2. Flushometers.
 - 3. Drinking Fountains
 - 4. Toilet seats.
 - 5. Fixture supports.
 - 6. Dishwasher air-gap fittings.
 - 7. Disposers.
 - 8. Water closets.
 - 9. Lavatories.
 - 10. Kitchen sinks.
 - 11. Service sinks.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. FRP: Fiberglass-reinforced plastic.
- D. PMMA: Polymethyl methacrylate (acrylic) plastic.
- E. PVC: Polyvinyl chloride plastic.
- F. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.

1.4 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. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act" for plumbing fixtures for people with disabilities and Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- E. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Stainless-Steel Residential Sinks: ASME A112.19.3.
 - 2. Vitreous-China Fixtures: ASME A112.19.2M.
 - 3. Water-Closet, Flushometer Trim: ASSE 1037.
- F. Comply with the following applicable standards and other requirements specified for lavatory/ and sink faucets:
 - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 4. Faucets: ASME A112.18.1.
 - 5. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 6. Hose-Coupling Threads: ASME B1.20.7.
 - 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 8. NSF Potable-Water Materials: NSF 61.
 - 9. Pipe Threads: ASME B1.20.1.
 - 10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 - 11. Supply Fittings: ASME A112.18.1.
 - 12. Brass Waste Fittings: ASME A112.18.2.
- G. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Atmospheric Vacuum Breakers: ASSE 1001.
 - 2. Brass and Copper Supplies: ASME A112.18.1.
 - 3. Dishwasher Air-Gap Fittings: ASSE 1021.
 - 4. Manual-Operation Flushometers: ASSE 1037.
 - 5. Plastic Tubular Fittings: ASTM F 409.
 - 6. Brass Waste Fittings: ASME A112.18.2.
 - 7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

- H. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
 2. Dishwasher Air-Gap Fittings: ASSE 1021.
 3. Flexible Water Connectors: ASME A112.18.6.
 4. Hose-Coupling Threads: ASME B1.20.7.
 5. Off-Floor Fixture Supports: ASME A112.6.1M.
 6. Pipe Threads: ASME B1.20.1.
 7. Plastic Toilet Seats: ANSI Z124.5.
 8. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 Fixtures and Trim

- A. Refer to the notes/schedule on the drawings for fixture and associate trim specifications.
- B. All waste and supply trim exposed to view shall be chrome plated brass.
- C. Toilet Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bemis Manufacturing Company.
 - b. Centoco Manufacturing Corp.
 - c. Church Seats.
 - d. Kohler Co.
 - e. Olsonite Corp.
 - f. Beneke Div, Sanderson Plumbing Products, Inc..
 - g. Sperzel.
 2. Description: Toilet seat for water-closet-type fixture.
 - a. Material: Molded, solid plastic with antimicrobial agent.
 - b. Configuration: Open front without cover.
 - c. Size: Elongated.
 - d. Hinge Type: self-sustaining check.
 - e. Class: Heavy-duty commercial.
 - f. Color: White.

2.2 FIXTURE CARRIERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Josam Company.
 2. MIFAB Manufacturing Inc.

3. Smith, Jay R. Mfg. Co.
 4. Tyler Pipe; Wade Div.
 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 6. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Water-Closet Carriers:
1. Description: Combination carrier designed for wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with neoprene gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
- C. Lavatory Carriers:
1. Description: Lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include rectangular steel uprights with feet.
- D. Sink Carriers:
1. Description: Sink carrier with hanger plate, bearing studs, and tie rod/, Sink carrier with hanger plate and exposed arms for sink-type fixture. Include steel uprights with feet.
- E. Drinking Fountain Carriers:
1. Description: Carrier with hanger and bearing plates for wall-mounted fixture. Include rectangular steel uprights with feet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install feet and anchor lugs of carriers securely affixed to floor using all bolt holes provided.
- C. Install fixtures level and plumb according to roughing-in drawings.
- D. Attach supplies to supports or substrate within pipe spaces behind fixtures to prevent loose piping fitting piping thru walls. Install -supply stop on each water supply to each fixture connected to water distribution piping. Install stops in locations where they can be easily reached for operation.
- E. Install flushometer valves for water closets with handle mounted on wide side of compartment or room. Install other actuators in locations that are easy for people with disabilities to reach.
- F. Install toilet seats on water closets.

- G. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- H. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- I. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Adjust flow regulators for proper flow and stream height and adjust water cooler temperature settings for drinking fountains.
- F. Install fresh batteries in sensor-operated mechanisms.

3.4 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.

- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4200

DIVISION

23

**HEATING, VENTILATING
AND AIR-CONDITIONING**

(This page intentionally left blank)

SECTION 23 0001 – BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes the following:
1. General Requirements
 2. Definitions
 3. Scope of Work
 4. Drawings and Specifications
 5. Reference Standards
 6. Allowances, Unit Prices and Alternates
 7. Site Visit
 8. Permits, Regulations and Inspections
 9. Project Management and Coordination
 10. Temporary Utilities
 11. Workmanship
 12. Protection
 13. Painting
 14. Cleaning
 15. Miscellaneous Equipment Connections
 16. Equipment Selection
 17. Shop Drawings
 18. Final Inspection and Punch List
 19. Operation and Maintenance Manuals
 20. Record Drawings
 21. Warranties
 22. Project Closeout
 23. Operation and Adjustment of Equipment
 24. Operating Demonstration and Instruction

1.2 GENERAL REQUIREMENTS

- A. All provisions of Division 00 Front End Documents and Division 01 General Requirements apply to work specified in this Division.
- B. Specification provisions of other relevant Divisions shall apply where applicable work is required to be performed under this HVAC work.
- C. A complete and functional HVAC system installation shall be provided under this Division. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

- D. The Mechanical and Electrical drawings and specifications assign work (labor and/or materials) to be provided by the General, Plumbing, Fire Suppression, HVAC or Electrical Contractor or their sub-contractors. Understanding that the contractors for mechanical and electrical work are sub-contractors to the (General) Contractor, such assignments are not intended to restrict the Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior 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 SCOPE OF WORK

- A. The scope of the HVAC work includes furnishing, installing, testing and warranty of all HVAC work shown on the HVAC drawings and specified herein, including Division 00, Division 01, Division 23 and applicable provisions of other relevant Divisions.

1.5 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word “proved,” as used, shall mean “furnish and install.” If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.
- B. Make all necessary field measurements to insure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having ductwork, pipe and fittings fabricated and delivered in advance of making actual measurements shall be sufficiently in advance as

to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

- D. The Architect/Engineer shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties.
- E. Equipment, ductwork or piping shall not be installed or run above electrical switchgear or panelboards, nor in or above the access space in the immediate vicinity of the electrical switchgear/panelboards, in accordance with NEC Article 384.
- F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of ductwork, piping, etc., where conflict arises.
- G. Provides offsets in system runs, additional fittings, necessary drains and minor valves, traps, dampers and devices required to complete the installation, or for the proper operation of the system. Each Contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.
- H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

1.6 REFERENCE STANDARDS

- A. Where standards (NFPA, NEC, ADTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

1.7 ALLOWANCES, UNIT PRICES AND ALTERNATES

- A. Refer to Sections 012100 Allowances, 012200 Unit Prices and 012300 Alternates.

1.8 SITE VISIT

- A. Refer to Section 017300 Execution.
- B. Each bidder shall visit the project site to understand the existing conditions and compare the conditions with information shown on the drawings. Report immediately to the Architect any issues or discrepancies which are discovered that affect the bid. Changes to contract price will not be considered for site condition issues that are readily apparent from a thorough site review.

1.9 PERMITS, REGULATIONS AND INSPECTION

- A. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawing and specifications shall govern. Install no work contrary to minimum legal standards.
- B. Except where the permit application is made by the Architect or the Engineer, the HVAC contractor shall be responsible to file for and obtain all required permits from the governing inspection agencies for the HVAC work. Where the Architect or Engineer is the Architect or Engineer of record, they will furnish sealed and signed drawings and specifications required by the permit authorities.
- C. Include payment of all permit and inspection fees applicable to the work in this Division.
- D. All work shall be subject to inspection and approval of Federal, State and local agencies as may be appropriate as well as the Architect and Engineer.
- E. Furnish for the Owner certificates of approval from the governing inspection agencies as a condition for final payment.

1.10 PROJECT MANAGEMENT AND COORDINATION

- A. Refer to Section 013100 Project Management and Coordination.

1.11 TEMPORARY UTILITIES

- A. Refer to Section 015000 – Temporary Facilities and Controls for division of responsibilities for temporary utilities.
- B. The use of the permanent HVAC system for temporary heating and ventilation during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period. Provide and maintain temporary air filters to protect coils and ducts. Replace temporary filters with the specified filters (clean) when the systems are placed on permanent duty. Air filters specified for the systems and units, including specified spare filters, are not to be used for temporary service.
- C. Cover all return duct openings with temporary filter media when recirculating air. Stop fans during heavy dust generating operations. Before turning the system over to the Owner, the Contractor shall clean duct interiors and interior surfaces and components with the air handling equipment if dirt, dust and debris have accumulated on these surfaces.
- D. Warranty periods on equipment, materials and system shall commence upon Owner acceptance of the building or system. Temporary heat use shall not jeopardize or alter the warranty requirements.

1.12 WORKMANSHIP

- A. Refer to Section 014000 Quality Requirements.

- B. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect shall have the right to stop the work if highest quality workmanship is not maintained.
- C. HVAC work shall be performed by licensed HVAC Contractors in accordance with requirements of the jurisdiction.

1.13 PROTECTION

- A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.
- B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide plastic sheeting, drop cloths or similar barriers where dust and debris is generated, to protect adjacent areas.
- C. Contractor shall protect all equipment and materials from detrimental effects of weather or construction activity. All items shall be stored and secured in a protected location away from the daily work area. Equipment or materials shall be placed on raised skids to protect from surface moisture. Where appropriate, provide plastic sheeting or similar vapor barrier underneath the stored products to reduce the effects of ground moisture or curing concrete on the local humidity levels. Where unfinished ferrous products or finished ferrous products with raw edges are stored, provide local, dry heat to maintain ambient relative humidity levels below 65% RH to prevent rust.
- D. All equipment shall retain the original packaging until required to be removed for installation or operation. Open ends of ducts, piping, conduit, etc. shall be capped or sealed and ventilation openings into equipment shall be wrapped and sealed in plastic sheeting to prevent dust or dirt entry both when stored and after installation but still open to the effects of construction activity. Stored items as well as installed equipment shall be covered with plastic sheeting at all times until placed in service or until dust generating activity in the area has ceased.

1.14 PAINTING

- A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 23:
 - 1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint.
 - 2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint.

3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
 4. Inside of ducts, behind grilles and registers, shall be painted flat black to eliminate the viewing of shiny surfaces.
- B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 Finishes. All rust must be removed before application of paint.
- C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the “Cutting and Patching” paragraph in this Section for finishing requirements.

1.15 CLEANING

- A. Debris, dust, dirt, etc shall be removed daily, particular attention shall be paid to areas that the Owner is continuing to occupy or use; any mess created in corridors, stairwells and egress paths that are maintained during construction shall be cleaned immediately.
- B. The Owners dumpsters and trash receptacles shall not be used. If a dumpster is required, it shall be provided by the contractor and located where approved by the Owner. Coordinate dumpster requirements with other contractors.
- C. Before turning an area back over to the Owner, thoroughly clean the space to leave the area in a similar condition before the start of the project where finishes are to remain. The contractor shall also clean duct interiors and interior components of new or existing air handling system equipment if dirt, dust or debris have generated in the course of work have accumulated on these surfaces.
- D. Before placing each system in operation, the equipment shall be thoroughly cleaned; cleaning shall be in accordance with equipment manufacturer's recommendations.
- E. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

1.16 EQUIPMENT SELECTION

- A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.
- B. The selection of materials and equipment to be furnished under this contract shall be governed by the following:
1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specifications, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturer's listed.

2. Where the words “or approved equal: appear after a manufacturer’s name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
 3. Where the words “equal to” appear, followed by a manufacturer’s name and sometimes a model or series designation, such designation is intended to establish a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer’s approval.
- C. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.
- D. Before bidding equipment, and again in the preparation of shop drawings the Contractor and his supplier shall verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.
- E. If extensive changes in pipe, duct or equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in the contract.

1.17 SHOP DRAWINGS

- A. Refer to Section 016000 Product Requirements.
- B. One set of shop drawings, in electronic format (.pdf), with descriptive information shall be assembled by each Contractor of equipment and materials furnished in his contract, and submitted to the Architect and/or Engineer for review as stated in Division 01. These shall be submitted as soon as practicable and before special equipment is manufactured and before installation.
- C. Shop drawings for equipment fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. Failure to do so may be cause for rejection of shop drawings.
- D. The review of shop drawings by the Architect or Engineer shall not relieve the Contactor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer’s attention in a separate clearly stated notification at the time of submittal for the Engineer’s review.
- E. Shop drawings for the following HVAC equipment and materials shall be submitted:
1. Pipe, fittings and joining methods for the various systems.
 2. Pipe Hangers and Supports.
 3. Valves.
 4. Flexible Connectors.
 5. Meters and Gauges.

6. Vibration Isolators.
7. Pipe Insulation.
8. Equipment and Breeching Insulation.
9. Ductwork Insulation.
10. Ductwork and Sealing Systems.
11. Air Duct Accessories.
12. Tanks.
13. Hydronic System Specialties.
14. Pumps.
15. Water Treatment Systems.
16. Boilers and Burners.
17. Prefabricated Stacks and Flues.
18. Furnaces and Cooling Coils.
19. Condensing Units.
20. Air-Cooled Condensers.
21. Refrigerant piping schematic and components.
22. Vertical Package Air Conditioning Units.
23. Heating Coils.
24. Fan-Coil Units.
25. Unit Heaters.
26. Convectors.
27. Central Air Handling Units.
28. Fans.
29. Roof Ventilators.
30. Air Filters.
31. Air Control Terminal Units.
32. Diffusers, Registers and Grilles.
33. Louvers.
34. Temperature Controls System.

1.18 FINAL INSPECTION AND PUNCH LIST

- A. Refer to Section 017700 Closeout Procedures.

1.19 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Section 017823 Operation and Maintenance Data.
- B. All shop drawing and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. Air and water balance reports shall also be included. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required.
- C. These shall be assembled into three-ring loose lead binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to

the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.20 RECORD DRAWINGS

- A. Refer to Section 017839 Project Record Drawings.

1.21 WARRANTIES

- A. Refer to Section 017700 Closeout Procedures.
- B. This Contractor shall warrant all workmanship, equipment and material entering into this contract for a period of one year of date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner.
- C. This provision is intended specifically to cover deficiencies in contract completion or performance which are discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.
- D. This provision shall not be construed to include maintenance items such as replacing filters, re-tightening or repacking glands, greasing, oiling belt tightening and cleaning strainers after these have been done for final close-out.
- E. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.
- F. Extended warranties shall be provided where indicated in the equipment specification sections.

1.22 PROJECT CLOSEOUT

- A. Refer to Section 017700 Closeout Procedures.

1.23 OPERATION AND ADJUSTMENT OF EQUIPMENT

- A. As each piping system and air distribution system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing air and water systems, adjusting fan speeds, belts, pulleys, tightening packing glands, and adjusting all operating equipment.
- B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.
- C. Test relief valves, air vents and regulating valves to insure proper operation.

1.24 OPERATING DEMONSTRATION AND INSTRUCTIONS

- A. Refer to Section 017900 Demonstration and Training as well as individual Division 23 Sections for requirements.
- B. The Contractor shall set the various systems into operation and demonstrate to the Owner and Architect that the systems function properly and that the requirements of the Contract are fulfilled.
- C. The Contractor shall provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.
- D. A minimum of 16 hours shall be allowed for instructions to personnel selected by the Owner. Instructions shall include not less than the following:
 - 1. Show locations of items of equipment and their purpose.
 - 2. Review binder containing instructions and equipment and systems data.
 - 3. Coordinate written and verbal instructions so that personnel understand each.
 - 4. Separate instructions shall be given by manufacturer's representatives for the temperature control systems.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION – NOT APPLICABLE

END OF SECTION 23 0001

SECTION 23 0513 - ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for electrical work for HVAC equipment including single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation and other electrical equipment, devices, fuses, wire, conduit and installation methods.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.
- B. Refer to the Mechanical drawings and also the Electrical drawings for requirements related to each trade. Coordinate all aspects of electrical components and wiring to complete the systems.

1.3 QUALITY ASSURANCE

- A. Equipment, devices shall be designed, constructed and installed in accordance with applicable standards of NEMA and the National Electric Code. Equipment shall be tested and listed by UL or other approved agency and installed in accordance with all instructions included as part of such listing.
- B. Electrical equipment, devices, fuses, wire, conduit and methods shall comply with applicable provisions of Division 26 - Electrical.

PART 2 - PRODUCTS

2.1 Motors

- A. General duty motors shall be induction type 1750 rpm NEMA Design "B" with copper windings, Class B or F insulation, and motor enclosure to suit the application. Service factor shall be 1.15 minimum.
- B. Two-speed motors shall be two-winding type with six leads unless otherwise specified.

- C. Motors for other than general duty application shall be furnished to suit the application and operating environment.
- D. Premium efficiency motors shall be equal to Century “E + 3”, General Electric “Energy Saver Premium Efficiency”, Baldor “Super E Premium Efficient” or Reliance “Premium Energy Efficient” series. Motor efficiencies shall be tested and conform to NEMA Standard Publication MG-1 and IEEE 112 Test Method B.
- E. Motors used with variable frequency controllers shall be rated for inverter service in accordance with NEMA Standard Publication MG-1, Part 31, designed to handle 1600V at a 0.1 micro-second rise time and include Class F or H insulation, but with a Class B temperature rise. Motors shall be equipped with a maintenance free, conductive micro fiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge electrical shaft currents within the motor and/or its bearings.
- F. Motor sizes shown on the drawings are to be considered minimum. Motors furnished shall be sized so as to not operate in the service factor range. Motors for direct driven pumps and fans shall be selected so as to not operate in the service factor range at any point on the curve.
- G. The HVAC Contractor and equipment suppliers shall compare the electrical power requirements of the intended equipment with power feeders to the equipment shown on the Electrical drawings. Verify adequacy and compatibility of voltage, phase, wiring, capacity, number and size of conductors (versus equipment connection points), fusing and other information on the electrical and mechanical drawings to that required for the equipment. If the selected equipment requires revision of the electrical, added cost must be borne by the HVAC Contractor.

2.2 STARTERS

- A. Magnetic starters shall comply with provisions of Division 26 - Electrical Specifications and shall be NEMA construction (IEC rated not acceptable) with thermal overload element on each phase, 115 volt control voltage and hand-off-automatic switch, where appropriate. An integral control transformer shall be incorporated in the starter for each motor of 200 volt and greater. A single control transformer is acceptable for multiple motor packaged equipment, however, when such is the manufacturer's standard. Duplex type units (pumps, compressors, etc.) are not included in this exception. A control transformer shall be provided in each starter to insure standby operating capability.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Motor connections of factory assembled equipment shall be made with flexible conduit except for plug-in electric cord connections.
- B. All power wiring shall be run in conduit. Control wiring shall be run in conduit except where open wiring is permitted in other applicable specification sections.

- C. Fuses shall be furnished and installed in fuse clips of equipment and switches provided by the Mechanical Contractors.

END OF SECTION 23 0513

(This page intentionally left blank)

SECTION 23 0519 – METERS AND GAUGES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Thermometers.
 - 2. Pressure Gauges.
 - 3. Pressure-Temperature (PT) Test Plugs.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 THERMOMETERS

- A. Thermometers shall be 9" blue reading organic spirit filled tube column type with cast aluminum case with epoxy finish, acrylic window, aluminum scale with white background and black markings, 1% accuracy, adjustable angle hinge assembly and 3.5" aluminum insertion stem, equal to Terice BX91403.
- B. Provide a separable socket insertion thermowell shall be furnished with each thermometer. A lagging extension neck, with appropriate increase in thermometer stem length, shall also be furnished where piping is insulated.
- C. Ranges of thermometers shall be selected from standard Fahrenheit scales to be consistent with anticipated temperatures, typically, 0°F – 160°F for chilled systems and 30°F – 240°F for heating systems, and 0°F – 100°F for condenser water systems.

2.2 PRESSURE GAUGES

- A. Pressure gauges, including compound gauges and vacuum gauges, shall be Bourdon tube type with 4-1/2" dial and cast aluminum case, measuring in psi, equal to Terice 600CB Series. Accuracy shall be 1% at full scale.
- B. Pressure gauges for low pressure application, calibrated in inches of water gauge, ounces per sq. in., or 0-5 psi, as appropriate, shall be equal to Terice 860.

- C. Pressure gauges at pumps shall be glycerine liquid filled Bourdon tube type with 4” dial and stainless steel case and internals, measuring in psi, equal to Trerice 700 Series. Accuracy to be 1% at full scale.
- D. A brass cock or bronze ball valve and a pressure snubber shall be furnished with each pressure gauge.
- E. Ranges of pressure gauges shall be selected to be consistent with anticipated pressures. Range shall be approximately twice the normal system working pressure at the gauge location.

2.3 PRESSURE-TEMPERATURE (PT) TEST PLUGS

- A. Pressure-temperature test plugs for insertion of a pressure gauge or thermometer shall be a brass fitting with neoprene or Nordel self-sealing insert and knurled brass cap with plastic capture tab. Fittings shall be equal to Peterson “PT”. Furnish two thermometers and two pressure gauges with integral insertion stem appropriate for use with the test plugs.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Thermometers shall be installed where shown on the drawings and also at:
- B. Pressure gauges shall be installed where shown on the drawings, where required by applicable codes and also at:
- C. Thermometers and gauges shall be positioned to be read with unobstructed view from the floor. Pressure-temperature test plugs shall be installed where shown, located in a position to be most readable.
- D. Install thermometer wells in piping tees in the vertical position. Fill the well with oil or graphite and secure the thermometer in position.

END OF SECTION 23 0519

SECTION 23 0523 – GENERAL DUTY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Butterfly valves.
2. Ball valves.
3. Check valves.
4. Gate valves.
5. Balancing-Shutoff valves.
6. Globe valves.
7. Plug Valves.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- C. Sweat end valves of equal construction and features are acceptable in lieu of those specified with screwed ends. Valves of equal construction and features with ends compatible with grooved end pipe mechanical joint couplings are acceptable on such systems, and may be manufactured by the coupling system manufacturer. Grooved end valves shall conform to ANSI/AWWA Standard C-606.
- D. Butterfly valves and ball valves in piping which is to be insulated shall have extended shaft necks to accommodate the insulation.

PART 2 - PRODUCTS

2.1 See schedule on drawings.

2.2 MANUFACTURERS

A. Valves shall be as specified above, or of equal construction manufactured by:

1. Anvil
2. Apollo
3. Crane/Stockham
4. Flow Design
5. Flowserve
6. Griswold
7. Watts

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Drain valves shall be the same as for the shut-off service. Provide a ¾" hose thread adapter on the outlet of each drain valve that is not piped to a drainage point. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.
- B. Internals shall be removed and the remaining elements of sweat end valves shall be protected against heat damage during soldering or brazing.
- C. Valves shall be installed with the stem at or above the centerline of the pipe. Valves shall be located to be accessible for operation, servicing and/or removal.
- D. Packing glands shall be tightened before placing the valves in service.

END OF SECTION 23 0523

SECTION 23 0525 – FLEXIBLE PIPE CONNECTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Corrugated Metal Pipe Connectors

1.2 SUBMITTALS

- A. Product Data:
- B. Shop Drawings:

PART 2 - PRODUCTS

2.1 CORRUGATED METAL

- A. Corrugated metal pipe connectors shall be constructed of seamless corrugated inner tubing of Type 300 series stainless steel, woven wire braid outer jacket of the same alloy and flanged or grooved ends. Rated working pressure shall be safely in excess of the duty imposed. Pipe connectors shall be equal to Metraflex “MMC Metra-Mini”.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Flexible pipe connectors and piping shall be installed in accordance with manufacturer's recommendations. Piping shall be aligned (both axially and radially), movement of piping shall be confined and flange spacing set so as to not stress the connector or piping.

END OF SECTION 23 0525

(This page intentionally left blank)

SECTION 23 0529 – PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Hanger Rods and Attachments.
- B. See Division 23 Section “Metal Ducts” for duct hangers and supports.

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design seismic-restraint hangers and supports for piping and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS

- A. Hangers and supports for piping shall be equal to the Anvil catalog numbers as follows:

1. General Service – clevis type – Anvil Fig. 260.
 2. Uninsulated Copper Tubing - copper plated clevis type – Anvil Fig. CT-65 (or plastic coated clevis).
 3. Where the length of the hanger rod between the top of the hanger and the attachment is 3" or less, clevis type hangers with rollers, Anvil Fig. 181, shall be used to allow for expansion travel
- B. Hangers on insulated horizontal piping shall be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, the following shall be provided at each hanger:
1. Pipe 2" and smaller – Anvil Fig. 168 18 ga. sheet metal rib-lock shield with belled ends, 12" long.
 2. Pipe 2-1/2" and larger – pre-insulated saddle, 3 PCF polyisocyanurate. Tru-Balance Model 3300E.

2.2 TRAPEZE HANGERS

- A. Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with pipe rollers (to allow for expansion travel) and spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension.

2.3 HANGER RODS AND ATTACHMENTS

- A. Hanger rods shall be solid steel, threaded-end or all-thread rod, of diameter listed below. A hanger attachment device (for attachment to the structure) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis hanger.

- B. Pipe Hanger Rod Size Schedule

<u>Pipe Size</u>	<u>Min. Rod Dia.</u>
1" and smaller	1/4"
1-1/4" to 3"	3/8"
4" to 6"	1/2"
8"	5/8"
10"	3/4"
12"	7/8"
14" to 16"	1"
18" to 20"	1-1/4"

- C. Hanger rod attachment devices for attachment to the structure shall be:

1. After-set steel expansion type concrete inserts.

2. Beam clamps for steel construction equal to Anvil Fig. 92, 93, or 94. Utilize swivel type in sloped steel construction to provide vertical support of pipe without bending hanger rods.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Spacing of hangers shall be as follows:
 1. Steel pipe - Horizontal:
 - a. 2" and smaller – 8 ft. intervals
 - b. 2-1/2" thru 6" – 10 ft. intervals
 - c. 8" and larger – 12 ft. intervals.
 2. Copper Tubing – Horizontal
 - a. 1-1/4" and smaller – 6 ft. intervals
 - b. 1-1/2" – 2" – 8 ft. intervals
 - c. 2-1/2" and larger – 10 ft. intervals
- B. Attachment of pipe hangers to the structure shall be with:
 1. Wood lag screws.
- C. Pipe hangers shall be adjusted to proper elevation and all hanger rods set in a vertical position before pipe insulation is installed.
- D. Hanger assemblies which will remain exposed on completion of the project shall be painted before installation.

END OF SECTION 23 0529

(This page intentionally left blank)

SECTION 23 0530- EQUIPMENT BASES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Equipment Bases

PART 2 - PRODUCTS

2.1 CONCRETE BASES

- A. Concrete base pad with steel reinforcement as detailed on the drawings. Bases shall be formed on all sides and hand troweled to a smooth, dense finish with neatly chamfered corners. Large concrete pads on grade shall be constructed with reinforcing steel or reinforcing roadway mesh.

END OF SECTION 23 0530

(This page intentionally left blank)

SECTION 23 0548 – VIBRATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Vibration Isolators

1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Open Spring Isolator
 - 1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 - 2. Spring Mounts: Provide with leveling devices, 0.25 inch neoprene sound pads and zinc chromate plated hardware.
 - 3. Mason Industries Series “SLFH”
- B. Housed Spring Isolators
 - 1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 - 2. Spring Mounts: Provide with leveling devices, 0.25 inch neoprene sound pads and zinc chromate plated hardware.
 - 3. Restraint Housing: Cast steel housing with non-adjustable neoprene sponge inserts
 - 4. Mason Industries Series “C”.
- C. Neoprene Mounts
 - 1. Mount: Double deflection neoprene with a minimum static deflection of 0.35”. All metal surfaces shall be neoprene covered to prevent corrosion and have friction pads both top and bottom.
 - 2. Mason Industries Series “ND”

D. Neoprene Pad Isolators

1. Pad shall be 1” thick sandwich type consisting of a 0.5” cork center with 0.25” neoprene waffle pad top and bottom.
2. Mason Industries Series “NK”.

E. Spring Hanger

1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Housings: Neoprene in shear or double deflection LDS rubber upper and lower elements.
3. Mason Industries Series “30N”

F. Neoprene in Shear Hanger

1. Element: Double deflection LDS rubber isolator color coded for load carrying capacity.
2. Mason Industries Series “HD”.

G. Concrete Inertia Base

1. Forms: Rectangular concrete pouring forms including minimum 0.5” bars welded in place on 6” centers running both ways.
2. Templates: Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured.
3. Springs: Springs shall be as specified in Open Springs above.
4. Mason Industries Series “K” or “BMK”

2.2 MANUFACTURERS

- A. Mason Industries.
- B. Kinetics Noise Control
- C. Amber Booth

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Isolators installed outside shall be furnished weather protected with springs PVC coated and other ferrous parts hot dip galvanized or cadmium plated.
- B. Isolators for chillers, cooling towers, boilers and other equipment with significant water capacity shall be equipped with vertical limit stops.

3.2 INSTALLATION

- A. Follow manufacturer's instructions in setting and adjusting isolators. Insure that no direct hard surface to surface contact occurs. Fasten device to floor as recommended by the isolation supplier.
- B. Where electrical connections are to be made to equipment mounted on isolators, inform the Electrical Contractor to connect to the equipment with flexible conduits.
- C. See Specification Section 23 0529 Pipe Hangers and Supports for spring hanger locations and hanger installation requirements.
- D. Adjust isolators after piping system is at operating weight.
- E. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- F. Adjust active height of spring isolators.
- G. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 0548

(This page intentionally left blank)

SECTION 23 0553 - IDENTIFICATION FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment Labels.
 - 2. Pipe Labels.
 - 3. Valve Tags.
 - 4. Duct Labels.
 - 5. Controls Equipment Labels.

1.2 SUBMITTAL

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

1.3 QUALITY ASSURANCE

- A. Labels, tags and markers shall comply with ANSI A13.1 for lettering size, colors and length of color field.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Each item or major equipment shall be labeled.
- B. Labeling shall be:
 - 1. Permanently attached engraved brass or plastic laminated signs with 1" high lettering. Signs on exterior equipments shall be brass.
 - 2. Stencil painted identification, 2" high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.2 PIPE LABELS

- A. Pipe markings shall be applied to all piping.
- B. Labeling shall be:

1. Plastic semi-rigid snap-on type, manufacturer's standard pre-printed color coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl pipe markers similar to above.
 2. On piping and insulation 6" and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-coded plastic tape not less than 1-1/2" wide, full circle at both ends of the marker.
- C. Identification markings shall include service (e.g. hot, chilled, steam) and arrows indicating direction of fluid flow provided integral with the pipe marker or separate at each marker.

2.3 VALVE TAGS

- A. Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled, typewritten on 8-1/2" x 11" paper, tabulating valve number, piping system, abbreviation, location of valve (room or area) and service (e.g. – south wing reheat boxes).
- B. Valve tags shall be polished brass or plastic laminate with solid brass S hook. Tags shall be engraved with "H" for HVAC and the designated number.

2.4 DUCT LABELS

- A. Duct markings shall be applied to all ductwork.
- B. Identification markings shall include service (e.g. supply, return, exhaust, outside air) and direction of air flow provided integral with duct marker or separate at each marker.
- C. Duct markings shall be laminated plastic color-coded pressure sensitive vinyl tape, 2-1/2" width, 3 mil minimum thickness.

2.5 CONTROLS EQUIPMENT LABELS

- A. Each controls device or major controls equipment shall be labeled to match controls drawings. This shall include thermostats, switches, sensors, controllers, panels and other similar equipment.
 1. Equipment labels - Self-Adhesive, Engraved, Laminated Phenolic Label: Adhesive backed, with black letters on a white background. Minimum letter height shall be 3/8 inch.
 2. Device labels - Marker Tape: Self-laminating, clear polyester, 3/8" high tape with black lettering.

2.6 ACCEPTABLE MANUFACTURERS

- A. Labels, markings and tags shall be manufactured by:
 - 1. W.H. Brady
 - 2. Seton
 - 3. Allen
 - 4. Industrial Safety Supply

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification marking and tagging shall be applied after insulation and painting has been completed.
- B. Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled on drawings.
- C. The Plumbing, Fire Suppression and HVAC Contractors shall coordinate labeling, marking and tagging to attain coordinated and consistent systems of identification.
- D. Equipment labeling shall consist of unit designation as shown on the drawings. Exhaust labeling shall also indicate service of room or area of service.
- E. Pipe and duct markers shall be placed at 25 ft. centers in mechanical rooms and concealed spaces and at 50 ft. centers in other exposed locations.
- F. Refer to appropriate sections of this specification for installation of underground line marker tape.
- G. Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above.

END OF SECTION 23 0553

(This page intentionally left blank)

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Hydronic Piping Systems:
 - a. Constant-flow systems.
 - b. Variable-flow systems.
 - 3. Reporting results of activities and procedures specified in this Section.

1.2 SUBMITTALS

- A. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

1.3 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.
- B. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing."
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 7.2.2 - "Air Balancing."
- E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.7.2.3 - "System Balancing."

1.4 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 TAB activities.
- B. Perform TAB 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 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 - 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are 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 system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- D. Examine system and equipment test reports.
- E. 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 that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- G. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- H. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- I. Examine strainers for clean screens and proper perforations.

- J. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine system pumps to ensure absence of entrained air in the suction piping.
- M. Examine equipment for installation and for properly operating safety interlocks and controls.
- N. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated 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 multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Sequence of operation for control modes is according to the Contract Documents.
 - 6. Controller set points are set at indicated values.
 - 7. Interlocked systems are operating.
 - 8. Changeover from heating to cooling mode occurs according to indicated values.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB 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 indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of

Environmental Systems" SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2 - "Air Balancing."
- 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 insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck 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 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 functioning.
- K. Check for proper sealing of air-handling unit components.
- L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by 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 component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - 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 such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections 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 that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated 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 submain 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 submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated 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 terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use 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 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 that adequate static pressure is maintained at the most critical unit.
 8. Record the final fan performance data.
- C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 1. Balance systems similar to constant-volume air systems.
 2. Set terminal units and supply fan at full-airflow condition.

3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 4. Readjust fan airflow for final maximum readings.
 5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
 6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 7. 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.
 8. Measure 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.
- D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
 2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
 3. Set terminal units at full-airflow condition.
 4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 5. Adjust terminal units for minimum airflow.
 6. Measure static pressure at the sensor.
 7. Measure 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.

3.7 GENERAL 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 indicated 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.

3.8 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure 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. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on 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 Cv 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 indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated 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.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR 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.
 - 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 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with 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.

3.12 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to 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 Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
1. Title page.
 2. Name and address of TAB firm.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB firm who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer, type size, and fittings.
 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 15. 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- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.

END OF SECTION 23 0593

SECTION 23 0713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Fiberglass.
 - 2. Protective Jacketing

1.2 SUBMITTALS

- A. Product Data:
 - 1. For each type of product indicated.
 - 2. Thickness and covering table.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 GENERAL

- A. See schedule on drawings for location and thickness schedules.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Manufacturers

1. Johns Manville Corporation
2. Owens Corning Corp.
3. Knauf Fiber Glass
4. Manson
5. CertainTeed

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be done by tradesmen specializing in insulation work in strict accordance with manufacturer's recommendations.
- B. Blanket insulation shall be wrapped tight to the duct. Insulation shall be secured to ducts 20” wide and greater with weld pins and fasteners, 18” on center maximum. Adhesive shall be applied to the duct as an aid to installation and adhesion. Vapor barrier jacket shall be lapped, stapled and sealed with adhesive and 3” wide FSK pressure sensitive tape.
- C. Board insulation with factory applied jacket shall be secured to the duct with weld pins and fasteners, 12” on center maximum. Vapor barrier jacket shall be lapped, stapled and sealed with adhesive and 3” wide ASJ pressure sensitive tape.
- D. Ductwork which is internally lined with acoustical insulation, flexible ductwork with factory applied insulation and fiberglass ductwork need not be further insulated. Required internal lining is shown on the drawings. Refer to Section 23 3113 Ductwork and coordinate with the various trades.

END OF SECTION 23 0719

SECTION 23 0716 – EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Fiberglass.
 - b. Foam Plastic.
 - 2. Protective Jacketing

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- B. Thicknesses shall be in compliance with ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 INSULATION GENERAL

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

2.2 FIBERGLASS INSULATION

- A. Fiberglass board – 3 p.s.f. semi-rigid board with factory applied “all service” jacket.
- B. Fiberglass pipe insulation – tubular with factory applied “all service” jacket with overlapping longitudinal joints with integral seal.
- C. Vapor barrier jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.
- D. Manufactures:
 - 1. Johns Manville Corporation
 - 2. Owens Corning Corp.
 - 3. Knauf Fiber Glass
 - 4. Manson

2.3 FOAM PLASTIC

- A. Flexible closed cell foamed elastomeric insulation applied with an air dried, contact adhesive compatible with insulation.
- B. Manufacturers:
 - 1. Armstrong
 - 2. Rubatex
 - 3. Armacell International

2.4 PROTECTIVE JACKETING

- A. PVC Plastic
 - 1. One piece molded type fitting covers and sheet material, 10 mill thickness, off white color. Connection with special Z-joint closure and factory supplied snap-straps.
- B. Aluminum Jacket
 - 1. Formed aluminum sheet, 0.016 thickness, smooth finish with longitudinal slip joints and 2 inch laps. Fitting covers shall be same thickness die shaped fitting covers with factory attached protective liner.

2. Metal jacket bands shall be 3/8 inch wide, 0.015 inch thick aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fiberglass board insulation shall be secured with weld pins and fasteners, 12” on center maximum, and joints sealed with 3” wide ASJ pressure sensitive tape. Tank ends shall be blocked in with insulation, pinned, and finished with glass lagging cloth and mastic.
- B. Fiberglass pipe insulation shall be applied with sealed overlapping longitudinal joints and , if necessary, secured with staples and mastic. Butt joints shall be sealed with 3” wide ASJ pressure sensitive tape.
- C. Foam plastic insulation shall be held in place with adhesive. All joints shall be sealed with a vapor tight mastic.
- D. Aluminum protective jacket, where specified below, shall be 0.016” thick sheet wrapped around the item of equipment / tank / breeching and secured with bands. Jacket shall be applied to sides only, not the ends, of tanks and vessels. Finish cement and lagging cloth may be omitted where the jacket is applied.

3.2 SCHEDULE

- A. Cold refrigerant surfaces not factory insulated which, in operation, will be cold (evaporator tank heads, piping, etc.).
 1. 1” thickness foam plastic insulation.
- B. Air/dirt eliminator fittings.
 1. 1” thickness fiberglass board or fiberglass pipe insulation.

END OF SECTION 23 0716

(This page intentionally left blank)

SECTION 23 0719 - PIPE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Fiberglass.
 - b. Flexible Elastomeric.
2. Protective Jacketing

1.2 SUBMITTALS

A. Product Data:

1. For each type of product indicated.
2. Thickness and covering table.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Thicknesses shall be in compliance with most current version of ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 INSULATION GENERAL

- A. See schedule on drawings for system and thickness requirements.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

2.2 FIBERGLASS INSULATION

- A. Factory molded tubular fiberglass with “all service” jacket having an integral vapor barrier. Longitudinal joints of the jacket shall be overlapping with factory applied adhesive. In lieu of the factory adhesive, staples on 6” centers may be used with vapor barrier mastic applied to seal both the joint and staple holes. Butt joints shall be sealed with 3” wide ASJ pressure sensitive tape.
- B. Vapor barrier jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- C. Manufacturers:
 - 1. Johns Manville Corp.
 - 2. Owens Corning Corp.
 - 3. Knauf Fiber Glass
 - 4. Manson Insulation Inc.

2.3 FLEXIBLE ELASTOMERIC INSULATION

- A. Factory molded tubular preformed flexible elastomeric cellular rubber insulation applied with an air dried, contact adhesive compatible with insulation.
 - 1. Minimum Service Temperature: -40°F.
 - 2. Maximum Service Temperature: 220°F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- B. Manufacturers:
 - 1. Aeroflex
 - 2. Armacell International
 - 3. Rubatex

2.4 PROTECTIVE JACKETING

- A. PVC Plastic
 - 1. One piece molded type fitting covers and sheet material, 10 mill thickness, off white color. Connection with special Z-joint closure and factory supplied snap-straps.
- B. Aluminum Jacket
 - 1. Formed aluminum sheet, 0.016” thickness, smooth finish with longitudinal slip joints and 2” laps. Fitting covers shall be same thickness die shaped fitting covers with factory attached protective liner.
 - 2. Metal jacket bands shall be 3/8” wide, 0.015” thick aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be done by tradesmen specializing in insulation work in strict accordance with manufacturer's recommendations.
- B. Overlap and seal all longitudinal joints. Staples and adhesive may be used as stated above. Tape and seal cross joints. Vapor barrier shall be continuous on insulation of all cold services. Vapor barrier type mastic shall be used where needed to maintain a vapor seal.
- C. Where insulation is terminated, insulation shall be beveled at 45° and the beveled surface sealed with vapor barrier mastic. PVC caps over straight cut ends which have been vapor sealed may be used in lieu of beveling.
- D. Mechanical joint fittings and couplings shall be considered as a part of the pipe line and shall be insulated. Bidders on the insulation work are cautioned to verify during the bidding period the extent of this work.
- E. Insulation on cold service piping shall be run through floor and wall sleeves to maintain vapor barrier continuity. Insulation on other services may likewise be run continuous when sleeve size permits. Refer to Section 230529 - Pipe Hangers and Supports for non-compressible insulation material and sheet metal saddles required at pipe hangers. Coordinate with the piping contractor on the furnishing, installation and detailed requirements of these. Provide insulation and vapor barrier on and around supports for pipe risers of services which require vapor seal so as to prevent sweating.
- F. Verify that piping has been tested before applying insulation materials and that piping surfaces are clean and dry, with foreign material removed.
- G. Fittings, valves, flanges and other devices, both exposed and concealed, requiring insulation shall be covered same thickness as pipe insulation with:
 - 1. Factory molded fitting insulation cover with PVC one-piece fitting cover.
 - 2. Miter-cut segments of pipe insulation, held in place with adhesive and/or wire, filled with insulating cement smoothed to shape and covered with PVC one-piece fitting cover.
 - 3. Fiberglass blanket insulation, held in place and covered with PVC one-piece fitting cover.
 - 4. Oversized pipe insulation, where applicable, finished same as straight run pipe insulation.
- H. Protective aluminum/PVC jacketing shall be provided on exterior insulation.

END OF SECTION 23 0719

(This page intentionally left blank)

SECTION 23 0913 - INSTRUMENTS AND CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes instruments and control devices for HVAC Direct Digital Control (DDC) systems and components.
 - 1. Electronic Sensors
 - a. Thermistor Temperature Sensors & Transmitters
 - b. Humidity Sensors
 - c. Pressure Transmitters & Transducers
 - 2. Status Sensors
 - 3. Detection Equipment
 - 4. Thermostats
 - 5. Humidistats
 - 6. Actuators
 - 7. Control Valves
 - 8. Dampers

- B. Related Sections:
 - 1. Section 23 0914 – Control Wiring and Cabling
 - 2. Section 23 0923 – Direct Digital Control System
 - 3. Section 23 0950 – Variable Frequency Motor Controllers

1.2 SUBMITTALS

- A. Product Data: For each control component indicated.

- B. Shop Drawings:
 - 1. Each component shall be labeled for proposed usage and its corresponding item tag per the control drawing, diagram and sequence of operation submittal.
 - 2. Damper schedule.
 - 3. Valve schedule.

- C. Operation and maintenance data.

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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Where a list of manufacturers is not provided, products offered by the controls system contractor or their preferred vendor may be incorporated, subject to compliance with the specification.
- B. Where a list of manufacturers is provided under components below, the product shall be selected only from the list of manufacturers provided.

2.2 CONTROL SYSTEM COMPONENTS

- A. Refer to Section 23 0923 “Direct Digital Control System” for manufacturers and specifications for the DDC system, including operator workstation, distributed controllers, network requirements, accessories, control software and graphic requirements.
- B. Refer to Section 23 0914 “Control Wiring and Cabling” for power wiring, control cabling, transformers, fusing power distribution cabinets and power line filtering for the DDC system.
- C. Control system components specified in this Section include sensors, detection equipment, indicators, thermostats, humidistats, air flow measuring stations, meters, actuators, control valves and dampers.

2.3 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, pipe immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors & Transmitters:
 - 1. Accuracy: $\pm 0.36^{\circ}\text{F}$ at calibration point.
 - 2. Wire: Twisted, shielded-pair cable.
 - 3. Single Point Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 10 sq. ft.
 - 4. Averaging Elements in Ducts: 36 inches long, flexible for ducts 10-20 sq. ft. and 72 inches long, flexible for ducts over 20 sq. ft.
 - 5. Insertion Elements for Liquids: Brass or stainless-steel socket with insertion length of:
 - a. 2-1/2” for pipes 8” and smaller
 - 6. Wall Mounted Temperature Sensor:
 - a. Manufacturer's standard cover, approximately 3”W.x 5”H.x 1”D., white color, conforming to NEMA-1 requirements. UL listed. Surge immunity compliance with IEEE C62.41.
 - b. Digital LCD display for system values such as setpoints, operating mode (occupied/unoccupied/override), VAV discharge air temperature, etc.
 - c. LED override status light.
 - d. Three button keypad for temperature setpoint adjustment up/down and timed override (typical for VAV box application).

- e. Separate wiring subbase and electronics.
 - f. Unshielded twisted pair, non polarity sensitive connection to controller
 - g. RJ-45 jack for network access via PC.
 7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- C. Humidity Sensors: Thermoset polymer capacitive sensor.
 1. Accuracy: 2 % over full range with linear output.
 2. Room Sensor Range: 5 to 95% relative humidity, non-condensing.
 3. Wall Mounted Sensor:
 - a. Manufacturer's standard cover, approximately 3"W x 5"H x 1"D, white color, conforming to NEMA-1 requirements. UL listed. Surge immunity compliance with IEEE C62.41.
 - b. No LCD display or keypad, sensor only.
 - c. Separate wiring subbase and electronics.
 - d. Unshielded twisted pair, non polarity sensitive connection to controller
 - e. RJ-45 jack for network access via PC.
 4. Duct Sensor: 20 to 80% relative humidity range with element guard and mounting plate.
 5. Outside-Air Sensor: 20 to 80% relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of -22 to +185°F.
- D. Pressure Transmitters & Transducers:
 1. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2% of full scale with repeatability of 0.5%.
 - b. Output: 4-20 mA.
 - c. Building Static-Pressure Range: 0-0.25 inches w.g.
 - d. Duct Static-Pressure Range: 0-5 inches w.g.
 2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
 3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
 4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
 5. Pressure Transmitters: Direct acting for gas or liquid service; range suitable for system; linear output 4 to 20 mA.

2.4 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- 5-inches w.g.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig piped across pump.

- C. Current Switches and Relays: For status inputs for electric motors shall comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter (20A single phase) or separate relay (contacts rated for 120/240V and appropriate amperage) for higher amperage single phase and three phase motors all within a common junction box, current sensor status, adjustable status trip point, LED status indication lights and suitable for 175 percent of rated motor current.
- D. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- E. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- F. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
- G. Momentary Contact Switches:
 - 1. Momentary contact switches shall be white, wall mounted push-button type to provide digital input to the DDC system to initiate a control function.
- H. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- I. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.5 ACTUATORS

- A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1. Manufacturers: Belimo Aircontrols (USA), Inc.
 - 2. Listing: Actuators shall have ISO 9001 quality certification and be UL listed under standard 873.
 - 3. Characteristics: Actuators shall be fully modulating/proportional, pulse width, floating/tri-state or two-position as required and be factory or field selectable. Each actuator shall have visual position indicators. Proportional actuators shall accept a 0-10VDC or 0-20mA input signal with 2-10VDC and 4-20mA operating range, respectively. Actuators shall be capable of operating on 24, 120 or 230VAC or 24VDC

- and Class 2 wiring as required by the application. Power consumption shall not exceed 10VA for 120V actuators and 8 watts for DC actuators. Actuators shall be capable of being mechanically and electrically parallel to increase torque if required
4. Fail-Safe Operation: Mechanical, spring-return mechanism shall be provided on all dampers and valves except where noted otherwise. Provide external, manual gear release on non-spring return actuators.
 5. Valves: Size for torque required for valve close off at maximum pump differential pressure plus 25% safety factor.
 6. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch w.g. (of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch w.g. of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
 - g. Coupling: V-bolt and V-shaped, toothed cradle.
 7. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 8. Run Time: 12 seconds open, 5 seconds closed.

2.6 CONTROL VALVES

- A. Control Valves: Factory fabricated, of type, body material, and pressure class based on fluid system, maximum pressure and temperature rating of piping system, unless otherwise indicated.
- B. Sizing Schedule – Hydronic system control valves shall be either:
 1. Ball Valves – Piping 3” and smaller.
 2. Butterfly Valves – Piping 4” and larger.
- C. Ball Valves
 1. Body: Nickel plated, forged brass with female NPT threads, 400 psi min rating.
 2. Trim: Stainless steel ball and stem with an equal percentage flow characterizing disc, dual EPDM O-ring packing and fiberglass reinforced Teflon seats.
 3. Actuator coupling: Four bolt mounting flange to provide field changeable mounting arrangement. A high temperature non metallic coupling shall be provided for a direct mechanical connection between the actuator and the valve body while providing thermal isolation.
 4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:
 - a. Two Position: Line size.
 - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
 - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
 5. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 125 percent of total system (pump) dead head.
- D. Butterfly Valves

1. Body: ASTM A126 Cast iron or ASTM A536 ductile iron body & bonnet, fully lugged, drilled and tapped, 200 psig rated, ANSI 125/150 flanges.
2. Trim: Stainless steel polished and contoured disc, field replaceable EPDM or Buna N sleeve and phenolic backed seat with full 360-degree seating without gasket seals. Bubble tight close off shall be provided in both directions. Flow characteristic shall be modified equal percentage for two valves. Extended, stainless-steel stem with internal spline connection between stem and the disc without pins or screws. The shaft shall be supported at four locations with PRTFE bushings.
3. Sizing: 3-psig maximum pressure drop at design flow rate or the following:
 - a. Two-Position: Line size.
 - b. Two-Way Modulating: Twice the load pressure drop based on CV factors at 60°, with a maximum fluid velocity of 12 fps, but not more than value specified above.
 - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

2.7 DAMPERS

- A. Dampers: AMCA-rated, parallel and opposed blade design as required by the application.
- B. Outside air and relief air dampers (exposed to outside air) shall be severe cold option design with the following features:
 1. Frame: Extruded aluminum, 4" x 0.08" thickness with polystyrafoam insulation.
 2. Blades: Extruded aluminum, double wall profile with expanded polyurethane foam insulation filled cores and thermally broken. Insulation factor of R-2.29
 3. Seals: Blade and frame edge seals are extruded silicon, secured in an integral slot.
 4. Bearings: Celcon inner bearing fixed to a 7/16" aluminum hexagonal blade pin, rotating within a polycarbonate outer bearing without metal-to-metal or metal-to-plastic bearing contact.
 5. Linkage: Hardware mounted within the frame, aluminum and zinc plated steel construction.
 6. Operating temperature: -40 to 155°F.
 7. Leakage: 4.9 cfm/sq. ft. at 4" w.g., maximum
- C. Return and other control dampers not exposed to outside air shall be constructed with the following features:
 1. Frame: Extruded aluminum, 5" x 0.125" thickness.
 2. Blades: Extruded aluminum, airfoil profile.
 3. Seals: Blade seals shall be extruded EPDM. Frame seals shall be extruded TPE thermoplastic, secured in an integral slot.
 4. Bearings: Molded synthetic
 5. Linkage: Hardware mounted within the frame, aluminum and zinc plated steel construction.
 6. Operating temperature: -72 to 275°F.
 7. Leakage: 3 cfm/sq. ft. at 1.0" w.g. max.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify location of wall mounted sensors with drawings and room details before installation. Install devices to match rough in height of light switches provided by the Electrical Contractor, Coordinate location and placement with other wall mounted devices, cabinets, etc.
- B. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- C. Install guards on thermostats in the following locations:
 - 1. Where indicated on drawings.
- D. Automatic dampers shall be furnished by the controls subcontractor to the HVAC Contractor for installation in accordance with Section 23 3300 "Air Duct Accessories."
- E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- F. Damper linkages shall be through frame hardware; linkage attachments to blades are not acceptable.
- G. Damper jack shafting is not permitted, provide an actuator for each damper section.
- H. Install labels and nameplates to identify control components according to Section 23 0553 "Identification for HVAC Piping and Equipment."
- I. Install hydronic instrument wells, valves, and other accessories according to Section 23 2113 "Hydronic Piping."
- J. Install refrigerant instrument wells, valves, and other accessories according to Section 23 2300 "Refrigerant Piping."
- K. Install duct volume-control dampers according to Section 23 3300 "Air Duct Accessories" specifying air ducts.

END OF SECTION 23 0913

(This page intentionally left blank)

SECTION 23 0914 – CONTROL WIRING AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control wiring, both line and low voltage, transformers, power distribution, fusing and panels, power filtering and communication cabling which is required to perform the automatic control functions described.
- B. Related Sections:
 - 1. 23 0913 Instruments and Control Devices
 - 2. 23 0923 Direct Digital Control System

1.2 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. Wiring, both line and low voltage, shall comply with NEC and shall be subject to approval by the local code enforcing authorities.
- C. Wire, conduit and installation methods shall conform to applicable provisions of Division 26 - Electrical except that wiring smaller than No. 12 and conduit smaller than 3/4" are permitted as appropriate for the application.
- D. Communication cabling shall conform to applicable provisions of Division 27- Section "Communications Horizontal Cabling".
- E. All wiring and cabling insulation in air return plenums shall not exceed maximum flame spread rating of 25 and smoke development rating of 50 as established by NFPA 255 test methods.

PART 2 - PRODUCTS

- A. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1. Output ripple of 5.0 mV maximum peak to peak.
 - 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

- B. Power Line Filtering: Provide internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - 1. Minimum dielectric strength of 1000 V.
 - 2. Maximum response time of 10 nanoseconds.
 - 3. Minimum transverse-mode noise attenuation of 65 dB.
 - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

- C. Power distribution, fusing and panels:
 - 1. Power distribution transformers, fuses, termination strips etc. shall be organized in NEMA 1 enclosure panels. Panels shall be 16 gauge steel construction, with removable front cover and various size removable knockouts, arranged for surface mounting and polyester powder coat finish inside and outside, UL listed. Arrange and bundle wiring inside of panels neatly with cable ties. Panel and internal devices shall be permanently marked to correspond to power wiring diagram shop drawings provided in the operating and maintenance manual.

- D. Cabling:
 - 1. Provide CAT 5E Ethernet fiber optic cabling to interconnect major controllers and work station computer or Web server to establish the primary network configuration as determined by the direct digital control system architecture. Provide excess cabling at each connection for servicing by looping cable near the panel.
 - 2. Secondary LON or BacNet MS/TP bus wiring to secondary controllers such as unitary controllers serving VAV boxes shall be as required by the communication protocol.
 - 3. All cabling insulation shall be approved and labeled for use in air plenums where installed in these locations.

PART 3 - EXECUTION

3.1 ELECTRICAL POWER SUPPLIES

- A. The Electrical Contractor will provide a power source to motors through his starters only. Where power sources are required beyond these starters, or beyond sources explicitly shown on the electrical drawings, these shall be provided by the Controls Contractor. Where auxiliary contacts are required on starters to perform the required functions, these too shall be provided by the Controls Contractor, where not provided under the Electrical Contract. Auxiliary relays may be provided in lieu of auxiliary contacts.

- B. Electrical circuits serving direct digital or electronic control panels, transformers and other control equipment and devices shall be from the nearest appropriate electrical panel. Coordinate with the Electrical Contractor.

- C. Circuits serving control panels and transformers for low voltage service shall be independent and used for no other purpose. These shall originate from the nearest appropriate electrical panel. Circuit wiring from the electrical panel shall be included in this contract. These circuits shall be clearly identified at the panels.

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install all work in accordance with the following:
1. All wiring to be ran in a neat, workmanlike manner. All wiring to be tie wrapped or in conduit as per specifications. Wiring or conduit to be ran parallel or at right angles to building structure. Install all wiring free of sags. Bundle wiring together that follows a common path.
 2. All conduit, plenum wiring, and panels shall be supported directly from the building structure with beam clamps and bridle ring. Do not support from pipe, pipe hangers, threaded rod, ductwork, ductwork strapping or other conduit.
 3. Do not lay conduit or plenum wiring on acoustic ceiling tiles, grid members or uninsulated water piping. Conduit and wiring should be installed in such a way as to not interfere with removing ceiling tiles for above ceiling access.
 4. Do not run wiring near lighting ballasts or other high voltage devices that could cause interference.
 5. All line voltage wiring must be kept separate from low voltage wiring. Line and low voltage wiring may not be run in the same conduit. Line and low voltage wiring must be kept separate in control panels.
 6. Label all wire jackets at control panel/controller and at device with tag as shown on wiring details and flow diagrams.
 7. Observe proper polarity as shown on wiring diagrams when connecting 24VAC power and ground controllers and other devices. Note that all transformer secondary grounds must be tied to chassis ground as shown in wiring diagrams unless otherwise noted.
 8. Coordinate with General Contractor and all trades to perform rough-ins for temperature control sensors and devices.
 9. Coordinate with General Contractor and all trades to confirm mounting locations for temperature control panels.
 10. Completely seal all duct, unit and wall penetrations. Avoid ceiling penetrations if at all possible. Completely seal any ceiling penetrations that are absolutely necessary.
 11. All network communication wires shall be labeled at each controller with the designation or the controller that the communication wire originates from and terminates to
 12. Verify network communications and correct any issues.
 13. Clean all construction debris from inside temperature control panels before operation.
- B. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- C. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." All line voltage wiring and low voltage wiring (except as stated below) shall be run in conduit. Low voltage wiring concealed above accessible ceilings and in hollow walls for drops to thermostats may be run without conduit. Open wiring dropping into walls shall be run in conduit. Thermostats shall be installed on a single gang box and conduit shall be installed to extend into the plenum. Open wiring shall be bundled and supported at 3 ft. maximum intervals with a system of J-hooks or equivalent means. Open wiring in air plenums shall be rated for such use and so labeled.

END OF SECTION 23 0914

(This page intentionally left blank)

SECTION 23 0923 – DIRECT DIGITAL CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. A complete system of computer based, direct digital automatic temperature controls shall be installed under this contract as required to accomplish the sequence of control for various items of equipment and systems indicated on the drawings and as specified in Division 23.
- B. This Section includes Direct Digital Control (DDC) components, including operator work station, controller/server, equipment specific and generic controllers, I/O interface, software and graphics.
- C. See Sections 23 0913 “Instruments and Control Devices”, Section 23 0914 “Control Wiring and Cabling” for requirements that relate to this Section.

1.2 SUBMITTALS

- A. Product Data: For all hardware and software.
- B. Shop Drawings:
 - 1. Schematic air and fluid flow control diagrams, sequence of operations descriptions and points list.
 - 2. Power, wiring diagrams.
 - 3. DDC System Hardware components, including controllers, actuators, sensors, valves, dampers, cabinet enclosures, etc.
 - 4. Control System Software
 - 5. Graphics- screen examples specific to the project for AH unit, VAV box, hot water system and chilled water system.
- C. Software and firmware operational documentation.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Each control subcontractor must be an authorized temperature control contractor in the business of installing and servicing direct digital temperature control systems for over five (5) years. The bidder must have installed and successfully completed at least ten (10) DDC systems of similar size using the same hardware that is proposed.
- B. Subcontractor installation and service office must be located within 75 miles (90 minute travel time maximum) of the building site.

- C. Design and installation of the digital control system shall be performed by employees trained and certified by the equipment supplier. Electrical power work other than low voltage shall be performed by licensed electricians.
- D. The temperature controls subcontractor shall provide all necessary engineering support for a complete and functional system, including but not limited to engineering, programming, installation, supervision, commissioning and troubleshooting.
- E. 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.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

- A. Contractors:
 - 1. Alerton.
 - 2. Delta
 - 3. Honeywell International Inc Authorized Controls Integrator (ACI) (local authorized contractors only, branch office is not acceptable)
 - 4. BuildingLogiX
- B. Complete BacNet MSTP DDC system shall consist of operator workstation, sensors, indicators, actuators, final control elements, interface equipment, wiring, cabling, power supplies and power distribution, other apparatus, accessories, software and graphics connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems as specified here and in related Division 23 Sections.

2.2 LICENSING AGREEMENT AND OPEN PROTOCOL

- A. A true Open Licensing Agreement shall be provided and executed with the Owner to permit total and open access to the system for servicing and software revisions by other qualified servicing contractors.
- B. The supplied system must incorporate open protocol with the ability to access all data using Java base Web enabled browsers without requiring proprietary operator interface and configuration programs.
- C. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a server. Proprietary database and user interface programs are not acceptable (except for unitary controllers as noted below).

- D. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995, BACnet to assure interoperability between all present and future system components is required.
- E. Proprietary programming shall not be utilized. In addition, all required programming software and graphics shall be embedded in the server or controllers without the need for external software to execute queries or revisions. All graphics shall reside in the server. Remote access via LAN or Web shall not require external software to provide complete access to all data, graphics, alarms, programming, etc.

2.3 DDC ARCHITECTURE

- A. DDC system shall be complete with an Operators Workstation/Server, Configurable Controllers, Unitary Controllers, required I/O modules for controller expansion, communication cards in controlled devices such as chillers, variable frequency drives (furnished with the equipment, coordinate card requirements), arranged for a completely integrated building automation system network.
- B. Physical connection of BACnet network controllers shall be via Ethernet/Ethernet IP using the Owner's Local Area Network (LAN).
- C. Where data drops are not shown for the Configurable Controllers or Operator Station/Server, the temperature control subcontractor shall be responsible to provide the IP data drop to each network controller location for controller connectivity. Installation shall be subcontracted to the division 27 technology contractor; coordinate connection requirements. In addition, provide an additional IP data drop to each controller, or group of controllers to provide local access to data acquisition for the HVAC service technician.
- D. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
- E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.
- F. DDC system accessibility over the LAN or the Internet shall be user name and password protected. Provide separate user name/password for multiple level hierarchy to restrict access to appropriate personnel at the different levels (view, programming, etc.). The system must be set up to have at least 3 access levels: guest, user and administrator. Guest privileges shall be limited to view only. Users shall be able to make setpoint and schedule changes. Administrators shall have all privileges as users in addition to being able to assign passwords.

2.4 OPERATOR WORKSTATION/SERVER

- A. An operator workstation/server shall be provided to effectively program, manage and access DDC information from all of the controllers. Interface shall utilize dynamic color graphics of each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- B. All DDC information shall be accessible through the server over the LAN as well as over the Internet via Ethernet IP.
- C. Operator Workstation/Server Computer: Equal to Dell Studio XPS 630.
- D. Minimum Requirements (or equivalent):
 - 1. Processor: Intel Core 2 Duo.
 - 2. Ports/Jacks: (6) USB 2.0, (2) IEEE 1394a, headphone, microphone, 19-1 media reader, (1) RJ-45, 2.1 audio, S video in/out, S/PDIF optical
 - 3. Random-Access Memory: 2GB Dual Channel DDR2 SDRAM.
 - 4. Monitor: 20" wide screen, WSXGA resolution, 5ms pixel display rate, 720p high definition display flat panel.
 - 5. Graphics: Intel GMA 3100
 - 6. Hard-Disk Drive: 160 GB .
 - 7. 48X combo optical drive.
 - 8. Communications: Integrated Gigabit Ethernet (10/100/1000Base-T), internal WiFi 802.11 a/b/g/n Draft 2.0
 - 9. 10W Stereo Speakers
 - 10. Operating System: Microsoft Windows
 - 11. Keyboard.
 - 12. Mouse: Three button, optical.
 - 13. Six outlet surge protector.
 - 14. Printer: Laser jet type, B&W, 8Mb RAM equal to HP LaserJet 1022
 - 15. Workstation desk and chair will be provided with loose furnishings by others.
- E. The server shall provide integrated control, supervision, data logging, alarming, scheduling and network management functions. The controller/server provides the Internet connectivity and Web serving capabilities, presenting real time information in Web based, rich graphical displays for the system. Application control programs to provide: Calendar functions, Scheduling, Trending, Alarm monitoring and routing, and Time synchronization.
- F. Proprietary programming shall not be utilized. In addition, all required programming software shall be embedded in the server or controllers without the need for external software to execute queries or revisions. All graphics shall reside in the server. Remote access via LAN or Web shall not require external software to provide complete access to all data, graphics, alarms, programming, etc.
- G. The server shall support standard Web browser access via the Intranet/Internet.
- H. Provide and maintain an Audit Log that tracks defined activities on the system. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached a user-defined buffer size. Archive the log locally. For each log entry, provide the following data: Time and date, User ID, Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

- I. The controller/server shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval. Copies of the current database and the most recently saved database shall be stored in the server. The age of the most recently saved database is dependent on the user-defined database save interval. The controller/server database shall be formatted to allow for user viewing and editing, if desired.

2.5 CONFIGURABLE CONTROLLERS/SERVERS

- A. Individual configurable controllers shall be provided for each central HVAC equipment or system (AH unit, boiler, chiller, etc.). Distributed HVAC equipment, such as air control box terminals, fan coils, unit heaters, etc may utilize local, unit specific controllers.
- B. Controllers shall be capable of functioning in either a standalone capacity or integrated into the building network.
- C. Controllers shall be fully configurable type with both control and server capabilities including integrated control and management of external devices, supervision, data logging, alarming, scheduling, network management functions, Internet connectivity, web serving. The controller shall include software technology capable of integrating a variety of devices, interoperable networks and protocols such, BACnet, etc into a seamless operating platform.
- D. The controllers shall be expandable by the use of input/output I/O modules to provide additional points beyond resident points provided on the controller module.
- E. Each configurable controller shall include the following minimum hardware features. Where required for functionality provide additional communication cards, memory cards or I/O modules: Two (2) Ethernet Port -10/100 Mbps, One (1) RS-232 port, One (1) RS-485 ports (BacNet MS/TP), BACnet driver (Ethernet and Ethernet IP), Power Supply 24V power supply module, Battery Backup, 64 Mb flash memory for long term data backup and 64 Mb RAM.
- F. I/O modules shall connect to the controller with a single multi pin plug, powered through the controller with a minimum of eight (8) universal inputs, four (4) analog outputs and four (4) relay outputs, Form A contacts. Do not exceed maximum I/O modules recommended by the manufacturer.
- G. The controller/server must be capable of operation over a temperature range of 0 to 50°C and storage temperatures of between 0 and 70°C. The controller/server must be capable of operation over a humidity range of 5 to 95% RH, non-condensing.
- H. The controller/server shall support standard Web browser access via the Intranet/Internet.
- I. Where acting as a server, provide and maintain an Audit Log that tracks all activities performed on the controller/server. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the controller/server), to another controller/server on the network, or to a server. For each log entry, provide the following data: Time and date, User ID, Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

- J. The controller/server shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval. Copies of the current database and, at the most recently saved database shall be stored in the controller/server. The age of the most recently saved database is dependent on the user-defined database save interval. The controller/server database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.
- K. Controllers shall be fully programmable with “drag and drop” graphic representations of control algorithms and easy to use “wizards” that automate controller configurations.
- L. Controllers shall be “Native” BacNet devices with interoperable native BacNet, IP, and MS/TP communication support.
- M. Each controller with I/O modules shall include input/output capabilities with, as a minimum, sufficient universal inputs, digital inputs, universal outputs and digital outputs to perform the required function and include an additional spare two (2) universal inputs, (2) analog outputs and two (2) relay outputs for future upgrade capability (spare points are not required for unitary controllers).

2.6 UNITARY CONTROLLERS

- A. Controller designed specifically for VAV reheat box terminal units, fan coil, unit heater, etc., shall be used for each distributed HVAC equipment item. Local controllers shall be capable of functioning in either a standalone capacity but shall be integrated into the building network.
- B. Use of a dedicated network with a proprietary communication protocol that is compatible for integration into the configurable controllers is acceptable provided the unitary controllers use true peer to peer communication for all devices, the communication network uses simple non polarity sensitive twisted pair wiring and the network provides for interoperability between devices and controllers such as Echelon LonWorks is acceptable.
- C. For VAV reheat box terminal units:
 - 1. The controller shall include where required a digital communications to wall sensor, velocity pressure pneumatic input via polyethylene tubing for supply air flow reading, supply air sensor, flow balancing software (damper adjustment, set point monitoring and adjustment, flow validation and calibration, sequence/calibration/control set point logs)
 - 2. Damper actuator shall be separate from the VAV reheat box controller; integrated controller/actuator devices are not acceptable.
 - 3. The remote wall sensor shall include a communication jack for connecting a laptop to the box controller for air/water balance purposes.
 - 4. Integral controller/damper actuator are not acceptable, provide separate controller and damper actuator devices for this purpose
- D. Controllers used for remote temperature and humidity sensing, adjustment and override such as VAV box controllers and fan coil units shall include S-link communication via two wire, unshielded cable (non polarity sensitive) to provide power and communication interface for remote sensors.

2.7 CONTROLLER ENCLOSURE AND LISTING

- A. Controllers shall be placed within enclosures that conform to NEMA-1 construction and shall further meet UL 94-5V flammability ratings for plenum application use.
- B. Each controller shall be UL-916 listed and meet FCC Part 15 Class A.

2.8 GUI DISPLAY FRAMES

- A. The system must be set up to have at least 3 access levels: guest, user and administrator. Guest privileges shall be limited to view only. Users shall be able to make setpoint and schedule changes. Administrators shall have all privileges as users in addition to being able to assign passwords.
- B. Each AHU, heating water system and cooling system shall have a minimum of 5 graphic screens available from the tree view. One screen shall display the airflow pattern with all dampers, coils and fans shown in their correct schematic location and dynamic data for all input values shown. This main graphic screen shall show the control devices in mechanical flow diagram format with directional arrows to indicate normal flow arrangement. These screens shall be available to anyone with access to the system, and therefore shall be view only. Another screen shall display text information with the following primary categories: Unit status, temperatures, heating, cooling, economizer, static pressure, supply fan, exhaust fan including setpoints. A loop tuning screen shall also be furnished for each control loop, so that people with the appropriate access can change loop tuning parameters from PCs without needing individual programming tools. Override screens shall be furnished for each controller to permit overriding control points without the need for vendor specific software. An alarm screen shall also be furnished each AHU. The Heating systems and Cooling systems shall have similar screens as the AHUs. Each VAV shall have a graphics screen and a text screen. Systems that won't permit creating these customized screens as described herein will not be acceptable. Systems that use controllers that won't permit overrides of inputs and outputs from a browser based graphic screen will not be acceptable.
- C. All shapes shall be 3-D with a common perspective. All dampers shall have a minimum of 4 animation levels to show partially open, half open, mostly open, fully open, and closed position of dampers. All analog inputs shall show the actual value and engineering units on the graphic screen. Binary inputs shall be linked to flashing animated displays. Safety alarms will flash when in alarm. Filter status shall be indicated when value indicates that they are dirty. To prevent clutter on the graphic displays, symbols will only be shown for equipment that is controlled or monitored by the DDC system. Also, normal status for safeties will not be indicated, and normal status for safeties will be indicated by an image of a clean filter. Pumps and fans shall rotate when flow is proven by a monitoring device. Coils shall change color when valves are open to permit water flow through the coils.
- D. Graphics shall use common color schemes to make the overall system easy to understand. All overall backgrounds shall be white. All text shall be black. Any value that is in alarm shall have a red background. Any value that is overridden shall have a blue background. All like sensors shall be the same color. For example, all temperature devices shall be yellow, all pressure devices shall be purple, all humidity devices shall be teal, all fire alarm devices shall be red, and all CO2 devices shall be green.

- E. Current setpoints and occupancy status shall be shown at the bottom of each graphic screen.
- F. Floor plan drawings shall be provided, and permit access to each zone's individual floor plan sections. On the individual floor plan sections, room numbers and room temperatures shall be displayed. Values that are out of the acceptable range shall appear in a different background color and / or flash. Each VAV shall have its own graphic that contains the points from within its controller including the box flow setpoint, room temperature setpoint, maximum cooling flow setpoint, minimum cooling flow setpoint, and minimum heating flow setpoint, plus the discharge air temperature from the AHU supplying the unit. The VAV text screen shall have the same information as the graphic screen plus high and low flow calibration values, damper rotation adjustment (CW or CCW), and air balance set-up features. GUI shall permit operator the ability to enable, set or disable high and low occupied and unoccupied limits for each room temperature reading.
- G. Text Screens shall be available for all levels of access. Setpoint and output values are changeable from the text screen for users with appropriate access privileges and administrators, but not guests. When a value can be overridden or edited, a red box shall appear around it when the cursor is position on it. A single click of the mouse shall bring up pop up menu that provide options to make a permanent override, change setpoint, or release a previous override of an output point. Analog inputs shall have pop up menus that allow setting high and low alarm limits and the ability to enable and disable alarm limits as appropriate for the sensing device. Pop up menus must be customized to include a description of the point that is being modified. Generic override menus are not permitted because they would not describe to an operator what is about to be modified. The Control Contractor shall set up all initial alarms as indicated in the point matrix.
- H. Text screens shall include schedule information including current state and date and time of next scheduled event. Positioning the mouse over the current state shall permit single click access to the schedule. The schedule screen shall allow the operator to edit a yearly, weekly, daily, holiday or special event schedule for the system being viewed. Temperature values and setpoints shall be displayed below the schedule information, and shall have a minimum of 1 decimal place. Heating, cooling and damper outputs shall be displayed next. The OA temperature for economizer switchover shall be displayed and adjustable from the text screen. Air flow readings shall be shown with setpoint and actual readings. Fan information shall be shown next, followed by static pressure readings and setpoints, which shall have a minimum of 2 decimal places. Miscellaneous setpoints including night setback cooling and heating, average zone temperature, return air warm-up and cool-down, dehumidification, and unoccupied mixed air temperature setpoints shall all be shown and adjustable. All safeties shall be shown, followed by coil pump control information.
- I. Each system shall have its own specific alarm screen available to all operators but only editable by operators with user and administration access privileges. From the alarm screen, users and administrators shall be able to enable and disable alarms. Points that are in alarm shall have an alarm symbol highlighted in red. Points that are not in alarm shall be shown in gray. Alarms that are disabled shall have a way to indicate this on the alarm screen graphic.
- J. Loop tuning screens shall be available through the web browser interface to save the owner the cost and time associated with using vendor specific software for tuning loops. Access to these screens shall not be provided to guests. Air handling units shall have dedicated screens for discharge air temperature, static pressure, and outside air control loops. Loop tuning screen for discharge air temperature shall include the discharge air temperature, discharge air temperature

setpoint, cooling loop throttling range, I-gain and ramp time, heating loop throttling range, I-gain and ramp time, economizer loop throttling range, I-gain and ramp time, unoccupied heating loop throttling range, I-gain and ramp time, cooling valve output, heating valve output, and damper control output. Screens shall also have graphs that show 5 minutes of live data for the discharge air temperature, setpoint, cooling valve, heating valve and mixed air dampers. Each loop tuning screen shall include the appropriate throttling range, I-gain and ramp time.

- K. Each non-unitary controller shall have an override screen. These screens shall be available on-site for use during point-to-point check-out and commissioning. The override screen shall show the inputs and outputs for each controller with the points in their wired location. Unused points shall be shown as spares. Points that are in alarm shall have a red background, and points that are overridden shall have a blue background just as on other screens. These screens shall show the actual values that come back from the controller, not the values that may have been typed in for override at the GUI if the controller software is not accepting the override value. The override screen shall also permit timed overrides.
- L. Each AHU shall also have an overview screen listing every VAV terminals data in a text format that includes occupancy mode, room temperature, room setpoint, box flow, flow setpoint, temperature leaving VAV terminal, % cooling and % heating. Also, each VAV AHU shall have an air balance screen that will permit balancing the system through a computer connected to the Ethernet or directly to the appropriate BC without vendor specific software. The air balancing screens shall permit at least 8 manual override commands: normal, position (%), flow value, flow percent, open, close, min flow, and max flow.
- M. Heating systems and cooling systems with multiple pieces of equipment such as pumps with lead-lag control shall display which device is lead and when the other device will become lead on the text screen.
- N. Although only one outside air temperature sensor is needed per building, the GUI shall use independent outside air temperature points, so that during check-out and commissioning, the outside air temperature for a system can be changed without changing the outside air temperature for the whole building. The GUI shall also have a global outside air temperature point that can be overridden from the screen for the controller where the point is physically connected. Overriding this outside air temperature value will change it for all systems, except when outside air temperature has been overridden for an individual system.
- O. The system shall allow for the easy development and editing of dynamic graphics. Wizards shall be utilized to assist the operator with their manipulation of the graphic system. The operator shall be able to, through a single mouse function, select between the dynamic display mode and the graphic edit mode for the currently viewed graphic frame, assuming appropriate access level is provided to the operator. Systems requiring multiple mouse or operator keyboard commands to enter the graphic edit mode are not desirable and require thorough definition of steps involved to accomplish function.
- P. Animation of system data shall be provided via graphic elements on the display frames. Standard graphic element library shall be provided to assist the operator with their implementation. The ability to define and add new animated graphic elements shall be provided. As a minimum, the ability to move, size, draw, arrange, align, layer, space, rotate, invert, duplicate, cut, copy, paste, erase any animated element shall be provided. System parameters and setpoints shall be assignable and modifiable by the animated graphic elements, relieving the need for keyboard commands for system manipulation.

- Q. The ability to simultaneously display a dynamic X/Y chart of selected points, shall be provided. The chart shall be an element of the graphic display and shall automatically update with the display data. The chart shall allow for dynamic manipulation to modify the range, rate, and timeframe of view, in both a real-time as well as historical configuration. A minimum of 4 values shall be included on any chart display element. There shall not be a limit to the quantity of chart elements displayed on a graphic frame. Trace colors and X values shall be User configurable. Systems not providing this capability are required to provide an equivalent charting package with the GUI offering.
- R. The ability to provide graphically displayed global scheduling and editing functions shall be provided. The ability to link these functions to the associated equipment or zone frames shall be a standard feature. A calendar shall be provided for display and modification of the SDC time clock functions. The User shall be able to view a daily, weekly, monthly, annual, special or holiday schedule from a defined display frame. A list of served areas shall be displayed on the same screen, this list shall be displayed at all times, pull down menus or other means of accessing these areas shall not be acceptable. The system shall have a master override screen that will allow an operator to change the schedule for every piece of equipment in every building by changing the master schedule.
- S. All analog values shall be trended every 15 minutes. The trend samples shall be saved in the BC for at least 36 hours. Access to trended data shall be available by the single click of a mouse on the analog value. Systems that open other windows and require a selection of the desired data are not acceptable.

2.9 GUI ALARMING

- A. The GUI shall provide, as standard, alarm annunciation of system data. On every display frame, the ability to view, acknowledge, delete and manipulate real-time and historical alarms shall be provided. The ability to provide a unique and custom alarm display for every display frame shall be provided. The ability to continuously or upon request, view the alarm display, shall be provided.
- B. Alarm conditions shall be capable of invoking, as a minimum; a display frame, an email message, a text message sent to a pager or cellular phone.
- C. Alarm logging shall be provided in a user definable configuration. All alarms shall be displayed and/or routed as follows, as a minimum; GUI display frame, local printer, server printer, client printer, logged to file, and archived in standard format for information management. Alarm groupings shall be hierarchical in nature allowing up to 8 alarm groups and 16 sub-groups. The GUI shall not possess any limits on the quantity of alarms that can be logged, including historical data archiving. Systems possessing limits must define the restrictions and may not be acceptable.
- D. Provide up to 999 alarm priorities with up to 5 alarm color changes, per priority, according to alarm status.

2.10 GUI TRENDING

- A. The GUI shall automatically perform time based, user defined, periodic collection of real time point data. The data shall be presented as an X/Y chart in the display frame. The data shall be stored and archived in a file format that allows for the manipulation and utilization of the data by third party applications.
- B. A dynamic trend shall be defined as a group of at least 4 data points, with a circular buffer of 2000 data points. A historical trend shall be defined as a group of at least 8 data points, with the sampled points limited only by archival disk space. Sampling rates shall be user selectable from instantaneous (one per second) to once a week. Collection of data shall be user selectable to start and stop on a specific time and date. There shall be no limit to the number of X/Y charts within a display frame.
- C. X/Y charting and column and row reporting shall be an integral part of the system. All points shall be chartable or reportable. Analytical data shall be displayed for any of the selected points in a clearly displayed X/Y chart. This analytical data shall consist of at least the following: Average Mean, Standard Deviation, Simple Average, Current Value, Cycle Length, Cycle High and Cycle Low.
- D. X/Y charting shall provide for the following chart manipulation: display, zoom, scroll, centering, pen legend and export to Excel, Text via Dynamic Data Exchange.

PART 3 - EXECUTION

- 3.1 Furnish a complete set of shop drawings showing the kind of control equipment for each of the various systems and their functions, along with indication on the drawing of all original setpoints and calibration values and set up parameters, and sequence of operation and also that of the automation system. These drawings shall be submitted for approval to the Engineer, together with a complete brochure describing the equipment and their function and operation.
- 3.2 The control equipment supplier shall submit a detailed outline of the owner training material for review and comment by the Engineer during the shop drawing phase. The control system training program shall be customized to reflect the systems installed under this contract and shall cover, as a minimum: software navigation (via custom graphics and Windows based icons), system architecture, pass wording and system security features, input/output control functions, alarm functions/acknowledgement, trending/long term reporting, and control component operation.
- 3.3 Upon completion of the project, furnish and turn over to the Owner and Architect (3) complete sets of brochures describing the various items of equipment, their functions and directions for operation and maintenance.
- 3.4 Upon completion of the control system, the Control Contractor shall adjust all components of the system. ATC Contractor shall make all adjustments in the control system required and as directed by the air balance contractor to achieve the desired air balance quantities. All instruments shall be carefully calibrated and each control function shall be demonstrated to function properly, to the satisfaction of the Engineer and the Owner. Provide a complete instruction manual covering the function and operation of all components. At the time of demonstration, each function shall be simulated to insure that controls respond properly to all signals, and the Owner shall be instructed in the proper operation of the system.
- 3.5 In addition to the adjustments and fine tuning, the Contractor shall include as a part of this contract an additional 40 hours of service technician time for work as directed or authorized by the Engineer to make software changes or field adjustments to hardware.
- 3.6 During the first year of operation, after acceptance by the Owner, the Control Contractor shall provide complete service to adjust or assist the Owner in adjusting the equipment to obtain optimum performance from the control equipment and from the heating and air conditioning systems in general. This shall be done without additional expense to the Owner. This work shall include revisions to DDC software programs and controller programs, and all PC front end software upgrades. All software shall be provided to the Owner in disk form, including backups of final field programs.
- 3.7 The control equipment manufacturer shall provide instruction and training of the Owner's personnel regarding the hardware and software of the system. Software training shall include programs, methods of programming, control loops, scheduling and reports. Training covering

hardware shall include operation information, functional use, wiring diagrams and schematic diagrams necessary to troubleshoot the operating system. Training shall include “hands on” instructions to completely familiarize Owner’s personnel with the equipment and system. Training of Owner’s personnel shall be equal in scope and detail to that provided by the manufacturer to its service technicians.

3.8 TRAINING

The control equipment supplier shall provide 16 hours of instruction at the job site to familiarize the Owner’s personnel in the application and details of the installed system. Site training classes shall not be scheduled for longer than 4 hours duration except at the discretion of the Owner.

3.9 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 6. Test each system for compliance with sequence of operation.
 - 7. Test software and hardware interlocks.
- C. DDC Verification:
 - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 - 2. Check instruments for proper location and accessibility.
 - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 - 4. Check instrument tubing for proper fittings, slope, material, and support.
 - 5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 - 6. Check temperature instruments and material and length of sensing elements.
 - 7. Check control valves. Verify that they are in correct direction.
 - 8. Check dampers. Verify that proper blade alignment, either parallel or opposed, has been provided.
 - 9. Check DDC system as follows:

- a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

END OF SECTION 23 0923

SECTION 23 0950 – VARIABLE-FREQUENCY MOTOR CONTROLLERS (VFD's)

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes solid-state, pulse-width modulated (PWM), variable frequency controllers (VFD's) for speed control of three-phase, squirrel-cage induction motors.
- B. VFD's shall be furnished where noted on the drawings or in the specifications. Provide a VFD for each motor except for supply or return fan wall applications where a single VFD is acceptable when so noted in the AH unit schedule.
- C. VFD's shall be furnished by the HVAC contractor to the Electrical Contractor who will mount the VFD and shall install power wiring required for the installation.

1.2 SUBMITTALS

- A. Product Data: For each type of VFD.
- B. Shop Drawings: For each VFD.
 - 1. Include wiring diagrams.
 - 2. Indicate all accessories required for interface with building automation system for proper operation and control of the motor each drive serves.
- C. Field quality-control test reports.
- D. Operation and maintenance data.
- E. Indicate on the VFD submittals that they have been reviewed and coordinated with the direct digital control system to ensure that all necessary components and accessories are included for proper motor operation and control sequence.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.
- B. Comply with NFPA 70.
- C. Comply with IEEE Standard 519, Special Applications for Line Notching and Distortion. The manufacturer shall include any additional equipment to meet this requirement, including, AC line filter(s) of the RLC type and/or isolation transformer, or both to meet full compliance.

1.4 COORDINATION

- A. Coordinate features, accessories, inputs/outputs and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB (ACH 550 Series).
 - 2. Yaskawa (Z1000 Series).
 - 3. Square D (“S-Flex” Series).
- B. All variable frequency drives required for the HVAC systems shall be from a single manufacturer.

2.2 VARIABLE FREQUENCY CONTROLLERS

- A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
 - 1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.
- B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Output Rating: 3-phase; 6 to 60 Hz.
- D. Unit Operating Requirements:
 - 1. Input ac voltage tolerance of plus or minus 10 percent.
 - 2. Input frequency tolerance of 60 Hz, plus or minus 6 percent.
 - 3. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - 4. Minimum Displacement Primary-Side Power Factor: 96 percent.
 - 5. Overload Capability: 1.1 times the base load current for 60 seconds; 150 percent peak.
 - 6. Starting Torque: 100 percent of rated torque or as indicated.
 - 7. Speed Regulation: Plus or minus 1 percent.
- E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range with input signal type as coordinated with temperature control contractor as applicable.
 - 1. Electrical Signal: 4 to 20 mA at 24 V or 0-10 VDC.

- F. Internal Adjustability Capabilities:
1. Minimum Speed: 10 percent of maximum rpm.
 2. Maximum Speed: 100 percent of maximum rpm.
 3. Acceleration: 1 to a minimum of 600 seconds.
 4. Deceleration: 1 to a minimum of 600 seconds.
 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- G. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
 2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, 150 percent of rated current.
 4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 5. Instantaneous line-to-line and line-to-ground overcurrent trips.
 6. Loss-of-phase protection.
 7. Reverse-phase protection.
 8. Short-circuit protection.
 9. Motor overtemperature fault.
 10. Power loss ride-thru (2 seconds).
- H. Automatic Reset/Restart: Attempts no less than three and no more than five restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- I. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- J. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- K. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- L. Input Line Conditioning: As required to comply with IEEE 519.
- M. VFD Output Filtering: As required to comply with IEEE 519.
- N. Face-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control.
- O. Indicating Devices: Meter(s) or digital readout device(s) and selector switch, mounted on face of controller and connected to indicate the following controller parameters:
1. Output frequency (Hz).
 2. Motor speed (rpm/Hz/percent, selectable).

3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Elapsed Time Meter (hrs)
 7. Fault or alarming status (code).
 8. PID feedback signal (percent).
 9. DC-link voltage (VDC).
 10. Set-point frequency (Hz).
 11. Motor output voltage (V).
 12. KW.
- P. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC control systems:
 - a. 0 to 10-V dc
 - b. 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Keypad display for local hand operation.
 3. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).
 4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of any available programmable setting.
 5. Embedded communications protocol and interface communications card for LonWorks, BACnet or Ethernet/IP, as required by the temperature control contractor for the direct digital control system provided.
- Q. Communications: Provide an RS485 interface allowing VFD to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFD to be programmed via the direct digital control system. Provide capability for VFD to retain these settings within the nonvolatile memory.
- R. Drive enclosure shall incorporate an integral motor circuit protector circuit breaker or disconnect switch.

- S. Manual Bypass: Not required except where noted otherwise on the drawings
- T. Isolating Switch: Provide load break switch arranged to isolate VFD from supply source with lock-out provisions.
- U. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3 MULTIPLE MOTOR CONTROL

- A. Where plans/schedules indicate a single VFD for control of multiple motors, the VFD shall be Manufacturer's Model/Series designed for multiple motor application and shall be sized appropriately for the sum of motors Full Load Amps (Horsepower) to be started/controlled simultaneously. The VFD shall include, within its enclosure:
 - 1. Separate, adjustable electronic overload or thermal overload protection for each individual motor to be controlled.
 - 2. Separate, integral motor circuit protector or disconnect switch for each individual motor to be controlled.
 - 3. Separate power terminals for each individual motor to be controlled.

2.4 ACCESSORIES

- A. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to VFD (NEMA 1 enclosure) before shipping.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.
- B. Select horsepower rating of controllers to suit motor controlled.
- C. Provide complete wiring diagrams for use in interfacing with the equipment. Include these diagrams with the shop drawings.

3.2 INSTALLATION

- A. VFD's will be furnished by the HVAC contractor and turned over to the Electrical contractor for mounting.

3.3 IDENTIFICATION

- A. Identify VFD's, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.4 CONTROL WIRING INSTALLATION

- A. Power wiring between the electrical distribution panel and the VFD as well as the wiring between the VFD and motor shall be installed by the Electrical Contractor.
- B. Control wiring shall be provided by the temperature control subcontractor.
- C. Bundle, train, and support wiring in enclosures.

3.5 FIELD QUALITY CONTROL

- A. Prepare for equipment start up as follows:
 - 1. Test insulation resistance for each supply and feeder circuit. Ensure that leads are not connected to VFD when meggar testing so as not to damage equipment components.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following for equipment start-up:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Ensure that all accessories, components, motor control parameters and programming capabilities are available and set for the required control sequence and are coordinated.
 - 2. Coordinate the Manufacturer's Field Service Rep site visit to ensure all interested parties are present for equipment startup and verification of all control and setup parameters.

3.6 DEMONSTRATION AND INSTRUCTION

- A. Demonstrate the operation of the variable frequency drive to the Owner's representative and provide complete instruction and training for the equipment. Demonstration shall include the use of bypass switch where provided, interface and control strategies and basic troubleshooting.

END OF SECTION 23 0950

SECTION 23 2113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes materials and methods for hydronic piping. Included in this Section are the following:
 - 1. Pipe, Fittings and Joining Methods.
 - 2. Unions and flanges
 - 3. Dielectric Connectors
 - 4. Makeup-water piping.
 - 5. Pipe sleeves, openings, curbing and escutcheons
 - 6. Installation methods of piping
 - 7. Pipe Testing
 - 8. Pipe cleaning
- B. Refer to other Sections in Division 23 for selection of piping materials for the various services. Piping materials and installation methods peculiar to certain individual systems are specified in Sections related to those systems.

1.2 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pipe and fittings.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- B. Welders shall be qualified and fully certified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- C. Welding procedures and testing shall comply with ANSI Standard B31.1.0 Standard Code for Pressure Piping, Power piping and The American Welding Society Welding Handbook.
- D. All pressure piping systems regulated by the Ohio Pressure Piping Systems Code, Chapter 4101:8 shall conform to applicable requirements of the Code. Welders shall carry a current State of Ohio, Pressure Piping Board Certification. Each welder shall submit a copy of their signed performance qualification record to the Engineer for approval prior to beginning work on any pressure piping system.

1.4 PIPE SLEEVES

- A. Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all floor slabs, poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and allow for expansion, contraction and normal movement of the pipe. Sleeves are also required for all existing piping related to the various trades in new walls, partitions, floors and roof slabs, same as for new piping.
- B. Sleeves are not required in the following:
 - 1. In floor slabs on grade.
 - 2. In stud and gypsum board or plaster walls and partitions which are not fire rated.
 - 3. For uninsulated pipe passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions.
 - 4. In core drilled openings in solid concrete not requiring water protection. Sleeves are required, however, at core drilling thru hollow pre-cast slabs and concrete block walls, to facilitate containment of required firestopping material.
 - 5. In large floor openings for multiple pipe and duct risers which are within a shaft, unless the opening is to be closed off with concrete or other material after pipe are set.
- C. Where pipes penetrate walls and floors other than those required to be fire rated, the annular space between the sleeve, core drilling or opening and the pipe insulation shall be closed to retard the passage of smoke.

PART 2 - PRODUCTS

2.1 See piping systems schedule on the drawings for application.

2.2 PIPE SLEEVES

- A. Schedule 40 black steel pipe or 18 gauge galvanized steel in poured concrete floors, walls and roof decks.
- B. 26 gauge galvanized sheet or Schedule 40 clack steel pipe in the other than poured concrete.
- C. Cast iron pipe or Schedule 40 galvanized steel pipe in exterior walls below grade, with intermediate wall stop and anchor collar set in place before concrete pouring. Sleeve shall be a part of the sealing assembly. When the wall opening is core drilled the wall sleeve may be omitted. A mechanically compressed EPDM rubber modular seal assembly providing cathodic separation, reinforced nylon polymer pressure plates and corrosion resistant treated bolts and nuts shall be placed in the annular space between pipe and sleeve or core drilling.

- D. Galvanized sheet metal for existing pipes passing thru new poured concrete floors (18 gauge) and thru new walls and partitions (26 gauge)
- E. Combination pre-set floor sleeve and firestopping assembly equal to Hilti CP 680.
- F. Concrete curbs shall be formed and poured around multiple pipe risers in above grade mechanical rooms Curbs shall be 4” wide x 4” high with chamfered corners. Pipe sleeves shall be as described for normal areas or extended to the top level of the curb where the concrete is full depth throughout the curbed area.
- G. Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished rooms and areas where pipes penetrate walls, floors, ceilings or overhead structure.

PART 3 - EXECUTION

3.1 PIPING

- A. Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.
- B. Piping shall be pitched for drainage. The low points shall be fitted with a ¾” drain valve (with hose thread adapter if not piped to a floor drain) except that on piping 1-1/4” and smaller where a drain valve is not shown, a drain plug is acceptable.
- C. Piping shall be installed consistent with good piping practice and run concealed wherever possible. Coordinate with other trades to attain a workmanlike installation.
- D. Piping shall be supported as specified in Section 230529 Pipe Hangers. Piping with mechanical joints for grooved end or press fit pipe shall be supported in accordance with the manufacturer’s recommendations. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before insulation is applied and the system accepted.
- E. Inform the Insulation sub-contractor during the bid period as to the extent of use of mechanical joints so that sub-contractor can price the work accurately.
- F. Internals of sweat end valves shall be removed when damage or warping could occur due to applied heat of soldering. Where silver brazing is specified, solder connection of valves shall be used to reduce the danger of damage.
- G. Piping within 2 ft. of the coil connections to small heating and/or cooling units, reheat box coils and duct coils may be Type “K” soft copper to facilitate connection in a confined space. Joints shall be soldered consistent with the piping system or flared-tubing fittings may be used where appropriate.

- H. Close open ends of piping during installation to keep interior of the pipe clean.
- I. Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with N.E.C. Article 384.
- J. Bulb wells for temperature sensing specified in Section 23 0913 Instruments and Control Devices shall be furnished by the Control Sub-Contractor and installed by the HVAC Contractor. Other types of control devices (differential pressure switches, flow meters, etc.) shall also be installed by the HVAC Contractor. Devices, fittings (tees, weldolets, threadolets), locations and installation details shall be closely coordinated with the Controls sub-contractor and device manufacturer's instructions.
- K. Automatic control valves shall be furnished by the Controls sub-contractor for installation by the HVAC piping contractor. Flare fittings for flare end valves shall be provided by the HVAC piping contractor.

3.2 UNIONS AND FLANGES

- A. Unions and flanges shall be installed at pipe connections to major equipment and as required for erection purpose. A union shall be installed at each threaded shut-off valve on the side of the valve for which shut-off services intended.

3.3 PIPE SLEEVES

- A. Pipe sleeves shall be placed in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to assure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the Architect.
- B. Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1" above finished floor. Pipe sleeves shall be sized to allow insulation to pass thru the sleeve, for insulation requiring continuous vapor barrier (domestic cold water, chilled water refrigerant, etc.). Where vapor barrier continuity is not needed, the sleeve may be sized to pass the pipe only or the insulation as well.
- C. Pipe sleeves which are part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.
- D. Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed with caulking to retard the passage of smoke.
- E. Where uninsulated pipes requiring no pipe sleeves pass thru non-fire rated floor, wall or partition, the annular space shall be closed with material and methods compatible with the wall or partition material (Type M masonry grout, drywall joint compound, plaster, etc.).

3.4 PIPE TESTING AND INSPECTION

- A. All piping provided in this work shall be pressure tested as specified below.
- B. Pipe testing for HVAC piping shall be:
 - 1. Water piping – hydrostatic at 125 psig for 6 hours at the low point of the system, or 1 ½ times maximum operating pressure throughout the system, whichever is higher. Refer to special testing requirements for existing chilled glycol piping at the high school.
 - 2. Condensate drainage piping, same as for plumbing drainage piping.
 - 3. Refrigerant piping – refer to appropriate Refrigeration Sections.
 - 4. Other piping – refer to appropriate Sections.
- C. Testing shall be performed prior to application of insulation. Insure that air is vented from piping when piping is hydrostatically tested.
- D. Tests shall be shall be monitored by a recorder. Test times shall be established at a minimum of 48 hours in advance and notice given to the Architect to allow field representatives of the Architect or Engineer to witness testing if desired. Furnish a written record of each piping system test indicating date, system, pressure, duration and results of tests. Copies of test reports shall be included in the O&M manuals.
- E. Leaks discovered during testing shall not be patched. Threaded connections shall be either tightened or replaced. Small leaks in welded pipe may be chipped and rewelded.
- F. Where a new pipe connects to an existing pipe, provide the following to facilitate testing, cleaning, draining and eventual shutoff service:
 - 1. A shutoff valve in the new pipe near the point of connection.
 - 2. A ¾” valved stub with capped ¾” hose connector beyond the valve for testing of the new pipe extension. Close valve, remove handle after testing is complete. Wire handle to valve body.

3.5 PIPE CLEANING

- A. After hydrostatic tests and repairs are completed and before placing each new piping system in operation the system shall be thoroughly flushed and cleaned, see section 23 2500 for requirements.

END OF SECTION 232113

(This page intentionally left blank)

SECTION 23 2114 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes.
 - 1. Hydronic Specialties and Accessories
 - 2. Expansion Tanks
- B. Related Sections:
 - 1. 23 0523 General Duty Valves
 - 2. 23 0529 Pipe Hangers and Supports
 - 3. 23 2113 Hydronic Piping.

1.2 PERFORMANCE REQUIREMENTS

- A. Piping systems shall conform to ANSI and State rules for pressure piping where applicable. Welders and fitters shall be fully certified for work performed.
- B. Safety valves and all pressure vessels shall bear the appropriate ASME label.

1.3 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Hydronic specialties.
- B. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTIES

- A. Air Eliminator and Dirt Separator shall be a full flow coalescing type combination air eliminator and dirt separator. Separator shall be fabricated steel, rated for 150 psig working pressure, stamped and registered in accordance with ASME Section VIII, Division I for unfired pressure vessels. Spirotherm Spirovent Series VDT, or equal by Bell & Gosset or Thrush.
- B. Pressure reducing valves for system water make-up shall be equal to Bell & Gossett Model B7 (adjustable setting to 25 psi) setting as indicated on the drawings.

- C. Pressure relief valves other than those on boilers shall be ASME rated for water relief, equal to Bell & Gossett No. 790 (3/4") / No. 1170 (1") / No. 3301 (1-1/2") / 4100 (2") with low inlet pressure check valve, setting as indicated on the drawings.
- D. Reduced pressure backflow preventer assembly in the cold water make-up line to the system shall be equal to Watts No. 909 complete with valves, strainer, vents, test cock and an air gap funnel drain below the unit, piped to a floor drain.
- E. Air vents shall be manual type unless specifically noted to be automatic. Air vents shall be:
 - 1. Large capacity automatic type for installation on boiler or air removal fitting, equal to Hoffman 792, 150 psig operating pressure rating. Provide a ball valve on the inlet pipe and pipe the outlet to the nearest drain.
 - 2. Large capacity automatic type, 150 psig operating pressure rating, equal to Hoffman 78. For use on air handling unit coils and on main piping. Provide ball valve at inlet of each vent. Pipe outlet to nearest drain point with 1/8" ID copper tube.
 - 3. Large capacity manual type – 1/2" ball valve for use on air handling unit coils and on main piping. Elbow down to facilitate catching water during venting.
 - 4. Small capacity manual-automatic with screwdriver stop, 50 psi, equal to Hoffman 500, for use on room heating and cooling units, VAV unit heating coils and duct heating coils.
 - 5. Small capacity manual type air vent – 1/4" ball valve, for use on room heating and cooling units, VAV unit heating coils and duct heating coils. Elbow down to facilitate catching of water during manual venting.
- F. Strainers shall be 125 lb. wsp "Y" pattern cast iron construction with removable stainless steel strainer element and screwed or flanged ends. Strainer elements shall be 20 mesh for 2" and smaller, 1/16" for 2-1/2", 3" and 4" and 1/8" for larger sizes.
- G. Combination valves and devices such as Bell & Gossett Triple Duty Valve (check, balancing and shutoff) are not acceptable.
- H. Pump suction diffusers for inlet condition enhancement shall be equal to that manufactured by Bell & Gossett.

2.2 EXPANSION TANKS

- A. Expansion tanks for pressurization and expansion control of the water systems shall be pressurized bladder type as indicated on the drawings, pre-charged to match the system make-up pressure.
- B. Each tank shall be welded steel constructed in accordance with ASME requirements for 125 psi. The tank shall be fitted with a system pipe connection drain tapping and an integral butyl rubber diaphragm or replaceable bladder, to separate water from the pressurized air. Bladder type tank shall have a bottom drain tapping with plug and a flanged top opening for removal and reinstallation of the bladder. Tank shall be prime coat or finish painted.

- C. The tank shall be vertical with floor mounting ring or horizontal with mounting cradles, as indicated on the drawings.
- D. Tank shall be Bell & Gossett or equal by Armstrong, American Wheatley or Taco, of configuration and acceptance volume as indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Drawings (plans, schematics and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, pipe expansion, pump sizing and other design considerations; therefore, it is imperative that piping be installed as indicated.
- B. Refer to Section 23 2113 Hydronic Piping for installation of piping and accessory devices and equipment.
- C. Air vents shall be installed at high points of piping and system, on each heating coil and cooling coil and at other locations subject to air binding. Air vents shall be installed in locations accessible for servicing. A shutoff valve or cock on the inlet and drain tubing extending to a drain is required for each large capacity automatic vent. The drain tube shall be extended to a drain location (floor drain, janitor sink, etc.) or, in mechanical rooms, turned down over a clear area of the floor to afford notice by maintenance personnel.
- D. Install strainers as indicated on the drawings. Provide a nipple and ball valve in the blow down connection of each strainer 2" and larger.
- E. Vertical expansion tanks shall be floor set on a 4" high concrete base. Horizontal tanks shall be set on angles and suspended from the structure with hanger rods. Check and adjust the pre-charged pressure so that it matches the system make-up pressure.

END OF SECTION 23 2115

(This page intentionally left blank)

SECTION 23 2123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Pipe mounted In-Line.
 - 2. Base mounted end suction
- B. Related Sections
 - 1. 23 0513 Electrical Requirements for HVAC Equipment

1.2 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
- C. Operation and maintenance data.

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.
- C. Pumps shall be tested and rated in accordance with Hydraulics Institute standards.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Motors shall be 1750 rpm unless specifically noted otherwise. Motors shall be sized to not overload or enter into the service factor area at any point on the operating curve of the pump. Submittals shall include pump curves. Drives and couplings shall be protected with guards conforming with OSHA standards.

- B. Motors 1 HP and larger shall be “premium efficiency” series motors.

2.2 IN-LINE PUMPS

- A. Horizontal motor axis pipe mounted split-case centrifugal, bronze fitted with cast iron casing, brass or bronze impeller, oil lubricated sleeve or ball bearings, mechanical seals, flanged ends and direct connected motor with flexible connector.
 - 1. Seals shall be EPT/Tungsten-Carbide material suitable for water pH levels of up to 11.
 - 2. Manufacturers:
 - a. Bell & Gossett Series 60, or equal by:
 - b. Armstrong
 - c. Grundfos
 - d. Patterson

2.3 BASE MOUNTED END SUCTION

- A. Base mounted end suction pumps shall be centrifugal type with flexible coupling, motor and channel steel or cast iron base with “back pull out” design. Each pump shall be bronze fitted with cast iron casing, bronze impeller, grease lubricated ball bearings, mechanical seals and flanged pipe connections (except pumps 2” and smaller may be threaded end).
 - 1. Manufacturers:
 - a. Bell & Gossett Series 1510, or equal by
 - b. Armstrong
 - c. Grundfos
 - d. Patterson

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

- A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- C. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight.
- D. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
- E. Furnish a spare pump seal for each type and size of pump.

3.2 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

END OF SECTION 23 2123

(This page intentionally left blank)

SECTION 23 2300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.3 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
- D. The equipment manufacturer shall provide piping installation instructions to the Contractor and supervision as needed to insure that the piping system is installed in accordance with the equipment manufacturer's recommendations.

1.4 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B280 Type “ACR” hard, seamless copper thoroughly cleaned and dehydrated for use with the refrigerant used. Tubing which has not been so prepared and sealed or which has been open to the atmosphere for any length of time shall not be used.
- B. Fittings: ASME B16.22 wrought-copper fittings.
- C. Brazing Filler Metals: AWS A5.8/A5.8M silver brazed joints.

2.2 VALVES AND SPECIALTIES

- A. Refrigerant devices specified below shall be specifically designed for the refrigerant application and of construction pressure class consistent with the duty imposed.
- B. Manual Shutoff Valves:
 - 1. Brass construction with sweat ends. Valves shall be ball type or may be packed type with backseating construction or packless type.
- C. Service Valves:
 - 1. Shutoff type with charging and test ports.
- D. Solenoid Valves:
 - 1. Brass body, sweat ends, normally closed with manual lift stem and holding coil in a NEMA 1 enclosure, voltage to match controls.
- E. Thermal Expansion Valves:
 - 1. Thermostatically operated diaphragm type with brass body, external equalizer and external superheat adjustment.
 - 2. Expansion valves shall be manufactured by:
 - a. Alco
 - b. Sporlan
- F. Hot Gas By-pass Valves:
 - 1. Pilot operated modulating regulators with integral solenoid pilot assembly and external equalizer tubing and connections.
 - 2. Hot Gas By-pass valves shall be manufactured by:
 - a. Alco FA8
 - b. Sporlan
- G. Flexible Pipe Connectors:

1. Corrugated copper bellows type with woven bronze wire protective jacket suitable for 400 psi refrigerant use.

H. Filter Dryers:

1. Sealed type or replaceable core type equal to Sporlan “Catch-All”.

2.3 REFRIGERANTS

A. ASHRAE 34, R-134a: Tetrafluoroethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arkema Inc.
 - b. DuPont Fluorochemicals Div.
 - c. Genetron Refrigerants; Honeywell International Inc.
 - d. Mexichem Fluor Inc.

B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arkema Inc.
 - b. DuPont Fluorochemicals Div.
 - c. Genetron Refrigerants; Honeywell International Inc.
 - d. Mexichem Fluor Inc.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arkema Inc.
 - b. DuPont Fluorochemicals Div.
 - c. Genetron Refrigerants; Honeywell International Inc.
 - d. Mexichem Fluor Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. 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 Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.

- C. All joints shall be brazed using silver solder while flowing an inert gas such as dry nitrogen through the piping.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Piping shall be hung from the building structure with clevis hangers and rods as described in 230529 Pipe Hangers and Supports. Hangers for insulated pipe shall be oversized and a sheet metal saddle with belled ends incorporated to protect the insulation.
- F. When brazing remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- G. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- H. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
- I. Service valves shall be provided on the condensing unit liquid and suction connections if not furnished on the unit.
- J. A solenoid valve, a sight glass-moisture indicator and a thermostatic expansion valve shall be provided for each evaporator coil circuit. A filter dryer shall be provided in each liquid line near the condensing unit or the evaporator coil. A shut off valve shall be provided on both the inlet and outlet of a replaceable core filter-dryer.
- K. Hot gas by-pass valve assembly shall be provided on the first stage of capacity control/for each compressor where lead-lag selection is incorporated and as indicated. Hot gas piping shall be run from the compressor discharge to the refrigerant distributor of the evaporator coil and the equalized line extended to the suction header.
- L. Flexible pipe connectors shall be provided where recommended by the equipment manufacturer.
- M. Solenoid valves shall be mounted within the enclosure of outdoor equipment or otherwise protected from weather.

3.2 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.3 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 2300

(This page intentionally left blank)

SECTION 23 2500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following HVAC water-treatment systems:
 - 1. Chemical treatment for East Building Hot Water.
 - 2. Pipe cleaning procedures for East Building Hot Water and South Building Chilled Water.

1.2 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. East building hot water system, recommend and provide sufficient quantities of chemicals to provide the following water qualities (or as recommended by the water treatment consultant) :
 - 1. pH: Maintain a value within 9-10.5.
 - 2. "P" Alkalinity: Maintain a value within 100-500 ppm.
 - 3. TDS: Maintain a maximum value of 10 ppm.
- D. South building chilled water system shall be provided with a premixed, inhibited glycol solution; further water treatment is not anticipated.

1.3 SUBMITTALS

- A. Field quality-control test reports.
- B. Other Informational Submittals:
 - 1. Water-Treatment Program: Provide a recommended chemical treatment program to follow to achieve water quality defined in the "Performance Requirements" Article above.
 - 2. Provide a water analysis report on the water quality available to the east building.
 - 3. Provide flush, clean, and refill plan with submittal.

1.4 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider regularly engaged in the water treatment business capable of analyzing water qualities and recommending/applying water treatment program shall be utilized as a subcontractor.

PART 2 - PRODUCTS

2.1 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment advisor. Chemicals shall be compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.
- B. System Cleaner:
 - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass (Shot) Feeder/Filter: 10 gauge steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top with 4" fill cap, built in filter support frame, 20 micron ring-top pleated filter, three leg stand with anchor bolts for full bottom drain and NPS 3/4 bottom outlet and top side inlet. 2-1/2 turn threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
 - 1. Capacity: 5 gal.
 - 2. Working Pressure: 300 psig @ 200 deg. F.
 - 3. Provide two (2) spare 20 micron filters.
- B. MANUFACTURERS
 - 1. Neptune Model DBFC
 - 2. J.L. Wingert or approved equal.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 PIPE CLEANING

- A. Contractor shall create a strainer chart showing locations of all strainers and post chart with valve tag chart.
- B. Flush: Place terminal equipment control valves in the open position and circulate water, cleaning strainers until they no longer accumulate debris, this may be a multi-day process.
- C. Cleaning: After flush period introduce cleaning agent and circulate the solution throughout the system for a 48-hour period, minimum.
- D. Drain cleaning solution refill with clean water and thoroughly flush until cleaner is removed. Refill system with clean water and add chemical treatment as required by this section.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and recommend chemical treatment program.
- B. After review with the Owner and Engineer, provide appropriate quantity of chemicals and introduce into the system. Provide testing to verify performance and appropriate chemical levels are achieved.
- C. Comply with ASTM D 3370 and with the following standards:
 - 1. Silica: ASTM D 859.
 - 2. Acidity and Alkalinity: ASTM D 1067.
 - 3. Iron: ASTM D 1068.
 - 4. Water Hardness: ASTM D 1126.
- D. Instruct Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment program.
- E. Contractor shall implement a water treatment maintenance schedule and shall monitor and adjust the systems on a monthly basis for the first three (3) months of system operation.

END OF SECTION 23 2500

(This page intentionally left blank)

SECTION 23 3113 - DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Duct materials.
2. Duct liner.
3. Duct connectors.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" per the design criteria indicated on the drawings.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Fabrication, assembly, and installation techniques.
2. Factory- and shop-fabricated ducts and fittings.
3. Reinforcement and spacing.
4. Seam and joint construction.
5. Duct Connectors
6. Duct Liner

7. Duct Sealants and Gaskets
8. Penetrations through fire-rated and other partitions.
9. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
10. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. See DUCT CONSTRUCTION AND SEALING schedule on drawings for material specifications.
- B. Ductwork shall be galvanized steel shall be lock-forming, 24 gauge minimum, except as otherwise noted or specified. Galvanize shall be "paint grip" type in exposed areas as noted below.
- C. Stainless steel ductwork shall be No. 304 grade. Joints and seams shall be continuously welded. Ductwork exposed in finished areas shall have No. 4 polished finish on the exterior with welds ground smooth and polished.
- D. Uninsulated duct exposed to view shall be painted in the field by the General Contractor. All duct in these areas shall have "paint grip" galvanizing finish.

2.2 DUCT LINER

- A. Interior insulating duct liner for acoustical and thermal insulating purposes shall be shop applied to rectangular ductwork as shown on the drawings. Duct liner in rectangular ducts shall be 1" thick flexible fiberglass equal to Schuller-Manville "Linacoustic RC", Owens Corning SOFTR Aeroflex Plus Type 300 or equal by Certainteed with microbial growth inhibitor, minimum R value 4.2 with acrylic coating to prevent air erosion. Liner noise reduction coefficient (NRC) shall be .65 or better. Liner shall be applied with mastic on 100% of the surface and pin fasteners, per manufacturers instructions. Leading edges shall be protected with a sheet metal

"Z" or channel and all joints shall be closed with heavy coating of neoprene. Duct sizes on drawings are inside clear dimensions. Sheet metal dimensions are 2" greater in each direction.

2.3 DUCT CONNECTORS

- A. Manufactured connectors shall be Ductmate Industries "25 and "35" or equal by Mez Industries or Ward Industries may be used on rectangular ductwork except where welding or brazing is specifically required. Adhere strictly to manufacturers instructions.
- B. Duct connections for round duct branch connection to rectangular sheet metal duct shall be Flexmaster Series FL or equal by Zen Industries or Sheet Metal Connectors, Inc., straight side with and without manual damper, as described on the drawings. Connectors installed on interior lined rectangular duct shall have an integral insulation guard sleeve. Rectangular tap-to-round branch connection with static boot configuration shall be equal to Flexmaster Type STO.

2.4 SEALANT AND GASKETS

- A. Duct sealant materials shall be United McGill "Water Based Duct Sealer" or equal by Ductmate or Carlisle Hardcast.
- B. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer, except approved, 1500 deg.F. gasket for hood exhaust duct connection to the kitchen hood.

2.5 HANGERS AND SUPPORTS

- A. Refer to details of duct hanger supports on the drawings.
- B. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Galvanized-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Size and arrange hangers to provide for continued support upon failure of any individual hanger.
- D. Transverse joints and longitudinal seams shall be assembled with sealant to conform to seal class as noted on the drawings. Selection of sealant materials shall be compatible with the application. Sealants shall be applied in accordance with manufacturer's recommendations.
- E. Attachment of hangers and straps to the structure shall be with:
 - 1. Refer to details on the drawings.
 - 2. Unistrut type channel support system may be utilized.
 - 3. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical.
 - 4. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.
- F. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures. Ductwork shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment in accordance with NEC.
- G. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- H. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

- I. Where ducts pass thru mechanical room walls near sound sensitive spaces, wrap all four sides of the opening with barium sulfate loaded vinyl, limp mass barrier material equal to Kinetics Noise Control Inc. Model KNM-100B extending 4” across the wall and duct and pack the annular space with fiberglass as detailed on the drawings to reduce noise transmission through the opening.
- J. Protect duct interiors from moisture, construction debris and dust, and other foreign materials by covering each open end of the duct with visqueen secured with duct tape before the end of each day’s work. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."
- K. Interior insulating duct liner shall be installed in strict accordance with manufacturer’s printed instructions and SMACNA standards. Liner in rectangular duct shall be shop applied with adhesive over 90% of the surfaces and with weld pins. Edges not factory sealed, cut edges and all joints shall be coated and closed with an adhesive-sealant, both in shop fabrication and field assembly. Leading edges shall be protected with metal “Z” or channel nosing where air velocity exceeds 3,000 fpm. Duct liner shall be protected from getting wet or dirty while being transported to the building site, stored on site and after installation.
- L. Coordinate openings required for the passage of ductwork thru walls, partitions, floors and roofs with the General Contractor.
- M. Sheet metal sleeves in conjunction with fire dampers shall be placed in walls and floors to pass ductwork. Floor sleeves shall project 4” above the finished floor in equipment rooms and areas of similar usage, and shall form a waterproof seal. Exceptions shall be at locations where the opening is protected from drainage falling thru by means of concrete curbs or shaft walls. This Contractor shall be responsible for providing 4” high x 4” wide concrete curbs with beveled edges to protect floor openings related to his work in equipment rooms or providing an equal effective waterproofing metal curb, if not specifically included in the General Contract.
- N. Where duct surfaces can be seen thru grilles, registers and diffusers, the inside of the duct shall be coated with flat black paint before the device is installed, to eliminate obtrusive appearances.
- O. Coordinate duct layout carefully with other trades to avoid conflict with structural elements, lighting and plumbing- heating piping. Flattening of ductwork and offsets to fit ductwork in available space is generally shown. In the absence of such, the Contractor shall arrange the ductwork to maintain concealment and allow ceilings and lights to be installed as intended. Do not hang ductwork until possible interference with electrical and mechanical trades have been resolved. Having ductwork fabricated and delivered in advance shall not be justification for interference with other trades.

END OF SECTION 23 3113

(This page intentionally left blank)

SECTION 23 3300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual balancing dampers.
2. Backdraft dampers.
3. Pressure Differential gauges.
4. Turning vanes.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Flexible ducts.

1.2 SUBMITTALS

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

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
 - d. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MANUAL BALANCING DAMPERS

- A. Balancing dampers shall be single cross-blade up to 12 blade widths and in larger sizes, multiple blade type 6" maximum width with opposed blade arrangement. Dampers shall be controlled by a locking quadrant positioner with handle equal to vent fabrics "Ventlock" #641 and for externally insulated ducts #644

2.2 BACKDRAFT DAMPERS

- A. Backdraft dampers shall be adjustable counterbalanced type with extruded aluminum frame and blades and extruded vinyl edge seals. Dampers shall be equal to Ruskin CBD6.

2.3 PRESSURE DIFFERENTIAL GAUGES

- A. Pressure differential gauges for air filter application shall be Dwyer "Magnehelic" Series 2000 dial type gauges. Range shall be appropriate for the application. Each gauge shall be furnished with vent valves, aluminum or plastic tubing, static pressure tips and mounting bracket or flange.

2.4 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall for ducts up to 36 inches wide and double wall for 36" wide and larger dimensions.

2.5 DUCT-MOUNTED ACCESS DOORS

- A. Access doors shall be factory fabricated constructed of the same material as the ductwork (except galvanized sheet metal for fiberglass duct), complete with hinged door, cam lock latches, frame and neoprene gasket between door and frame. Doors in insulated ductwork (internal and or external) shall have double wall insulated doors. Access doors shall be 18” x 16” minimum except smaller where duct size will not permit such size.
- B. Access doors and panels shall be designed to provide tight seal commensurate with the duct pressure. Apply duct sealer or rubber gasket between frame and duct and on ducts of 3” S.P. and higher construction class, mechanical fastening of the frame and rubber gasket shall be provided.
- C. Where sufficient clearance is not available to allow the door to swing open 90 degrees, an access panel with neoprene gasket, frame and cam lock latches on all four sides shall be provided in lieu of the hinged door.
- D. Plenum access doors shall be factory fabricated and as described for duct access doors except that doors shall be 18” x 48”(unless otherwise noted) with overlapping frame, continuous piano hinge and heavy duty latches (with lever of both outside and inside) equal to Ventfabrics “Ventlok No. 31.” Two latches shall be provided except on doors 50” and higher three shall be provided. Frame shall be mechanically fastened to the plenum wall.

2.6 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Ventfabrics, Inc.
 - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 30 oz./sq. yd.
 - 2. Net Fabric Width: 4” wide.
 - 3. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 4. Service Temperature: Minus 40 to plus 200°F.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd.
 - 2. Net Fabric Width: 4” wide.
 - 3. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

4. Service Temperature: Minus 50 to plus 250°F.

2.7 FLEXIBLE DUCTS

- A. Flexible insulated duct shall be constructed of galvanized steel spiral wire mechanically locked to an airtight aluminum or polyester inner core, 1" thick 3/4 lb. density fibrous glass insulation and a polyethylene or reinforced metalized vapor barrier outer jacket equal to Flexmaster Type 5 or 5M. Duct shall be rated at a minimum of 6" positive and 4" negative static pressure and shall be listed as Class 1 Air Duct or Air Duct Connector with 25-50 flame-smoke ratings per UL 181 and comply with NFPA 90A.
- B. Non-insulated flexible duct equal to Flexmaster NI-85 may be used on duct systems not specified to be insulated, with similar restriction stated above.
- C. Flexible duct shall be used at final connections to air control terminal units and ceiling air diffusers except as limited in Part 3.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 1. Install steel volume dampers in steel ducts.
 2. Install aluminum volume dampers in aluminum ducts.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install air filter pressure differential gauges in a readable location on or near the air handling unit, filter housing or as otherwise indicated on the drawings.
- F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. On both sides of duct coils.
 2. Control devices requiring inspection.
- G. Install access doors with swing against duct static pressure.

- H. Label access doors according to Division 23 Section "Identification for HVAC System" to indicate the purpose of access door.
- I. Install flexible connectors to connect ducts to equipment.
- J. For fans developing static pressures of 5-inch w.g. and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- K. Connect flexible ducts to metal ducts with Panduit straps or stainless steel clamps. End of the insulation and jacket shall be sealed to the metal duct with double wrapped duct tape. Maximum length of flexible duct shall be:
 - 1. Terminal units to supply ducts – 3 ft.
 - 2. Air devices to ducts – 7 ft
- L. Flexible duct shall not be installed:
 - 1. Where ductwork is exposed.
 - 2. Thru any wall, ceiling, floor or fire rated assembly.
 - 3. In the immediate vicinity of, and connecting to, air devices in fire rated ceilings where the assembly details require steel ductwork.

END OF SECTION 23 3300

(This page intentionally left blank)

SECTION 23 3400 - FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Inline Square Centrifugal Fan.
- B. Related Sections
 - 1. 23 0513 Electrical Requirements for HVAC Equipment
 - 2. 23 0531 Equipment Drives
 - 3. 23 0548 Vibration Control

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Fans shall be constructed, rated and labeled in accordance with AMCA Standard 210-67. Fans shall be statically and dynamically balanced throughout the operating range.
- B. 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.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Fans shall be provided as specified below and shown on the drawings, complete with motors, drives and associated devices.

- B. All fans of any one listed type shall be of the same manufacturer.
- C. Motor HP shall be sufficient to handle the full load of the fan, including drive losses, at the selected condition without exceeding the motor rating. In no case shall the motor size be less than shown without prior approval from the Engineer. All motors 1 HP and larger shall be “premium efficiency” series. Motors which are fed from variable frequency drive controllers for variable speed operation shall be designed and constructed for VFD drive duty and shall be compatible with the controller specified in Section 23 0531 Equipment Drives. Refer to Section 23 0513 Electrical Requirements for HVAC Equipment.
- D. Belt drive units shall have adjustable motor base, “V” belts and pulleys.
- E. Motorized backdraft dampers, where specified, shall be furnished with a motor with voltage compatible with the fan motor voltage and electric service to the fan. If not compatible, a transformer shall be furnished with the fan and damper to afford the appropriate voltage.

2.2 INLINE SQUARE CENTRIFUGAL FAN

- A. Construction – Backward inclined fan wheel, motor, adjustable “V” belt drive or direct drive, as indicated, belt guard, motor disconnecting means and inlet cone. Housing shall be constructed of square galvanized sheet metal with 1” acoustical lining.
- B. Mounting – Mounting brackets with neoprene vibration isolators for suspension mounting.
- C. Direct drive units shall have motor out of the air stream and be furnished with a solid state speed controller with off position, and cover plate. The speed controller shall be turned over to the Electrical Contractor for installation.
- D. Refer to the drawings for capacities, arrangement, class and other features and accessories. Fans shall be manufactured by:
 - 1. Acme
 - 2. Carnes
 - 3. Cook
 - 4. Greenheck
 - 5. Twin City Fan

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fans and roof curbs level and plumb, in accordance with manufacturer’s written instructions.
- B. Support units as described below using the vibration control devices specified herein or in Section 23 0548 Vibration Control.
 - 1. Roof curb mounted units: Set unit on the curb and fasten the fan base to the curb.

2. *Suspended unit:* Suspend unit from structural steel support frame using threaded steel rods and vibration isolation springs.
- C. Arrange installation of fans to provide access space around fans for service and maintenance.
 - D. Adjust damper linkages for proper damper operation. Motorized backdraft dampers are to be wired by the HVAC Contractor to open when the fan operates.
 - E. Perform the following operations and checks before start-up.
 1. Remove shipping blocking and bracing.
 2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork and electrical are complete. Verify proper thermal overload protection is installed in motors starters and disconnects.
 3. Verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Align belts and reinstall belt guards.
 4. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.
 5. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full open position.

END OF SECTION 23 3400

(This page intentionally left blank)

SECTION 23 3600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Single-duct air terminal units

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.
- B. Operation and maintenance data.

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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- D. Terminal units shall be certified to comply with ARI Standard 880.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unit sizes (inlet duct dimension) shall conform to those listed on the drawings except where larger size is required (or smaller size is acceptable) to meet noise or operational requirements. Resultant noise level from the control unit, ductwork and diffusers, as a system, shall not exceed a room NC level of 25 from both airborne and radiated noise, based on a 10 db room absorption coefficient, with 1.5" s.p. differential across the unit at maximum cfm setting. Sound performance shall be ARI certified.
- B. Pressure drop thru the terminal unit and hot water coil shall not exceed the maximum drop listed on the drawings. The coil face area shall be upsized if necessary to meet this requirement. The terminal unit casing shall be correspondingly upsized or the larger coil furnished separately.

For a separately furnished coil and intervening duct transition, with internal insulation same as that in the terminal unit casing, shall be provided.

2.2 COMPONENTS AND ACCESSORIES

- A. Unit casing shall be 22 gauge minimum galvanized or galvanealed sheet metal with beaded round inlet duct connection. Casing shall be lined internally with ½” thick dual density fiber free lining. Lining shall meet UL 181 erosion standards and NFPA 90A fire and smoke requirements. Edges, joints and other exposures shall be additionally coated or protected with metal edging.
- B. Fan blower shall be constructed of steel with forward curved blades, dynamically balanced wheels and direct drive motor. Unit shall include a backdraft damper at the fan section outlet to prevent cold primary air from flowing back through the fan into the ceiling plenum. Motor shall be an ECM DC brushless motor complete with and operated by a single phase integrated controller/inverter that operates the wound stator and sensor motor position to electronically commutate the stator. All motors shall be designed for synchronous rotation. Motor shall maintain a minimum of 70% efficiency over its entire operating range. Motor shall be direct coupled to the blower. Provide isolation between the motor and the blower assembly. Unit shall include a manual fan speed control for field adjustment of fan air flow set point.
- C. Hot water reheat coil shall consist of copper tubes, aluminum fins and galvanized steel casing. Coil shall have ARI certified ratings and shall be hydrostatically tested at 200 psi. The coil section shall contain an access door on the upstream side of the coil, located on the bottom of the casing. Provide a manual air vent on the coil. Hot water control valve shall be furnished by the Temperature Controls Contractor.
- D. Air flow control damper or valve shall have linear control characteristics and shall be 16 gauge galvanized steel or extruded aluminum with gasketing and self lubricating bearings.
- E. Velocity sensor shall be multi-point averaging type. The velocity sensor shall be mounted in the inlet air stream and shall amplify the air flow signal to provide accurate control at low, as well as high, inlet static pressure conditions. Required minimum static pressure of the volume regulator shall not exceed .25 inch w.g. for proper operation.
- F. Air flow taps shall be provided to enable direct reading of total static pressures. A conversion chart shall be attached to each unit to convert pressure readings to air flow quantities.
- G. Casing leakage and damper leakage shall each not exceed 2% of maximum air flow cfm at 3.0” s.p. differential across the unit.

2.3 MANUFACTURERS

- A. Units shall be manufactured by:
 - 1. Price
 - 2. Titus
 - 3. Trane
 - 4. Tuttle & Bailey

5. Enviro Tech

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Units installed in a return air plenum shall have a sheet metal housing to enclose non-plenum-rated control devices and wiring which are mounted on the exterior of the casing.
- B. Support the units from the building structure with solid steel hanger rods or sheet metal strap hangers. Units shall not be supported from the ceiling suspension system.
- C. Coordinate unit locations with ceiling components, light fixtures and other elements to insure adequate clearance for access and servicing. Provide ceiling access panels where the ceiling system does not afford ready access. Coordinate right/left hand connections prior to placing order. Units ordered with coil connections and or control boxes on inaccessible sides shall be re-ordered, the mounting of units “up-side-down” is not acceptable.
- D. Connect supply and return piping to each hot water coil with valves and unions. Provide a manual air vent at the coil. Automatic control valve will be furnished by the Temperature Control Contractor, installed by the HVAC Contractor.
- E. Control devices furnished by the Temperature Controls Contractor are to be sent to the unit manufacturer for factory mounting on the unit. Refer to the Temperature Control sections for controls and coordinate to provide a complete and operational system.
- F. Digital controller, damper operator and linkage, hot water control valve and room temperature sensor are to be furnished by the Temperature Control Contractor. Controller, damper operator and linkage are to be sent to the terminal unit manufacturer for factory mounting.

END OF SECTION 23 3600

(This page intentionally left blank)

SECTION 23 3713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grilles
2. Registers
3. Diffusers
4. Louvers

B. Related Sections:

1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 GRILLES, REGISTERS AND DIFFUSERS

A. Air outlet and inlet devices shall be equal to those specified by catalog number and description in the schedule on the drawings. Damper operators shall be concealed screw type. An auxiliary mounting frame shall be furnished with each grille and register except those mounted on exposed ducts or in lay-in application.

B. Linear "T" bar air supply diffusers shall be slotted diffusers with fixed air pattern control complete with a galvanized sheet metal supply plenum having a round or oval duct connection and 1/2" neoprene coated fiberglass insulation on the interior. The unit shall be designed to mount on or alongside the ceiling "T" bar and shall include flanges on both sides of the diffuser to support the ceiling tiles. Additional "T" bars matching those of the ceiling system shall be provided by the HVAC Contractor if the diffuser does not have these flanges. Units shall have a center notch where required to accommodate intervening "T" bars.

C. Manufacturers:

1. Price
2. Titus
3. Tuttle & Bailey
4. Kreuger

2.2 LOUVERS

- A. Louvers shall be exterior weatherproof type equal to those scheduled and shown on the drawings. Louvers shall be assembled entirely by welding. Louvers shall withstand uniform wind loading pressure of 20 psf. Performance data indicating pressure loss and water penetration, derived from AMCA 500 testing, shall be included with submittals.
 1. Aluminum louvers shall be 12 ga. Extruded aluminum with R1 caustic etch and finished with clear anodized color is to be selected by the Architect from the manufacturer's standard colors.
 2. Bird screen shall be ½" mesh aluminum wire on the interior face of the louver attached at 12" centers on the perimeter.
- B. Manufacturers:
 1. Ruskin
 2. Airolite
 3. Greenheck

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall be responsible for comparability of ceiling mounted devices with the ceilings and suspension systems (lay-in, concealed spline, plaster , drywall, etc.). Verify with architectural drawings.
- B. Carefully align square and rectangular devices with the vertical and horizontal building lines. Diffusers shall be attached rigidly to the ductwork. Where connected by flexible ducts, special supports shall be provided as required, either from the ceiling suspension system or by independent suspension wires or rods from the building structure.
- C. Inside of ducts behind grilles, registers, and diffusers shall be painted flat black, as needed, to eliminate the sight of shiny surfaces.
- D. Exterior louvers shall be installed by the General Contractor. Blank off all unused portions of the louver with 14 ga. Aluminum and insulate blank off with 1" rigid foil faced insulation. Seal blank off areas air tight.

END OF SECTION 23 3713

SECTION 23 3723 - GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of roof-mounting intake and relief ventilators:
 - 1. Louver penthouses.
- B. See Division 23 Section 23 3400 for roof-mounting exhaust fans.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: Include plans, elevations, sections, details, and ventilator attachments to curbs and curb attachments to roof structure.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating, mill phosphatized.
- D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.

2.2 FINISHES

- A. Exterior of the ventilator shall be:
 - 1. Primed and finished with semi-gloss enamel of color selected by the Architect.

2.3 LOUVER PENTHOUSES

- A. Manufacturers:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Aerovent; a Twin City Fan company.
 - 3. Greenheck.
 - 4. Loren Cook Company.
 - 5. Penn Ventilation.
- B. Construction: Aluminum construction with heavy gauge extruded aluminum louvers on four sides with mitered and welded corners, reinforcing channels on the interior, sheet aluminum top and counterflashing angled up on the inside to afford additional weather protection and condensation troughing.
- C. Filters: 2" channels with 2" washable aluminum mesh filters and hinged top for accessibility.
- D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; rigid fiberglass insulation adhered to inside walls; and wood nailer. Size as required to fit roof opening and ventilator base.
 - 1. Configuration: Wood cant strips around the curb only if recommended for the roof system. Match roof slope so that the top of the curb is level.
 - 2. Overall Height: 12 inches.
- E. Bird Screening: Aluminum, 1/2-inch square mesh.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install intake and relief ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Secure intake and relief ventilators to roof curbs with cadmium-plated hardware. Use concealed anchorages where possible. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- C. Install intake and relief ventilators with clearances for service and maintenance.
- D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- F. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

- G. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.
- H. Vent air units shall have the underside of the hood insulated to prevent condensation of the vent air on the underside of the hood.

END OF SECTION 23 3723

(This page intentionally left blank)

SECTION 23 5100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Listed double-wall vents and chimneys.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Building-heating-appliance chimneys.
- B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

PART 2 - PRODUCTS

2.1 LISTED BUILDING-HEATING-APPLIANCE CHIMNEYS

- 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. Heat-Fab, Inc.
 - 2. Metal-Fab, Inc.
 - 3. Metalbestos.
 - 4. Van-Packer Model CS Type BH
- C. Description: Double-wall metal vents tested according to, UL 1738 (condensing) and rated for 1000 deg F continuously, or 1700 deg F for 10 minutes.
- D. Construction: Inner shell and outer jacket separated by at least a 1-inch air space.
- E. Inner Shell: AL 29-4C Stainless steel or 316 Stainless Steel.
- F. Outer Jacket: 304 Stainless steel.
- G. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.

PART 3 - EXECUTION

3.1 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- C. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
- D. Lap joints in direction of flow.
- E. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- F. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- G. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 23 5100

SECTION 23 5216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for generating heating hot water.

1.2 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and wiring diagrams.
- C. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 80%, 60%, 40%, 20% and 7% input firing rates at incoming water temperatures ranging from 80 deg. F to 170 deg. F.
- D. Pressure Drop Curve. Submit pressure drop curve for flows ranging from 0 GPM to maximum boiler flow.
 - 1. Should submitted material be different from that of the basis of design, boiler manufacturer shall incur all costs associated with reselection of necessary pumps.
- E. Source quality-control test reports.
- F. Field quality-control test reports.
- G. Operation and maintenance data.
- H. Warranty: Standard warranty specified in this Section.

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. I=B=R Performance Compliance: Condensing boilers shall be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.
- C. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".

- D. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- E. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- F. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- G. NOx Emission Standards: When installed and operated in accordance with manufacturer's instructions, condensing boilers shall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.1; and the Texas Commission on Environmental Quality (TCEQD), Title 30, Chapter 117, Rule 117.465.

1.4 WARRANTY

- A. Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Fire-Tube Condensing Boilers:
 - a. The pressure vessel/heat exchanger shall carry a 10-year nonprorated warranty from date of start up against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
 - b. Manufacturer labeled control panels shall be warranted against failure for two (2) years from start up.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. HydroTherm KN Series
 - 2. Patterson Kelly – MACH Series
 - 3. Fulton – Endura
 - 4. Lochinvar – FTXL
 - 5. Thermal Sollutions – APEX
 - 6. Camus - ADVANTUS

2.2 CONSTRUCTION

- A. Description:

1. Boiler shall be natural gas fired, fully condensing, fire tube or cast iron design. Power burner shall have full modulation with a minimum 5:1 turndown ratio, and discharge into a positive pressure vent. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be factory-fabricated, factory assembled and factory tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket, flue-gas vent, combustion air intake connections, water supply, return and condensate drain connections, and controls.

B. Heat Exchanger:

1. The heat exchanger shall be constructed of 316L stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 5/8" OD, with no less than 0.065" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.375" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig.
2. The heat exchanger shall be a cast iron and or aluminum sectional unit designed for pressure firing and shall be constructed and tested for 100 psi water working pressure, in accordance with A.S.M.E. Section IV Rules for the Construction of Heating Boilers. Individual sections shall be subjected to a hydrostatic pressure test of 250 PSIG at the factory before shipment and they shall be marked, stamped or cast with the A.S.M.E. Code symbol. Boilers with less than 250-psi pressure test will not be acceptable. The sections shall be of a down fired counter flow single-pass design. Water ports shall be sealed with graphite port connectors. The sections shall be fully machined for metal to metal sealing of the gas side surfaces. The design shall provide for equal temperature rise through all sections. The heat exchanger shall be designed to prevent fluid boiling. The iron shall have a minimum thickness of 0.25". The heat exchanger shall have not limitations on temperature rise or restrictions to inlet water temperature.
3. Access to the tubesheet and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be not less than 10-inch diameter.

C. Pressure Vessel:

1. The pressure vessel shall have a maximum water volume of 50 gallons. The water pressure drop shall not exceed 5.5 psig at 258 GPM. The boiler water connections shall be 4-inch flanged 150-pound, ANSI rated. The pressure vessel shall be constructed of SA53 carbon steel, with a 0.25-inch thick wall and a 0.50-inch thick upper head.
2. Inspection openings in the pressure vessel shall be in accordance with ASM Section IV pressure vessel code.

D. Modulating Air/Fuel Valve and Burner:

1. The boiler shall be capable of a 15 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall produce less than 30 ppm of NOx corrected to 3% excess oxygen. The unit shall be certified by the South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.1 for boilers and water heaters greater than 2 MBTU's and less than 5MBTU's. The burner shall be metal-fiber mesh covering a stainless steel body with spark ignition and flame

rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor shall be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable frequency drive (VFD), controlled cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

E. Exhaust Manifold:

1. The exhaust manifold shall be of corrosion resistant cast aluminum with an 8-inch diameter flue connection. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.

F. Blower:

1. The boiler shall include a variable speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.

G. Ignition:

1. Ignition shall be via spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

2.3 TRIM

- A. Safety Relief Valve: ASME rated.
- B. Drain Valve: Minimum 0.75" hose-end ball valve.

2.4 CONTROLS

- A. The boiler control package shall be an integrated boiler management system capable of receiving signals from the building DDC system. The controls system shall be integral to each boiler, creating a control network that eliminates the need for a "wall mounted" stand-alone boiler control system.
- B. The boiler management control shall be capable of operating in the following ways:
 1. As a stand alone boiler control system using its own control protocol with one "Master" and multiple "Member" units.
 2. As a boiler network, enabled by a Building Management System, using its own protocol with one "Master" and multiple "Member" units.
 3. As "Member" boilers to a Building Management System with multiple input control methods.
- C. Each boiler control panel shall be networked together and shall have the following standard features.

1. Digital Communications Control
 - a. Boiler to Boiler: control panel protocol.
 - b. Building Management System: BACNET, coordinate with DDC system.
2. Analog 4:20 and 010vdc also supported.
3. Distributed control using boiler protocol for up to 16 total boilers.
4. System/Boiler operating status in English text display.
5. Interlock, Event, and System logging with a time stamp.
6. Advanced PID algorithm optimized for specific boilers.
7. Four (4) dedicated temperature sensor inputs for: Outside Air Temperature, Supply (Outlet) Temperature, Return Temperature (Inlet), and Header Temperature.
8. Automatically detects the optional temperature sensors on start up.
9. Menu driven calibration and setup menus with display.
10. Eight (8) dedicated 24vac interlock monitors and eight (8) dedicated 120vac system monitors used for diagnostics and providing feedback of faults and system status.
11. Multiple boiler pump or motorized valve control modes.
12. Combustion Air Damper control with proof time.
13. USB/RS485 network plug-in to allow firmware updates or custom configurations.
14. BACNET or LonWorks interface.
15. Alarm contacts.
16. Runtime hours.
17. Outdoor Air Reset with programmable ratio.
18. Time of Day clock to provide up to four (4) night setback temperatures.
19. Failsafe mode when a Building Management System is controlling setpoint. If communication is lost, the boiler/system shall run off the local setpoint.

2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

2.6 VENTING KITS

- A. The exhaust vent shall be UL listed for use with Category III and IV appliances and compatible with operating temperatures up to 480 degrees F, positive pressure, condensing flue gas service. UL-listed vents of A1 29-4C stainless steel shall be used with boilers.
- B. The minimum exhaust vent duct size for each boiler shall be 8-inches diameter.
- C. Combustion Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the boiler and the outdoors.

2.7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 BOILER INSTALLATION

- A. Install boilers level on concrete base. Concrete base shall be installed by the HVAC contractor.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve.

- D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Route condensate piping to the nearest floor drain and provide neutralizing cartridge prior to discharge into floor drain.
- H. Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- K. Connect boiler control panel to facility DDC system.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 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.
- B. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion. Provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION 23 5216

SECTION 23 6200 - PACKAGED COMPRESSOR AND CONDENSER UNITS (ACU-1)

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes air-cooled condensing units.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring diagrams.
- C. Operation and maintenance data.

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. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. Verification of Performance: Rate condensing units according to ARI 365

1.4 WARRANTY

- A. Standard Warranty: All parts, 12 months from start up or 6 months after shipment. All failed parts shall be repaired or replaced at no charge
- B. Special Warranty: In addition to the above standard warranty the manufacturer shall include the following parts only extended warranty:
 - 1. Warranty Period (Compressor Only): 4 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONDENSING UNITS, AIR COOLED

- A. Manufacturers:
 - 1. Daikin
 - 2. Trane
 - 3. Carrier
- B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.
- C. Cabinet
 - 1. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16" at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.
 - 2. The unit base frame shall be constructed of 15 gauge pre-painted galvanized steel.
 - 3. Lifting brackets shall be provided on the unit base with lifting holes to accept cable or chain hooks.
- D. Compressors
 - 1. Each unit shall have multiple, heavy-duty scroll compressors.
 - 2. Each compressor shall be complete with gauge ports, crankcase heater, sight-glass, anti-slug protection, motor overload protection and a 5 minute time anti-cycling time delay.
 - 3. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.
 - 4. Each compressor shall have a sound blanket installed to limit compressor noise.
- E. Refrigeration Circuit
 - 1. Each unit shall have two independent refrigeration circuits. Each circuit shall be complete with low pressure control, liquid line charging valve with a 3/8" charging port, a manual reset high pressure safety switch. Each Circuit shall be dehydrated, leak tested, and shipped with a Nitrogen holding charge. Unit shall have discharge and suction line shutoff valves.
 - 2. Hot gas bypass shall be provided on the lead compressor.

F. Air Cooled Condenser

1. The condensing section shall be open on the sides and bottom to provide access and to allow airflow through the coils. Condenser coils shall be multi-row and fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils are to be recessed so that the cabinet provides built in hail protection.
2. Condenser fans shall be direct drive, propeller type designed for low tip speed, vertical air discharge, and include service guards. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three-phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.
3. Units shall have at least one head pressure sensing condenser fan controlled to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 45° F ambient. SpeedTrol™ condenser fan speed control shall be added to the last fan off on each refrigeration circuit to provide cooling operation to ambient temperatures down to 0° F. Fan speed control shall be field adjustable.

G. Electrical

1. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with unit shall be number and color coded and labeled according to the electrical diagram provided for easy identification.
2. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch circuit short circuit protection, 115 volt control circuit transformer and fuse, system switches, and a high temperature sensor. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Knockouts shall be provided in the side of the main control panels for field wiring entrance.
3. All 115-600 volt internal and external wiring between control boxes and components shall be protected from damage by raceways or liquid tight conduit.
4. The receptacle shall be powered by a field supplied 115V source.
5. Single non-fused disconnect switch shall be provided for connecting electrical power at the unit. Disconnect switches shall be mounted internal to the control panel and operated by an externally mounted handle. Externally mounted handle is designed to prohibit opening of the control panel door without the use of a service tool.
6. Unit SCCR rating to be 10 kAIC.
7. Phase failure and under voltage protection shall be provided to prevent damage from single phasing, phase reversal, and low voltage conditions.

8. Ground fault protection on three-phase motors shall be provided to protect against arcing ground faults.
9. Unit shall be provided with a 24 volt transformer and terminal strip for field supplied controls

H. Controls

1. Refrigeration capacity control shall be accomplished by staging of the unit's multiple compressors. Unit shall be equipped with a 24V terminal strip for field supplied and installed controls.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Install condensing units on concrete base.
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.
- E. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories.

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. Perform electrical test and visual and mechanical inspection.
 2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 5. Verify proper airflow over coils.
- B. Remove and replace malfunctioning condensing units and retest as specified above.

END OF SECTION 23 6200

SECTION 23 7313 - MODULAR INDOOR AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Factory assembled air handling units.

1.2 SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 UNIT CASINGS

- A. Casings to house the various components shall be double wall as indicated on the drawings. Sections shall have bolted intervening connections. Casings and parts shall be galvanized sheet steel throughout or sheet steel chemically cleaned, phosphatized and painted on the exterior with enamel. Side panels of all modular sections shall be removable with two or more camlock type locks, fully gasketed around the entire perimeter of the panel. Panel size shall be large enough to allow maintenance and or replacement of internal components.
- B. Double Wall
 - 1. 2” thick panels, solid metal inside and out
 - 2. Insulation: 2” spray injected foam = R-13
- C. Access Doors:
 - 1. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Construction: Double wall insulated.
 - 2. Locations:
 - a. Access doors shall be provided indicated on the drawings
- D. Base Rail
 - 1. The casing sections shall be assembled on full length heavy gauge galvanized steel base rails, 6” high.

2.2 FAN, DRIVE, AND MOTOR SECTION

- A. ECM Fan Array
 - 1. Fan section(s) shall contain, fan, motor, drive components and accessories. Motor and drive shall be mounted with the casing and isolated. Fan shall be airfoil type with electronically commutated motor (ECM). See fan duty and HP requirements listed on the drawings.
 - 2. Integrated drive shall be provided for each fan array. Drive to be mounted on door side of fan section and to include fused disconnect with a motor starter. Drives are to be accessible through a hinged door assembly complete with a single handle latch. The unit manufacturer shall install all power and control wiring.

3. The drive output shall be controlled by the factory installed main unit control system and drive status operating speed shall be monitored and displayed at the main unit control panel. The supply and exhaust fan drive outputs shall be independently controlled in order to provide the control needed to maintain building pressure control.
 4. All drives shall be factory run tested prior to unit shipment.
 - a. The fan array will be arranged with high performance direct drive, single inlet, plenum fans with backwards inclined, high efficiency welded-aluminum or high performance composite impeller with galvanized or aluminum support frame. Manual blank-off plates shall be provided to block fan airflow, one plate to be provided per array. Backdraft dampers shall be provided to block fan airflow in lieu of blank-off plates.
 - b. The fans are driven by long-life, low-temperature brushless DC electronically commutated motor (EC-Motor) with external rotor and integrated maintenance-free electronic circuitry and electronics. The motor is manufactured with maintenance-free, permanently lubricated ball bearings and shall be statically and dynamically balanced in accordance with ISO 1940 part 1. The motor shall be closed, protection level IP 54, thermal class 155 with permissible operating temperature of -13°F to 140°F. Motor efficiency class shall comply with IE4. Fan characteristic curves indicate measurements on a chamber test in accordance with ISO5801. The three phase external rotor motor integrated into the fan hub meets the requirements for circulating electric machines set forth in DIN EN 60 034-1 (VDE 0530 Part 1).
 5. The fan bulkhead wall shall be constructed of minimum 1” foam injected panel. The panels walls shall be minimum 20 gauge galvanized metal and add structure to prevent vibration and “oil canning” of bulkhead wall. Bulkhead walls constructed of non-insulated sheet metal assemblies shall not be acceptable.
 6. ECM Motors: Provide a single control panel consisting of motor overloads, one for each fan, and DDC control input for fan modulation. All power and control wiring from control panel shall be provided by the unit manufacture as specified above. Panel shall be designed and wired to accept a single point power and controls connection by the respective trade contractors.
- B. Motor shall be “premium efficiency” series. Refer to Section 23 0513 Electrical Requirements for HVAC Equipment.

2.3 COIL SECTIONS

- A. General Requirements for Coil Sections:
1. Comply with ARI 410.
 2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
 4. Coils shall not act as structural component of unit.

B. Cooling Coils

1. Cooling coil(s) shall be direct expansion refrigerant type with copper tubes, aluminum fins, liquid distributors, suction headers and stainless steel frame. Coil(s) shall be tested at 400 psi, cleaned, dehydrated and sealed with a holding charge of dry nitrogen.
2. A drain pan shall be incorporated in sections containing cooling coils, first section downstream of cooling coil, outside air intake openings and other sections so noted on the drawings. Drain pan shall be double wall with insulation between. Interior liner shall be stainless steel. Drain pan shall be sloped in two directions and have a tapped drain outlet at that side of the pan.

2.4 AIR FILTRATION SECTION

- A. Filter types and efficiencies shall be as indicated in the Air Handling Unit Schedule and details. Filter dimensions shall be 12"x24" or 24"x24".
- B. Filter bank shall be designed for a maximum face velocity of 500 fpm.
- C. Two complete sets of pre-filters and two complete sets of final filters shall be provided by the air handling unit manufacturer for each unit.
- D. Filters shall be shipped direct to the job site independent of the air handling unit.
- E. Pre-Filters
 1. Minimum efficiency of MERV 8, in accordance with ASHRAE 52.1
 2. Pre-filters shall be 2" deep.
 3. Disposable cartridges fabricated of reinforced synthetic fibers bonded to a resistant water resistant and incombustible carton frame.
 4. Manufactured according to the standards established by UL class II.
 5. Pre-filters shall be Camfil-Farr 30/30 or equal by AAF.
- F. Final Filters
 1. Minimum efficiency of MERV 13, in accordance with ASHRAE 52.1
 2. Final filters shall be 4" deep.
 3. Disposable cartridges fabricated of reinforced synthetic fibers bonded to a resistant water resistant and incombustible carton frame.
 4. Manufactured according to the standards established by UL class II.
 5. Final filters shall be Camfil-Farr Riga-Flo or equal by AAF.

2.5 MIXING SECTION

- A. The mixing section shall consist of a casing with outside air dampers, vent air dampers and return air dampers. Dampers shall be aluminum air foil blades equipped with external linkage for automatic control, vinyl or neoprene blade edge seals and metal compressible jamb seals. AMCA certified with a maximum leakage of 12 cfm/sq.ft at 4" w.g. differential pressure. Maximum blade length shall be 60 inches. Mixing section and filter section may be combined

into a single section only where specifically indicated on the drawings. Provide access doors as indicated on the drawings or as required for damper access.

- B. Arrangement of outside air dampers and return air dampers shall be:
 - 1. Outside Air Damper: Parallel blade
 - 2. Return Air Damper: Parallel blade

2.6 MANUFACTURERS

- A. Manufacturers:
 - 1. Daikin
 - 2. Trane
 - 3. Carrier

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Each floor set unit shall be mounted directly on the floor as shown on the drawings. Coordinate location and dimensions of the unit and mounting elements with other trades
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- E. Install piping adjacent to air-handling unit to allow service and maintenance.
- F. Connect condensate drain pans using Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- G. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

END OF SECTION 23 7313

(This page intentionally left blank)

SECTION 23 8122 – SPLIT SYSTEM HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes split-system variable capacity heat pump air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.2 SUBMITTALS

- A. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Operation and maintenance data.

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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

- A. The units shall have a manufacturer's warranty for a period of 12 months from date of startup. The units shall have a limited labor warranty for a period of 12 months from date of. The compressors shall have a warranty of ten (10) years from date of startup. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of equipment manufacturer according to manufacturer's terms and conditions. All warranty service work shall be performed by a factory trained service professional.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Daikin
 2. Trane Company
 3. Carrier

2.2 EVAPORATOR-FAN UNIT

A. Multi-Position Air Handling Unit:

1. Indoor unit shall be a floor mounted vertical air handling unit with top discharge and bottom return. Unit shall be constructed with sound absorbing, foil faced insulation to control air leakage.

B. Refrigerant Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 3 row cross fin copper evaporator coil with 13 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4" outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A thermistor will be located on the liquid and gas line.

C. Evaporator Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipped with an automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
4. The airflow rate shall be available in three settings.
5. The fan motor shall be thermally protected.
6. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.
7. Fan motor external static pressure range for nominal airflow:

D. Filters:

1. Filters are provided external to the unit and are therefore not required in the fan coil units.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER UNIT

A. General:

1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of Inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. High/low pressure gas line, liquid and suction lines must be individually insulated by the installing contractor between the outdoor and indoor units.
2. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.
3. The system will automatically restart operation after a power failure and will not cause any settings to be lost.
4. The unit shall incorporate an auto-charging feature and a refrigerant charge check function.
5. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
6. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
7. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature.
8. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
9. The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.

B. Casing steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

C. Compressor:

1. The inverter scroll compressors shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” with a maximum speed of 7,980 rpm.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be 6% to 100%.
5. Each non-inverter compressor shall also be of the hermetically sealed scroll type.

6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be spring mounted to avoid the transmission of vibration.

D. Refrigerant Coil:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins are to be covered with an anti- corrosion acrylic resin and hydrophilic film type E1.
5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns

E. Fan:

1. The condensing unit shall consist of one or more propeller type, direct-drive 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan shall be a vertical discharge configuration.
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
6. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps.

2.4 CONTROLS

- A. Each fan coil unit shall be provided with a room mounted zone controller that includes an integral room temperature sensor. The sensor shall have an LCD display and room temperature setpoint capability.
- B. Control wiring between room sensor, fan coil unit, branch selector unit shall be 16VDC non-shielded, stranded 2 conductor cable rated for air plenum use.
- C. A centralized controller (CC) shall be provided which is capable of controlling multiple indoor/outdoor units. If not capable of controlling multiple units than one controller shall be provide for each heat pump system. The CC shall support operation superceeding that of the remote controllers, system configuration, daily/weekly/annual scheduling, monitoring of

operation status, error email notification, online maintenance toll and malfunction monitoring. The CC shall have basic operation controls which can be applied to an individual indoor unit, a group of indoor units or all indoor units. This control shall include on/off, operation mode selection (cool, heat, auto, dry, and fan), temperature setting, fan speed setting, airflow direction setting, error email notification, and online maintenance.

- D. Manufacturer shall provide a BacNet communication panel to allow for connection of the VRV CC to the building central DDC system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install evaporator-fan components on field fabricated return plenum box.
- B. Install ground-mounted, compressor-condenser components on new concrete pad.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections.
- B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- C. Startup and configuration of the Graphical User Interface shall be provided by the unit manufacturer. Training on use of the control system is to be part of 1 day owner training provided by the unit manufacturer.
- D. Provide on site integration support, working with the DDC temperature controls contractor to provide connection to the central DDC system.

END OF SECTION 23 8126

(This page intentionally left blank)

SECTION 23 8216 - HYDRONIC AIR COILS

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 hydronic duct mounted heating coils.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
 2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

PART 2 – PRODUCTS

2.1 DESCRIPTION

- A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2.2 COILS

- A. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
- B. Minimum Working-Pressure/Temperature Ratings: 200 psig (1380 kPa), 325 deg F (163 deg C).
- C. Source Quality Control: Factory tested to 300 psig (2070 kPa).
- D. Tubes: ASTM B 743 copper, minimum 0.035 inch (0.889 mm) thick.
- E. Fins: Aluminum or Copper, minimum 0.010 inch (0.254 mm) thick.
- F. Headers: Seamless copper tube with brazed joints, prime coated.
- G. Frames: Galvanized-steel channel frame, minimum 0.052 inch (1.3 mm) thick for slip-in or flanged mounting.

PART 3 – EXECUTION

HYDRONIC AIR COILS

3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible." Coils shall be level and plumb.
- B. Straighten bent fins on air coils.
- C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 23 0923 "Control Valves," and other piping specialties are specified in Section 23 2114 "Hydronic Piping Specialties."

END OF SECTION 23 8216

SECTION 23 8239 - UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cabinet unit heaters.
 - 2. Propeller unit heaters.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Equipment schedules to include rated capacities, furnished specialties, and accessories.
- C. Operation and maintenance data.

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. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

- A. Fan: Direct driven centrifugal with multi-speed permanent split capacitor motor having internal overload protection.
- B. Electrical Disconnect:
 - 1. Toggle disconnect switch furnished and mounted inside the cabinet.

- C. Heating Coil: Seamless copper tubes with bonded aluminum fins, hydrostatically tested at 300 psi.
- D. Cabinet:
 - 1. Concealed units shall have a discharge duct collar and where return duct is required, a return duct collar.
- E. Filter: 1” pleated media throwaway, MERV 7 (Farr 30/30)
- F. Controls: By T.C.C.
- G. Manufacturers:
 - 1. Trane.
 - 2. Zehnder-Rittling.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to drawings for arrangement, type, capacity, motor characteristics and other requirements.
- B. Install unit heaters to comply with NFPA 90A.
- C. Suspend unit heaters, all four corners, from building structure with steel hanger rods and auxiliary angles and fastening devices.
- D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- E. Wiring between the unit and wall mounted thermostats shall be run in conduit, furnished and installed by the HVAC contractor. See Section 23 0914 “Control Wiring”.
- F. Install new filters in each fan-coil unit within two weeks of Substantial Completion.
- G. Install piping adjacent to machine to allow service and maintenance.

END OF SECTION 23 8239

26

ELECTRICAL

DIVISION

(This page intentionally left blank)

SECTION 26 0001 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes the following:

1. General Requirements
2. Definitions
3. Scope of Work
4. Drawings and Specifications
5. Reference Standards
6. Site Visit
7. Permits, Regulations and Inspections
8. Project Management and Coordination
9. Temporary Electric Services
10. Workmanship
11. Protection
12. Painting
13. Cleaning
14. Equipment Selection
15. Shop Drawings
16. Testing
17. Final Inspection and Punch List
18. Operation and Maintenance Manuals
19. Record Drawings
20. Warranties
21. Operation and Adjustment of Equipment
22. Operating Demonstration and Instruction

1.2 GENERAL REQUIREMENTS

- A. All provisions of Division 00 Front End Documents and Division 01 General Requirements apply to work specified in this Division.
- B. Specification provisions of other relevant Divisions shall apply where applicable work is required to be performed under this Electrical work.
- C. A complete and functional Electrical system installation shall be provided under this Division. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.
- D. The Mechanical and Electrical drawings and specifications assign work (labor and/or materials to be provided by the General, Plumbing, Fire Suppression, HVAC or Electrical Contractor or

their sub-contractors. Understanding that the contractors for mechanical and electrical work are sub-contractors to the (General) Contractor, such assignments are not intended to restrict the Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior 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 SCOPE OF WORK

- A. The scope of the electrical work includes furnishing, installing, testing and warranty of all electrical work and complete electrical systems shown on the electrical drawings and specified herein, including Division 00, Division 01, Division 26 and applicable provisions of other relevant Divisions.

1.5 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.
- B. Make all necessary field measurements to insure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having equipment, wireways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause

to avoid making offsets and minor changes as may be necessary to install wireways, fittings and equipment.

- D. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.
- E. Equipment, ductwork and piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces About Electrical Equipment – 600 Volts Nominal or Less. For Equipment rated over 600 volts nominal – 110.32 Work Space About Equipment – 110.33 Entrance and Access to Work Space – 110.34 Work Space and Grounding. The Electrical Contractor shall caution other trades to comply with this stipulation.
- F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the Contractor causing such conflict. The Architect's decision shall be final in regard to arrangement of equipment, conduit(s), devices, wireways etc., where conflict arises.
- G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. Each contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.
- H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved from the work which is specified under his branch until instructions in writing are received from the Architect.

1.6 REFERENCE STANDARDS

- A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

1.7 ALLOWANCES, UNIT PRICES AND ALTERNATES

- A. Refer to Sections 012100 Allowances, 012200 Unit Prices and 012300 Alternates.

1.8 SITE VISIT

- A. Refer to Section 017300 Execution.
- B. Each bidder shall visit the project site to understand the existing conditions and compare the conditions with information shown on the drawings. Report immediately to the Architect any

issues or discrepancies which are discovered that affect the bid. Changes to contract price will not be considered for site condition issues that are readily apparent from a thorough site review.

1.9 PERMITS, REGULATIONS AND INSPECTION

- A. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawing and specifications shall govern. Install no work contrary to minimum legal standards.
- B. Except where the permit application is made by the Architect or the Engineer, the Electrical contractor shall be responsible to file for and obtain all required permits from the governing inspection agencies for the Electrical work. Where the Architect or Engineer is the Architect or Engineer of record, they will furnish sealed and signed drawings and specifications required by the permit authorities except fire alarm permit documents shall be prepared and submitted by an approved, licensed fire alarm subcontractor.
- C. Include payment of all permit and inspection fees applicable to the work in this Division.
- D. All work shall be subject to inspection and approval of Federal, State and local agencies as may be appropriate as well as the Architect and Engineer.
- E. Furnish for the Owner certificates of approval from the governing inspection agencies as a condition for final payment.

1.10 PROJECT MANAGEMENT AND COORDINATION

- A. The HVAC Contractor shall initially prepare and be responsible for ¼” scale coordination drawings. These drawings shall be reproduced and distributed to the Plumbing, Fire Suppression and Electrical Contractors for their input and revisions. Assure that all contractors work together to obtain finish coordinated drawings and no work being installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

1.11 TEMPORARY ELECTRIC SERVICES

- A. The temporary service and temporary lighting for construction is provided by the Electrical Contractor.
- B. The Electrical Contractor is cautioned to carefully consider the possible sources of temporary electric service and the probable location of the General Contractor's office.
- C. The General Contractor will make application to the local utility company for the temporary electric service and will pay for all electric power used during construction, including electric heating.
- D. The Electric Contractor shall furnish, install and pay for all necessary conduit, wire, metering, poles, switches, receptacles, lights and accessories to provide a 400 amp, 120/230 volt, 3 phase,

4 wire temporary electric service with the main disconnect switch, meter, and a 42 circuit load center at a location specified by the General Contractor.

- E. Consult the utility company for fees required and include same in Electrical Contract.
- F. Labor, receptacles, boxes, fixtures, wire, etc. required by the various Contractors inside their offices shall be paid for by the respective Contractors.
- G. Lighting fixtures shall be placed every 40 ft. along each corridor or where corridors do not occur, along the long axis of all rooms. Provide a minimum 800 lumen lamp in a commercial grade molded plastic socket and lattice wire guard temporary lighting assembly with extra heavy duty "ST" 3-wire cord. Lamps shall be spaced a minimum of 10 ft. apart. For large open areas or during the early stages of construction, 250 watt metal halide fixtures (or LED equivalent) with wire guards may be utilized. Receptacle circuits shall consist of 1-gang cast "FS" type box with grounded duplex receptacles a maximum of 50 ft. on center with a maximum of 4 per circuit. All receptacle circuits shall be protected by its own overcurrent device in a panel board. Install wiring and equipment above 6'-6" and below the finished ceiling. Extend circuits as required. Provide GFCI protected receptacles and circuits as required by NEC and OSHA.
- H. Contractors requiring extension cords shall provide their own cords and plugs up to capacity of 20 amperes. For services to larger items of equipment and welders, this Contractor shall extend proper feeders as requested at the expense of the Contractors requiring the service.
- I. The Electrical Contractor shall maintain the temporary light and power system for the duration of the work and shall remove it from the site when directed. Temporary wiring and equipment shall remain the property of the Electrical Contractor.
- J. The use of the permanent electrical system for temporary services during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period.
- K. Warranty periods on equipment, materials and systems shall commence upon Owner acceptance of the building or systems. Temporary use shall not jeopardize or alter warranty requirements.
- L. The complete temporary service shall comply with Power Company, OSHA, and all Code requirements.

1.12 WORKMANSHIP

- A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect shall have the right to stop the work if highest quality workmanship is not maintained.
- B. Electrical work shall be performed by a licensed Electrical Contractor in accordance with requirements of the jurisdiction.

1.13 PROTECTION

- A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.
- B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide plastic sheeting, drop cloths or similar barriers where dust and debris is generated, to protect adjacent areas.
- C. Contractor shall protect all equipment and materials from detrimental effects of weather or construction activity. All items shall be stored and secured in a protected location away from the daily work area. Equipment or materials shall be placed on raised skids to protect from surface moisture. Where appropriate, provide plastic sheeting or similar vapor barrier underneath the stored products to reduce the effects of ground moisture or curing concrete on the local humidity levels. Where unfinished ferrous products or finished ferrous products with raw edges are stored, provide local, dry heat to maintain ambient relative humidity levels below 65% RH to prevent rust.
- D. All equipment shall retain the original packaging until required to be removed for installation or operation. Open ends of ducts, piping, conduit, etc. shall be capped or sealed and ventilation openings into equipment shall be wrapped and sealed in plastic sheeting to prevent dust or dirt entry both when stored and after installation but still open to the effects of construction activity. Stored items as well as installed equipment shall be covered with plastic sheeting at all times until placed in service or until dust generating activity in the area has ceased.

1.14 PAINTING

- A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in the Electrical Contract:
 - 1. All metal which is not factory or shop painted and which remains exposed to view in the building including finished areas, mechanical rooms, storage rooms and other unfinished areas shall be given a prime coat of paint.
 - 2. All metal installed outside the building which is not factory or shop painted shall be given a prime coat of paint.
 - 3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
 - 4. Apply Z.R.C. Cold Galvanizing Compound, or approved equal, for touch-up of previously galvanized surfaces.
 - 5. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 Finishes. All rust must be removed before application of paint.
- B. Finish painting is included in the General Contract. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

1.15 CLEANING

- A. Debris, dust, dirt, etc shall be removed daily, particular attention shall be paid to areas that the Owner is continuing to occupy or use; any mess created in corridors, stairwells and egress paths that are maintained during construction shall be cleaned immediately.
- B. The Owners dumpsters and trash receptacles shall not be used. If a dumpster is required, it shall be provided by the contractor and located where approved by the Owner. Coordinate dumpster requirements with other contractors.
- C. Before turning an area back over to the Owner, thoroughly clean the space to leave the area in a similar condition before the start of the project where finishes are to remain.
- D. Before placing each system in operation, the equipment shall be thoroughly cleaned; cleaning shall be in accordance with equipment manufacturer's recommendations.
- E. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

1.16 EQUIPMENT SELECTION

- A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.
- B. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL label items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.
- C. The selection of materials and equipment to be furnished under this contract shall be governed by the following:
 - 1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
 - 2. Where the words "or approved equal" appear after a manufacturer's name, specific written approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
 - 3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval during shop drawing submittal.
- D. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.
- E. Before bidding equipment, and again in the preparation of shop drawings, the Contractor and his supplier shall verify that adequate space is available for entry and installation or the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC (and other applicable Code's) clearances are

met. The Contractor and his supplier shall also verify compatibility of equipment specified with available system/service voltages, etc.

- F. If extensive changes in conduit, equipment layout or electrical wiring and equipment are brought about by the use of equipment or existing site conditions which are not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in the contract.

1.17 SHOP DRAWINGS

- A. One set of shop drawings, in electronic format (pdf), with descriptive information shall be assembled by each Contractor of equipment and materials furnished in his contract, and submitted to the Architect and/or Engineer for review as stated in Division 01. These shall be submitted as soon as practicable and before special equipment is manufactured and before installation.
- B. Shop drawings for equipment fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. Failure to do so may be cause for rejection of shop drawings.
- C. The review of shop drawings by the Architect or Engineer shall not relieve the Electrical Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.
- D. Shop drawings of the following electrical equipment and materials shall be submitted:
 - 1. Wiring devices and coverplates.
 - 2. Panelboards and associated distribution equipment.
 - 3. Fuses.
 - 4. Motor controllers and disconnects.
 - 5. Lighting Controls including layout plans of Occupancy Sensors.
 - 6. Low voltage switching/lighting control system
 - 7. Lighting fixtures.
 - 8. Lighting standards.
 - 9. Manual transfer switches.
 - 10. Fire alarm system with schematic and point to point wiring diagrams.

1.18 TESTING

- A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.
- B. As each electrically operated system is energized, it shall be tested for function.
- C. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.

- D. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Submit four (4) copies of reports indicating results.
- E. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder when appropriate. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests.
- F. Instruments required for tests shall be furnished by the Contractor.

1.19 FINAL INSPECTION AND PUNCH LIST

- A. As the time of work completion approached, the Contractor shall survey and inspect his work and develop his own punch list to confirm it is complete and finished. He shall then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.
- B. Requests to the Architect, Engineer or Owner for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.
- C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.20 OPERATING AND MAINTENANCE MANUALS

- A. Two copies each of operating and maintenance manuals shall be assembled for the Electrical work by the Contractor.
- B. All shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of replacement material required. Major items of equipment shall consist of not less than the following:
 - 1. Motor controllers.
 - 2. Fire Alarm System.
 - 3. Specialty equipment.
- C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instruction is not available.
- D. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to

the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.21 RECORD DRAWINGS

- A. The Electrical Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.22 WARRANTIES

- A. This Contractor shall warrant all workmanship, equipment and material entering into this contract for a period of one (1) year minimum from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner.
- B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems and placed in operation. These items include, but are not limited to, motor controller malfunction, heater element changes required for motor controller, fuse replacement where fuses blow due to abnormal shorts, adjustments and/or replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.
- C. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.
- D. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.
- E. Extended warranties shall be provided where indicated in the equipment specification Sections.

1.23 OPERATION AND ADJUSTMENT OF EQUIPMENT

- A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents and adjusting all operating equipment.
- B. Caution: Verify that all bearings of equipment furnished are lubricated, all motors are operating in the right direction, and correct overload heater elements are provided on all motors. Do not depend wholly on the other trades judgment in these matters. Follow specific instructions in regard to lubrication of equipment furnished under this Contract.

1.24 OPERATING DEMONSTRATION AND INSTRUCTIONS

- A. The Contractor shall set the various systems into operation and demonstrate to the Owner and Architect that the systems function properly and that the requirements of the Contract are fulfilled.
- B. The Contractor shall provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.
- C. A minimum of 8 hours shall be allowed for instructions to personnel selected by the Owner. Instructions shall include not less than the following:
 - 1. Show locations of items of equipment and their purpose.
 - 2. Review binder containing instructions and equipment and systems data.
 - 3. Coordinate written and verbal instructions so that personnel understand each.
 - 4. Separate instructions shall be given by manufacturer's representatives for the various special and communications systems.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION – NOT APPLICABLE

END OF SECTION 26 0001

(This page intentionally left blank)

SECTION 26 0004 – FIRESTOPPING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.2 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Firestopping assemblies shall be tested and rated in accordance with ASTM E814 (ANSI/UL 1479) Fire Tests of Through-Penetration Fire Stops (minimum positive pressure of .01 inches of water column) and E119 (ANSI/UL 263) Fire Tests of Building Construction and Materials Time-Temperature Curve. Firestopping shall provide an “F” fire rating equal to that of the construction being penetrated. Firestop systems shall meet all requirements of the Ohio Building Code.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 - 2. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view or above ceilings in air return plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Firestopping materials shall be manufactured and/or supplied by:
1. Hilti, Inc.
 2. Johns Manville.
 3. Nelson Firestop Products.
 4. Specified Technologies Inc.
 5. 3M; Fire Protection Products Division.
 6. Tremco; Sealant/Weatherproofing Division.

2.2 FIRESTOPPING

- A. Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

PART 3 - EXECUTION

3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.
- B. Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.
- C. Provide firestop system for every conduit or opening at penetration of all fire resistance rated walls and horizontal assemblies.
- D. Provide rigid supports for conduit on both sides of the fire resistance rated wall or assembly where required as part of the fire stop assembly.
- E. Coordinate opening size and additional framing requirement with the General Contractor for each opening to meet the firestop installation requirements.
- F. Refer to 26 0533 Raceway and Boxes for Electrical Systems for sleeve requirements and treatment of penetrations not requiring firestopping.

END OF SECTION 26 0004

SECTION 26 0005 – EXCAVATION, BACKFILL AND SURFACE RESTORATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Excavating and backfilling for all in-grade underfloor conduit, exterior ducts, conductors, conduit, lighting standard bases, manholes, handholes, pullboxes, utility trenches and any incidental work included in the Electrical Contract.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over conduit or duct in a trench, including haunches to support sides of conduit.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Bedding Course: Course placed over the excavated sub-grade in a trench before laying manhole, pullbox or conduit.

C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

E. Fill: Soil materials used to raise existing grades.

F. 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.

G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below topsoil materials.

H. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1.4 GENERAL

- A. Excavate for all in-grade underfloor conduit, exterior ducts, conductors, conduit, lighting standard bases, handholes, pullboxes, utility trenches and any incidental work included in the Electrical Contract.. Backfill to finish grade or to levels consistent with the General Contractor's and Site Contractor's activities. Cut existing street, drive and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered. Repair or restore exterior surfaces to original condition where such are not affected by Division 2 – Site Work. Cut existing floor slabs and replace slabs in conformance to 26 002 Basic Electrical Materials and Methods. All work shall comply with requirements set forth in Division 2.
- B. Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in this contract.
- C. Contact the Ohio Utilities Protection Service (1-800-362-2764) well in advance of the start of any excavation to determine if any of the utility companies or departments have underground utilities in or near the project area.
- D. Contact local water and sewer departments, gas company, electric company, telephone company, etc., regarding the possibility of encountering existing utilities. The integrity of all existing utilities shall be respected.
- E. Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by the Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

- 2.1 Refer to Division 31 Earthwork for bedding and backfill materials

PART 3 - EXECUTION

3.1 EXCAVATION FOR UTILITY TRENCHES

- A. Interior and exterior trenches shall be over-excavated and the conduits, ducts or conductors shall be laid on 6" minimum depth sand bed.
- B. Backfilling of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with graded pea gravel, graded coarse sand or crushed limestone,

3/4" maximum size, to prevent undue settlement. Backfill material for plastic piping shall be pea gravel or sand. Other excavations and trenches shall be backfilled with similar materials up to 18" above the top of the conduit or conductor. The remainder shall be with similar materials or with excavated material having no large clods, stones or rocks.

- C. Maintain in place adequate barricades, guards, planking, plating signage, warning lights, etc., at and around excavations.
- D. Backfill shall be mechanically compacted in layers not over 6" deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of as directed by the General Contractor. Refer to Division 31 Earthwork for compaction requirements.
- E. Concrete floor slabs, paving, sidewalks, curbs sodded and other finished surfaces which have been damaged or removed in order to install the underground work shall be replaced but this Contractor equal to original conditions. Refer to Division 32 for Surface Restoration requirements. This requirement is not applicable in areas where the General Contractor or the Site Contractor is obligated to provide new surfaces.
- F. Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Any fee for activity in the roadways shall be included in this contract so that no additional cost will accrue to the Owner.
- G. All exterior underground direct buried conductor, conduit and concrete encased ducts shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6" wide with black letters identifying the type of service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18' above and on the centerline of the conductor, conduit or duct.
- H. In addition to a warning tape, concrete encased ducts shall have a concentrated red dye poured on top of the concrete before fully cured.

END OF SECTION 26 0005

(This page intentionally left blank)

SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

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 NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.
- C. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC and metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

- 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. AFC Cable Systems, Inc.
 2. Hubbell Power Systems, Inc.
 3. O-Z/Gedney; EGS Electrical Group LLC.
 4. 3M; Electrical Products Division.
 5. Tyco Electronics Corp.
- C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Stranded for No. 12 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- C. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- E. Branch Circuits Concealed in Walls (WHERE SPECIFICALLY INDICATED ON DRAWINGS) and Fixture Whips: Metal-Clad Cable, Type MC, cable shall have separate internal ground wire.
- F. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- G. Class 2 Control Circuits: Power-limited cable, in raceway.
- H. Use type THHN or XHHW (90 degrees C. rated) for connecting fluorescent fixtures and for running thru fixture housings.
- I. Use conductors such as type FEP with high temperature insulation as identified in the NEC for connections to resistance heating elements or in other areas subject to temperature exceeding the rating of THWN, XHHW or THHN.
- J. In addition to the conduit system, a separate grounding conductor shall be installed with all feeders and branch circuitry.

- K. Equipment grounding conductors shall be green, or completely taped green, at all accessible points.
- L. Wire size ampacity shall equal or exceed its overload protective device. Where sizes shown on the drawings are greater than the apparent ampacity requirements, the size shown shall prevail to compensate for voltage drop. In no instance shall conductors be installed that are less than required by the N.E.C. Minimum conductor size shall be No. 12 AWG except No. 14 AWG may be used for control wiring or where otherwise specifically indicated.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Provide a separate neutral for each branch circuit serving receptacles (no shared neutral).
- 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. Conduit systems shall be clean and clear before pulling wires. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway. Pulling of branch circuit conductors shall be performed by manual means without the use of levers or heavy pulling devices that may compromise the conductor's or insulation integrity.
- E. A maximum of 8 conductors shall be installed in a branch circuit conduit unless specifically noted otherwise on the drawings. Equipment ground conductors are not counted when determining maximum fill.
- F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- G. Wiring in vertical raceways shall be supported with strain relief devices; Kellems grips or approved equal.
- H. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."
- I. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- J. 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 and UL 486B.
- K. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- L. Underground splices (including splices in exterior pullboxes) shall be made using sealing kits or wire nuts U.L. listed and approved for the application.

- M. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack. Refer to additional notes on plans for branch circuitry installation requirements.

3.4 TESTING

- A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.
- B. As each electrically operated system is energized, it shall be tested for function.
- C. On all electric services including change-outs, backfeeds, etc. the Contractor shall verify phase rotation and voltage readings to assure the final installation is proper. Submit to the Engineer in writing a record of voltage readings and current readings taken at no-load and fully loaded conditions.
- D. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Engineer.
- E. Tests shall be witnessed by field representatives of the Engineer or shall be monitored by a recorder. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests. Copies of all test reports shall be included in the O&M manuals.
- F. Instruments required for tests shall be furnished by the Contractor.

END OF SECTION 26 0519

SECTION 26 0526 - 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 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 kmil, 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.

2.2 GROUNDING RODS

- A. Grounding Rods shall be copper clad, molten welded copper to steel; unless otherwise designated, 3/4" diameter X 10 ft. long.

2.3 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. Clamps and continuity devices shall be non-ferrous material, UL approved. Connections to ground rods and all underground connections shall be made with welded connections (“Thermoweld” or “Cadweld”).

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. 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.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. 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. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels.
- 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. Wiring devices shall be connected with grounding jumper from ground pole on device to grounding screw (or grounding pigtail) in the outlet box.
- D. 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.

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. 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.
- C. Main service neutral shall be grounded to the street side of the building water service. A bonding jumper shall be installed around the water meter. In addition to using the water service as a grounding electrode, effectively grounded building steel, driven ground rods outside or buried electrode shall be provided and connected. Bond to interior metallic water, gas and all other metallic lines.
- D. The complete metal conduit system shall be used for the equipment grounding system. Conduit systems and associated fittings and terminations shall be made mechanically tight to provide a continuous electrical path to ground and shall be safely grounded at all equipment by bonding all metallic conduit to the equipment enclosures with locknuts cutting thru paint of enclosures. Bond all conduits entering service entrance switchboard with a ground wire connecting the grounding bushings to the equipment ground bar. Conductors shall be sized per NEC Tables 250-66 and 250-122. Bond all communications conduit systems to ground.
- E. In addition to using the conduit system for grounding, a complete auxiliary green wire equipment grounding system shall be installed, continuous from main ground, thru distribution

and branch circuit panelboards and paralleling all feeders and branch circuit wiring. Grounding conductor sizes shall comply with NEC Table 250-122, minimum size shall be #12 copper except #14 on control circuits. This shall apply to all circuits rated 100 volts or more above ground potential.

- F. Ground neutral of all transformers for separately derived systems.
- G. Motor frames shall be bonded to the equipment grounding system by an independent green wire, sized as shown.
- H. Cord connected appliance frames shall be grounded to the equipment grounding system thru a green wire in the cord.
- I. A green grounding conductor shall be installed in each non-metallic conduit and all flexible conduits, including exterior underground conduits.
- J. System neutral connections shall be insulated from metal enclosures except at the neutral of the service entrance equipment and on the neutral of a separately derived system. Connections to the main service enclosure shall be by means of bonding jumpers.
- K. The building neutral shall be identified throughout with white conductors for 208/120 volt systems.
- L. A minimum #6 ground wire shall be run from each telephone backboard/data rack back to the main building ground. Or where indicated on the drawings or in the specifications, a separate communications grounding system shall be provided and bonded to the electrical grounding system at the main ground bar.
- M. Where metal covers on pull boxes and junction boxes are used, they shall comply with the grounding and bonding requirements of NEC Article 250.
- N. Connections to driven ground rods or other such electrodes shall be a minimum of 3 feet from the building foundation wall or beyond the roof drip line, whichever is greater.

END OF SECTION 26 0526

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.

1.2 PERFORMANCE REQUIREMENTS

- A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 QUALITY ASSURANCE

- A. 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:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. Thomas & Betts Corporation.
 - e. Unistrut; Tyco International, Ltd.
 - f. Wesanco, Inc.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. 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 and malleable-iron 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. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials 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:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 5. Toggle Bolts: All-steel springhead type.
 - 6. Hanger Rods: Threaded steel.

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. Utilize supports with swivel type attachments to maintain true vertical support from sloped structure or inclined structural elements (such as beam clamp with swivel option).

- D. 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.
- E. 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. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.
 - 7. 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 blocking attached to substrate by means that meet anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 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.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.4 CONCRETE BASES

- A. Provide dowel rods to connect concrete bases to concrete floors/slabs/substrates. Unless otherwise indicated, install dowel rods on maximum 18-inch centers around the full perimeter of concrete base.
- B. Provide epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor/slab/substrate, unless concrete bases are installed directly on grade. Place and secure anchorage devices. Using setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. 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. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast galvanized or stainless-steel anchor-bolt inserts into bases.
- D. Indoor bases shall be at least 4” thick and shall have straight and finished sides and a 1”-45 degree chamfer at the top perimeter. Reinforcing steel bars shall be placed in both directions of the bases. Where required for supplemental support, provide lateral support work to adjacent wall(s). Provide concrete bases/housekeeping pads beneath all electrical power and systems distribution equipment that is floor mounted or wall mounted within 4” of the floor.
- E. Outdoor bases shall be at least 6” thick and shall have straight and finished sides and a 1”-45 degree chamfer at the top perimeter. Perimeter of pads shall extend down below the frostline. Reinforcing steel bars shall be placed in both directions of the bases and a mesh overlay shall be provided. Where required for supplemental support, provide lateral support work to adjacent wall(s). Provide concrete bases/housekeeping pads beneath all electrical power and systems distribution equipment that is slab or grade mounted or mounted within 6” of slab or grade.
- F. Unless indicated otherwise in specifications or on drawings, use minimum 3000-psi, 28-day compressive-strength concrete. Size and provide concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
- G. Forms: As required for equipment pads or other special applications in field, provide forms made of steel, wood, or other suitable material of size and strength to resist movement during concrete placement, and to retain horizontal and vertical alignment until removal. Use straight forms, free distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends. Do not remove forms for 24 hours after concrete has been placed. Set forms to required grades and lines, rigidly braced and secured. Provide sufficient quantity of forms to allow continuous progress of work, and so that forms can remain in place at least 24 hours after concrete placement. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage. Form areas that involve termination of spare conduits below grade, or that involve continuation of conduits by others, accordingly to accommodate easy future access to the ends of conduits for future extensions.
- H. Reinforcement: Cut bars true to length with ends square and free of burrs. Provide metal expansion caps for one end of each dowel bar in expansion joints. Design caps with one end closed and minimum length of 3” to allow bars movement of not less than 1”, unless otherwise indicated. Provide these for joining applications where continuous pouring cannot be accomplished.

- I. Concrete Placement: Remove loose material from subbase surface immediately before placing concrete. Check subbase and forms for line and grade before placing concrete. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Place concrete using methods that prevent segregation of mix. Use splash boards to divert the flow of concrete away from the trench sides, and to avoid dislodging soil and stones. Coordinate with Owner's Representative at least 72 hours prior to placing concrete. Line up concrete trucks as required to achieve one continuous pour where applicable. Do not backfill until a minimum of 48 hours have passed.
- J. Concrete Finishing: Smooth surface by screeding after striking-off and consolidating concrete. Provide Class A finishing. Broom finish concrete pads, and aprons around pullboxes and structures. Protect concrete from damage until acceptance of work. Exclude traffic over affected areas for at least 14 days after placement.

3.5 PLYWOOD EQUIPMENT BOARDS

- A. Plywood Equipment Boards: Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent. Provide plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than $\frac{3}{4}$ inches deep. Provide marine grade plywood where subject to moisture conditions. Provide Simpson Strong Tie (or equal) expansion screw anchors.
- B. Unless otherwise noted, boards shall be painted with two coats of good grade weatherproof flat gray non-conductive fire-retardant paint on all sides and edges (prior to mounting) and plumbed in a true vertical position. Provide nominal $\frac{1}{2}$ " rustproof spacers between back of plywood and wall. Cut, fit, and place plywood equipment boards accurately in location, alignment, and elevations to support and anchor electrical materials and equipment. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members. Attach to substrates as required to support applied loads. Maintain at least 4 inches from bottom of plywood equipment boards and the finished floor surface.
- C. Unless directed otherwise in field, plywood equipment boards shall be 8 feet high by $\frac{3}{4}$ inches deep by length shown on drawings (as dimensioned or as scaled) or length as required to accommodate equipment if not indicated on drawings. Unless directed otherwise in field, provide plywood equipment boards for all indoor surface mounted panelboards and systems "head-end" equipment for all applications where located in mechanical or electrical rooms/areas and only where specifically shown on drawings for all other applications.

END OF SECTION 26 0529

SECTION 26 0533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 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, details, and attachments to other work.

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 NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. IMC: ANSI C80.6.
- C. EMT: ANSI C80.3.
- D. FMC: Zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket.
- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: Steel only; set-screw type.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. ENT: NEMA TC 13.
- B. RNC: NEMA TC 2, unless otherwise indicated.
- C. LFNC: UL 1660.
- D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

2.3 SURFACE RACEWAYS

- A. Surface Metal Raceways: Brushed Aluminum with snap-on covers.
 - 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:
 - a. Mono Systems.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Hubbell Wiring Systems.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- D. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- E. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- F. Cabinets:
 - 1. NEMA 250, Type 1, 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.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit.
 - 2. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, 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: Rigid steel conduit. Includes raceways in the following locations:
 - a. Mechanical rooms.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT except FMC may be utilized in walls where specifically noted on drawings.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 6. Damp or Wet Locations: Rigid steel conduit.
 - 7. Raceways for Optical Fiber or Communications Cable: EMT.
 - 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size, except 1/2-inch may be utilized where noted for motors.
- 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.
 - 2. EMT: Use all steel, setscrew type, concrete tight.
 - 3. Flexible conduit: Use malleable iron, “squeeze” type, non-insulated. (For lighting fixture whips only: Use all steel or die-cast screw-in connector).
 - 4. Liquid-tight conduit: steel or malleable iron.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter. Generally run conduit and conductors as high as practicable against underside of floor slab in concrete construction or immediately below the **top chord** of bar joist construction unless otherwise shown or noted. This high level zone shall be used for running electrical raceways and shall be grouped or

racked together wherever feasible. Runs at bottom chord level or ceiling grid level are not acceptable.

- 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. Complete raceway installation before starting conductor installation. Plan raceway routing to minimize the number of offsets and junction boxes.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated. All conduit shall parallel building lines.
- G. Conduit shall be run overhead and shall not be run below concrete slabs unless specifically indicated on the drawings and in the legend on the drawings.
- H. Where MC cable is noted as allowed, it shall be routed from a common room junction box (with homerun in EMT) to room wiring device(s) via horizontal run above accessible ceiling with vertical drop in wall to device. **No horizontal runs in walls except where a device is located below a window and a vertical drop is not feasible.**
- I. Conduit crossing building expansion joints shall have expansion provisions with grounding continuity, use special expansion fittings listed for the application. Refer to the Architectural and Structural floor plans and details for locations of expansion joints.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. 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.
- L. Raceways for Data, Audio Visual and Communications Cable:
 - 1. Refer to Technology Drawings/Specifications.
- M. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in all locations except MC may be used for lighting fixture whips.
- N. 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.
- O. Do not install wall-mounted boxes back-to-back in opposite sides of wall; in stud walls, boxes shall be on opposite side of studs.

- P. Provide access to all junction and pull boxes.
- Q. Set metal floor boxes level and flush with finished floor surface. Provide trim ring compatible with finish floor system.
- R. Pull mandrel or large swab thru conduit to assure freedom from debris before pulling wires. Use listed pulling lubricants where necessary.
- S. Provide four (4) 1 inch diameter spare conduits for each flush mounted branch circuit panelboard; extend from top of panelboard to above an accessible ceiling for future use.
- T. Contractor shall record carefully on a set of “as-built” prints, the exact location of all feeder conduits (100 amps and larger).
- U. Unless noted otherwise on the drawings, a maximum of 8 conductors shall be installed in a branch circuit conduit. This maximum is a count of all phase and neutral conductors only.

3.3 INSTALLATION OF EXPOSED CONDUIT OUTDOORS

- A. Only install conduit exposed outdoors when it is impossible to do otherwise, or only if specifically indicated for such installation case-by-case elsewhere in documents. Installation convenience, financial considerations, lack of coordination with other trades and similar rationale are not sufficient reasons for conduit sizes per NFPA 70 (National Electrical Code, NEC). Provide expansion fittings, which are Listed and labeled for the respective applications, at all building expansion joints and at maximum distances of 100 feet. Paint all such conduits with at least two coats of UV-resistant weatherproof paint. Provide colors to match respective surrounding surfaces; submit colors to Design Professional for review in advance of procuring paint.

3.4 INSTALLATION OF EXPOSED CONDUIT ON ROOFS

- 1. Only install conduit exposed on rooftops when it is impossible to do otherwise, or only if specifically indicated for such installation case-by-case elsewhere in documents. Installation convenience, financial considerations, lack of coordination with other trades and similar rationale are not sufficient reasons for doing so. In cases where conduits must be installed on rooftops, de-rate conductors and modify conduit sizes per NFPA 70 (National Electrical Code, NEC). Provide expansion fittings, which are Listed and labeled for the respective applications, at all building expansion joints and at maximum distances of 100 feet. Paint all such conduits with at least two coats of UV-resistant weatherproof paint. Provide white paint of flat rooftops that have finishes white in color, and for otherwise-colored roof finishes that are not visible from the building interior or from the ground outdoors. Elsewhere select colors to match surrounding surfaces; submit colors to Design Professional for review in advance of procuring paint.

END OF SECTION 26 0533

SECTION 26 0543 –UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.
3. Manholes.

1.2 SUBMITTALS

A. Product Data: For accessories for handholes, and boxes.

B. Shop Drawings for Factory-Fabricated Handholes and Boxes: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

C. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B. Utilize galvanized rigid steel for 90 degree bends (long sweep type) with proper adapters between PVC duct and galvanized steel.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- 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:
1. Cantex, Inc.
 2. CertainTeed Corp.; Pipe & Plastics Group.
 3. Heritage Plastics.
 4. Carlon Electrical Products.
 5. Manhattan/CDT; a division of Cable Design Technologies.
 6. Spiraduct/AFC Cable Systems, Inc.
- B. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, to provide minimum duct spacings while supporting ducts during concreting or backfilling.

2.3 HANDHOLES AND BOXES

- A. Description: Comply with SCTE 77.
1. Color: Gray.
 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, As indicated for each service.
 6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. 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.
- B. Polymer Handholes and Boxes: Molded of fiberglass-reinforced polymer concrete, with matching covers.
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:
 - a. Carson Industries LLC.
 - b. Quazite (Hubbell).
 - c. Highline Products, Inc.

PART 3 - EXECUTION

3.1 EARTHWORK AND RESTORATION

- A. Refer to Division 26 Section “Excavation, Backfill and Surface Restoration”.

3.2 DUCT INSTALLATION

- A. Slope: Pitch ducts 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.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends at other locations, unless otherwise indicated.
- C. Joints: Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Vaults: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. 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.
- F. 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.
- G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- H. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators 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.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
 - 3. 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.
 - 4. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

- a. 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.
5. Identify Ductbank with one of the following methods:
 - a. Mark the top of all underground duct runs with concentrated red dye or powder on top.
 - b. Provide 6” wide yellow plastic tape, with black letters indicating “Electric”; place approximately 18” above and continuously along the centerline of duct bank.

3.3 INSTALLATION OF CONCRETE MANHOLES

- A. Comply with ASTM C 891, unless otherwise indicated.
- B. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
- C. 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.
- D. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
- E. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- F. Hardware: 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.
- G. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.4 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 the 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: Set covers of handholes 1 inch above finished grade and boxes with bottom below the frost line.

- D. 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.

3.5 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.6 CLEANING

- A. Pull mandrel 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 26 0543

(This page intentionally left blank)

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Identification for conductors and communication and control cable.
2. Wiring device circuit identification.
3. Warning labels and signs.
4. Equipment identification labels.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Marker Tape: Vinyl or vinyl -cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 WIRING DEVICE CIRCUIT IDENTIFICATION

A. Marker Tape: Self-laminating, clear polyester, 3/8" high tape with black lettering.

B. Provide label on every wiring device cover plate, indicating panel and circuit breaker fed from. Utilize 12 pt. font. Mount label on face of device cover plate, centered near the top .

2.3 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. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 mm)."

2.4 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Phenolic Label: Adhesive backed, with black letters on a white background. Minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Electrical and Auxiliary Systems Box, Conductor and Cable Identification: Use marker tape to identify field-installed branch circuit, alarm, control, signal, sound, intercommunications, voice, and data wiring connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and cable pull points. Identify by system and circuit designation.
 - 2. Identify panel and branch circuit number(s) on all junction box covers permanently clearly printed with bold black indelible marker.
 - 3. Use system of designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
- B. Conduit and junction boxes:
 - 1. Color code or label all junction boxes and exposed conduit at 20 ft. intervals. Coding shall be painted or labels of the pre-manufactured type permanently mounted with metal or plastic band.

2. Label panelboard and branch circuit number(s) on outside of junction box cover at all junction boxes containing branch circuit wiring. Labelling shall be neatly done utilizing black indelible ink markers.
 3. Paint all junction boxes and covers for fire alarm wiring red.
- C. Branch circuit panelboards:
1. Identify panel designation on directory card within the panel.
 2. Fill out branch circuit directory indicating circuit number and area served, rooms, group of rooms, lighting, convenience outlets, motors, etc. Card index shall be neatly typed.
 3. Replace branch circuit directory in existing panelboards in areas of alteration.
 4. Branch circuit phase conductor color format shall be permanently identified inside each panelboard.
- D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
1. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and 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: Self-adhesive, engraved, laminated phenolic label. Unless otherwise indicated, provide a single line of text with 1/4-inch- high letters on 5/8-inch- high label; where 2 lines of text are required, use labels 1 inch high.
 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Disconnect switches.
 - c. Enclosed circuit breakers.
 - d. Motor starters.
 - e. Lighting Relay Panel(s).
 3. Label shall include equipment name, voltage and where fed from. Where equipment is located in finished spaces, accessible to the public, in addition to adhesive, secure labels with screws, one on each end.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White

END OF SECTION 26 0553

SECTION 26 0923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Indoor occupancy sensors.
- B. See Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Lighting.
 - 2. Leviton Mfg. Company Inc.
 - 3. Lutron Electronics.
 - 4. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 5. Watt Stopper (The).
 - 6. Sensorswitch.
 - 7. Greengate.
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
- C. Dual Technology Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.
- D. Emergency Bypass Relays:
1. Where an emergency power system is available and plans indicate control of emergency lighting via occupancy sensor controls, provide U.L. 924 Listed emergency bypass relay(s) to illuminate emergency lighting from emergency power system during a normal power outage.
- E. Application:
1. Utilize sensor type to best apply to the area it controls (i.e. office, corridor, restrooms, etc.) and provide proper quantity and spacing of sensors to adequately cover the entire area it serves.
 2. Sensors shall be located and adjusted in private office to prevent incidental activation from passerby in hallways or sensor shall utilize 'adaptive' technology to recognize usage patterns and adjust sensitivity.
 3. Provide override switch where indicated on plans to disable operation of sensor and leave lights off.

2.2 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 95 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. After construction period and just prior to turn-over of facility for beneficial use, reset all sensors that are "Adaptive Technology" (or "Smart Technology") to initiate their "learning mode" while in use by the Owner during move-in and beneficial use. Follow up with necessary sensor adjustments within 15 working days.
- C. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 1. After installing sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION 26 0923

SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 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.
- C. Panelboard schedules for installation in panelboards.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and/or surface-mounted cabinets, as indicated on the drawings.
 - 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. 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/or bottom as Project condition dictates.
- 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: Fully rated to interrupt symmetrical short-circuit current available at terminals.
- H. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cutler-Hammer.
 2. Siemens.
 3. Square D.
 4. General Electric (GE).

2.2 DISTRIBUTION PANELBOARDS

- A. Panelboards: NEMA PB 1, power and feeder distribution type.
- B. Doors: Secured with vault-type 3 point latch with tumbler lock; keyed alike.
- C. Mains: Circuit breaker/ Lugs only as identified on the drawings.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: Circuit breaker and/or lugs only as identified on the drawings. Sized to have 225 amp bussing unless indicated otherwise on drawings.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units. Sized to accommodate 54 poles unless indicated otherwise on drawings. Furnish number of breakers shown.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents listed on the drawings.
 - 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. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles. Where more than one pole is used, they shall employ a common trip.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type HACR for feeding heating, air conditioning and refrigeration equipment.
 - 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. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- B. 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 Division 26 Section "Fuses."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of lighting and appliance panelboard trim 72 inches above finished floor; distribution panelboard trim 90 inches above finished floor, unless otherwise indicated.
- C. 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.
- D. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges and ground fault settings as applicable.
- E. Install filler plates in unused spaces.
- F. Stub four 1-inch empty conduits from flush mounted panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- H. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Switchboards or panelboards containing a 4-wire, delta connected system where the midpoint of one phase winding is grounded shall be legibly and permanently field marked to indicate "high phase leg to ground" per (2017) NEC 408.3(F).
- C. Create a directory to indicate installed circuit loads and incorporating Owner's final room, area or equipment designations. Temporary conditions of occupancy shall not be utilized as circuit descriptions. Indicated spare circuits shall be specifically labeled as such. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- D. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- E. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Panelboards will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 2416

(This page intentionally left blank)

SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Wall-box motion sensors.
 - 3. Snap switches and wall-box dimmers.
 - 4. Solid-state fan speed controls.
 - 5. Wall-switch and interior occupancy sensors.
 - 6. Communications outlets.
- B. See Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.

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; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; 5361 (single), 5362 (duplex).
 - c. Leviton; 5351 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. All receptacles installed outdoors shall be weather resistant type.
- C. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; VGF20.
 - b. Pass & Seymour; 2085.
 - c. Leviton; 7899.
 - d. Hubbell; GF20.

2.4 TAMPER RESISTANT STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, NEC 517.18 and UL 498.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; TR8300 (duplex).
 - b. Hubbell; HBL8300 (duplex).
 - c. Leviton; T7899 (duplex).
 - d. Pass & Seymour; TR26362 (duplex).

2.5 TAMPER RESISTANT STRAIGHT BLADE GFCI RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, NEC 517.18 and UL 498.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; GFR5362 (duplex).
 - b. Leviton; T7899 (duplex).

- c. Pass & Seymour; 2095TR (duplex).

2.6 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.7 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, 0-10V, solid-state units with integral, quiet on-off switches. Unit listed and compatible for type of lighting controlled and rated for connected load unless larger rating is indicated for future capacity.
- B. Control: Continuously adjustable slider, with separate on-off switch; single-pole or three-way switching capability. Comply with UL 1472.

2.8 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, manufacturer shall match that submitted for ceiling mounted occupancy sensors.
 - 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..

2.9 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.035-inch- thick, satin-finished stainless steel.

- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.
 - 1. Outdoor receptacle covers shall be “In Use” type rated “Extra Duty”.

2.10 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Round, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 configuration 5-20R, black finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: As noted on plans or as indicated in applicable specification section.

2.11 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices: White, unless otherwise indicated or required by NFPA 70 or device listing. Switches, receptacles and coverplates for emergency lighting shall match color and type of normal lighting switches.
 - 2. Device plates: Nylon, to match color of wiring devices.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. 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 the 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.
 - 5. All 15 or 20 amp-120V wiring devices located within 6 feet from the edge of a sink, located in Kitchens or Bathrooms or serving electric water cooler shall be GFCI protected type device.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
3. 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 all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
3. When there is a choice, use side wiring with binding-head screw terminals.
4. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
5. Tighten unused terminal screws on the device.

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.

3.2 “PLUG CONNECT/PLUG TAIL” DEVICES

- A. In lieu of terminal screw connected receptacles and switches as specified above, specialized plug-in type devices may be provided as long as it is offered by the same manufacturer and listed equivalent to the same product line specified. Permanent wiring pigtails shall be of sufficient length to enable replacement of device with standard terminal screw type device as required by Code.

- B. Where plug-in type wiring devices are provided, furnish a minimum of five (5) of each type and color device installed to the Owner as spares. Where more than one hundred (100) of any type is installed, provide a minimum of ten (10) spare devices.

3.3 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. 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 not acceptable.
 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.

END OF SECTION 26 2726

SECTION 26 2813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cartridge fuses rated 600-V ac and less for use in, enclosed switches, panelboards, enclosed controllers and motor-control centers.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Cooper Bussman, Inc.
 - 2. Mersen.
 - 3. Littelfuse.

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. Feeders: Class RK1, time delay.
- B. Motor Branch Circuits: Class RK1, time delay.

- C. Other Branch Circuits: Class RK1, time delay.
- D. 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 Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION 26 2813

SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Fusible switches.
 2. Nonfusible switches.
 3. Shunt trip switches.
 4. Molded-case circuit breakers (MCCBs).
 5. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FUSIBLE/NON-FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cutler-Hammer.
 2. Siemens.
 3. Square D.
 4. General Electric (GE).
- B. All starters and disconnect switches shall be of the same manufacturer unless otherwise approved.

- C. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses specified when so indicated on the drawings, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. 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 SHUNT TRIP SWITCHES (Elevator Power Module)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Ferraz Shawmut, Inc.
 - 3. Littelfuse, Inc.
 - 4. Square D.
- B. 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.
- C. 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.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. 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; 24-V dc coil voltage.
 - 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cutler-Hammer.
 - 2. General Electric Company.
 - 3. Siemens.
 - 4. Square D.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. 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.
- D. 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. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 4. 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.
 - 5. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.

2.4 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. Kitchen/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 6'-0" A.F.F. unless otherwise indicated.
- B. Install fuses in fusible devices.
- C. Coordinate location of devices to allow working clearances and to avoid interference with other equipment and trades.

- D. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved laminated-plastic nameplate.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

END OF SECTION 262816

SECTION 26 2913 - ENCLOSED MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
 - 1. Across-the-line, manual and magnetic controllers.
 - 2. Multispeed controllers.
- B. Refer to “Disconnect Switches” section for switch requirements.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.
- B. Comply with NFPA 70.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.
- D. Motor starters and disconnects shall be manufactured and rated in accordance with NEMA, UL and IEEE Standards. IEC rated contactors and overloads are not acceptable.

1.3 COORDINATION

- A. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allen-Bradley Co (Bulletin 509)
 - 2. Cutler-Hammer (Class AN16).

3. Siemens (Class 14).
4. Square D Type S (Class 8536).
5. General Electric (300 Line).

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED." Manual Controllers furnished for fractional horsepower, single phase motors unless otherwise indicated on plans.
 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated. Provide Magnetic Controllers on all motors one horsepower and greater or any 3 phase motor, unless indicated otherwise on plans.
 1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Provide fusing on control transformer primary and secondary, each phase, and grounded on the secondary.
 2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
 1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL. Provide fusible disconnect only where specifically indicated on the drawings or where required by Code.
 2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
 3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 ENCLOSURES

- A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated.
 1. Outdoor Locations: NEMA 250, Type 3R.

2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, LED Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. A Hand-Off-Auto selector switch shall be mounted in the face of each starter enclosure. The selector switch shall be so wired that when it is in the Hand or Auto position, all safety controls are wired in series with the selector switch. All control devices shall be wired in the Auto position only.
- D. Provide a green LED pilot light mounted in the face of enclosure. Wire pilot light so that light will be on when motor is energized.
- E. Provide a red LED pilot light mounted in the face of enclosure. Wire pilot light so that light will be on when starter power supply is energized.
- F. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock control circuit open.
- G. Control Relays: Auxiliary and adjustable time-delay relays. Provide adjustable 0-60 second "on" time delay relay on starters where indicated on drawings and wire into the "Auto" position of the selector switch to delay starting.
- H. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting. Provide on all 3 phase motor starters 5 HP and larger; wire ahead of the H-O-A switch.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

3.2 INSTALLATION

- A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide floor set unistrut frame to mount adjacent to equipment being controlled. Allow proper service clearances to equipment.
- B. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.3 IDENTIFICATION

- A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Bundle, train, and support wiring in enclosures.
- B. Install all other control and interlock wiring in the field that cannot be factory pre-wired and is indicated on the plans or other specification sections as wired by the Electrical Contractor.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Test electrical phase rotation of 3-phase supply feeders.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Correct malfunctioning units and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 26 2913

SECTION 26 4313 – SURGE PROTECTIVE DEVICES (SPD) FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes SPD's for low-voltage power equipment.

1.2 QUALITY ASSURANCE

- A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer. Manufacturer shall have been engaged in the manufacture of SPD products specified and products shall have been in satisfactory service for not less than 5 years.
- B. 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.
- C. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- D. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."
- E. Comply with UL 1283 5th Edition, "Electromagnetic Interference Filters," and UL 1449 3rd Edition, "Surge Protective Devices."

1.3 PROJECT CONDITIONS

- A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F.
 - 3. Humidity: 0 to 85 percent, non-condensing.
 - 4. Altitude: Less than 20,000 feet above sea level.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Advanced Protection Technologies, Inc.
2. Current Technology, Inc.
3. Cutler-Hammer, Inc. (Clipper)
4. Liebert Corporation.
5. Thor Systems, Inc.
6. Siemens Energy & Automation, Inc.
7. Square D.
8. General Electric (GE).
9. LEA International.

2.2 SERVICE ENTRANCE SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
 1. LED indicator lights for power and protection status.
 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 3. Fuses/circuit breaker, rated at 200-kA interrupting capacity.
 4. Integral disconnect switch or circuit breaker to isolate entire suppressor components for repair/replacement.
 5. Redundant suppression circuits.
 6. Surge-event operations counter.
- B. Peak Single-Impulse Surge Current Rating: 150kA per mode (300 kA per phase).
- C. Connection Means: Permanently wired.
- D. SPD and overcurrent/disconnect device shall have a short circuit current rating greater than that available on the electrical system.
- E. Protection modes and UL 1449 voltage protection rating compatible with system voltage and configuration as indicated on the drawings for complete protection as follows:
 1. Line to Neutral.
 2. Line to Ground.
 3. Neutral to Ground.

2.3 PANELBOARD SUPPRESSORS

- A. Same characteristics and requirements as service entrance suppressors with the following exceptions:
- B. Surge-event operations counter not required.
- C. Peak Single-Impulse Surge Current Rating: 65kA per mode (130 kA per phase).

2.4 ENCLOSURES

- A. NEMA 250 (or better), with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible (not to exceed 18 inches). Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground. Twist input conductors together to reduce system inductance.
 - 1. Provide multipole circuit breaker or fusible disconnect switch as a dedicated disconnect for suppressor, fuse size and type as recommended by SPD manufacturer.

3.2 PLACING SYSTEM INTO SERVICE

- A. Do not energize or connect service equipment to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

- A. Testing: Perform the following field tests and inspections and document on test reports:
 - 1. Complete startup checks according to manufacturer's written instructions.

END OF SECTION 26 4313

(This page intentionally left blank)

SECTION 26 5113 - INTERIOR LIGHTING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, light engines (LED's) and drivers.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
- B. See Division 26 Section "Wiring Devices" for manual wall-box dimmers for LED fixtures or lamps.
- C. See Division 26 Section "Lighting Control Devices" for automatic control of lighting, including occupancy sensors, and multi-pole lighting relays and contactors.

1.2 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes and photometric data.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- C. LED Fixtures: Fixtures with LED light source are noted on lighting fixture schedule with advertised lumen output of light source for fixture/manufacturer specified and color temperature. Listed equal manufacturer shall provide fixture with equivalent lumen output as listed product. If insufficient information is provided, the Engineer may require Project Specific, point-by-point photometric calculations of sample areas utilizing the submitted fixture to prove equivalent performance.
- D. Product Certificates: For each type of driver, signed by product manufacturer.
- E. Utility Company Energy Rebate Programs
 - 1. LED lighting fixtures shall be Energy Star or DLC listed to comply with local Utility Company Rebate Programs. Does not apply to track lighting fixtures. Fixture submittals that do not have either of these listings clearly indicated in the product data shall be rejected.
- F. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. All LED fixtures and components shall be tested and comply under the standards of IESNA LM-79-08, LM-80-08, LM-82-12 and TM-21-11 for measurement and publication of projected long term lumen maintenance, color stability, photometric performance and LED source operating lifetime. Fixture submitted shall meet the listed lifetime rating of the fixture specified, as a minimum.

1.4 WARRANTY

- A. Provide a written, five year replacement material warranty for defective or non-starting LED source assemblies. Warranty period shall begin on date of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Lighting Fixture Schedule the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified on drawing schedule.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with UL 1598 and NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Polymer Components: Plastic or polymer housing/components of fixture assemblies shall be rated for the temperature (or plenum) environment installed and shall not degrade in structural integrity, shape, color or finish for a minimum of 10 years.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit servicing without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during servicing and when secured in operating position.
- F. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

- a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
2. Glass: Tempered glass, unless otherwise indicated.
- G. Servicing Access: Fixtures specified for installation in inaccessible (gypsum/drywall) ceilings/walls, etc. shall be fully serviceable/accessible from the fixture aperture.
- H. Disconnecting Means:
1. Lighting fixtures with luminaires that utilize fluorescent double-ended lamps and contain ballast(s) that can be serviced in place or ballasted luminaires that are supplied from multi-wire branch circuits and can be serviced in place shall have a local disconnecting means at/within the fixture complying with NEC Article 410.130(G).

2.3 DRIVERS

- A. Drivers for LED Light Sources:
1. Driver shall be separate component from LED light source and shall be replaceable utilizing mounting screws, factory provided clips and electrical connector bodies.
 2. Dimming (When noted or indicated on Fixture Schedule): 100 to 1 percent of rated lumens via separate 0-10V input (Dimmer) control. Line voltage dimming acceptable when noted on plans.
 3. Level Control/Step-Dimming (When noted or indicated on Fixture Schedule): Minimum capability of bi-level control (100%-50%-Off) or 1/3-2/3-Full on, as noted.
 4. Voltage input: 120-277 Volt multi-volt capability.
- B. Internal-Type Emergency Fluorescent Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with driver. Comply with UL 924.
1. Emergency Connection: Operate light source continuously at a minimum output of 1000 lumens. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture driver.
 2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 3. Battery: Sealed, maintenance-free, nickel-cadmium type.
 4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 5. Voltage input: 120-277 Volt multi-volt capability.

- C. Where plans call for multi-level switching/lighting, provide appropriate driver in fixture as required to accommodate the switching level arrangement of fixture.

2.4 EXIT SIGNS

- A. Internally Lighted Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
 - 1. Light source for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 - 2. Voltage input: 120-277 Volt multi-volt capability.

2.5 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns luminaire on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Luminaire automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects luminaire from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Voltage input: 120-277 Volt multi-volt capability.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge.
- C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- D. Recessed fixtures shall be supported at all 4 corners, independent of each other, from structure above with steel #12 single jack chains. Additionally, securely fasten each fixture to the ceiling framing member by mechanical means such as bolts, screws, rivets or approved clips; install a minimum of one on each four sides of fixture.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls.

- B. Comply with NFPA 70 for minimum fixture supports.
- C. Suspended Lighting Fixture Support:
 - 1. Single or Continuous Rows: Provide manufacturer required quantity of suspension cables at minimum intervals to support continuous row fixtures. The E.C. shall support suspended fixtures independently from the ceiling system and as specified by the fixture manufacturer.
- D. Surface or Flush Lighting Fixture Support:
 - 1. The E.C. shall coordinate fixture locations with the trade installing the ceiling system to assure support members are oriented and located to accommodate the lighting fixture layout.
 - 2. Surface or flush fluorescent fixtures in ceilings of the suspended lay-in type shall be installed so that the long dimension of the fixture is supported on the main support members of the ceiling system.
- E. Luminaires installed in exposed or concealed locations under metal corrugated sheet roof decking shall be installed and supported so there is not less than 1-1/2” measured from the lowest surface of the roof decking to the top of the luminaire.
- F. Adjust aimable lighting fixtures to provide required light intensities.
- G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Where applicable, verify transfer from normal power to battery and retransfer to normal.

3.3 SPARE LAMPS/FIXTURES

- A. For LED fixtures with LED source integral to the fixture assembly, provide one spare fixture for each type as noted on lighting fixture schedule.
- B. For fixtures with separate/replaceable LED luminaire (retrofit lamp), provide 5 spare lamps of each type utilized.

END OF SECTION 26 5113

(This page intentionally left blank)

SECTION 26 5200 – EXIT AND EMERGENCY LIGHTING

PART 1 - GENERAL

- 1.1 Exit lighting and emergency lighting system wiring shall be run in conduit system which is completely independent of normal wiring systems.

PART 2 - PRODUCTS – N/A

PART 3 - EXECUTION

- 3.1 Install a green ground wire throughout the wiring system.

END OF SECTION

(This page intentionally left blank)

SECTION 26 5600 – EXTERIOR AREA LIGHTING

PART 1 - GENERAL

- 1.1 Work includes complete new exterior lighting including luminaires, lamps, poles, bases, conduit, conductors, fusing, control devices, etc. as shown on the drawings. Include all excavation, backfill, concrete bases and encasement of underground conduits as detailed on the drawings.

PART 2 - PRODUCTS

- 2.1 Refer to data on the drawings for fixture details.
- 2.2 Aluminum poles, when specified, shall include a vibration dampener provided by the manufacturer.
- 2.3 Exterior building mounted lights utilized for emergency egress shall incorporate multiple drivers/LED sources where a single fixture is utilized at an exterior exit.

PART 3 - EXECUTION

- 3.1 Concrete bases for standards shall be round extending above finish grade as detailed on the drawings with rounded corners and rubbed finish. Furnish anchor bolts as recommended by the manufacturer. Concrete bases shall be poured-in-place at the job site; steel reinforced concrete, minimum 3500 lb. test.
- 3.2 Provide a surge arrester behind the handhole in pole base of each lighting standard and connect to each phase conductor and 0.625" diameter by 10 ft. long copper clad driven ground rod providing a good grounding path. Connect the equipment grounding conductor to this grounding terminal. A separate ground rod is required for each lighting standard exceeding 15 ft. in height. Surge arresters shall be Square D Series SDSA, Joslyn Model Series 1250 or G.E. 9L15E and F Series. Install per NEC Article 280.
- 3.3 Provide Buss "KTK" fuses in HEB waterproof in-line holder ahead of the ballast in each "hot" leg; locate behind handhole in pole base.
- 3.4 Consult manufacturer of pole and fixture(s) for recommended installation methods.
- 3.5 Mount standards truly vertical. Shim and grout under fixture base to level standards, visible shims are not acceptable. Provide anchor bolt covers.
- 3.6 Splicing shall be made with approved and UL Listed, waterproof splicing kits and shall be located in base of poles behind handhole or in splice box if indicated on plans.

- 3.7 Install a green ground wire throughout the underground wiring system and bond to all standards.

END OF SECTION 26 5600

SECTION 26 6101 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers fire alarm systems, including initiating devices, notification appliances, controls and supervisory devices.
- B. Work covered by this section includes the furnishing of labor, equipment and materials for installation of the fire alarm system as indicated on the drawings and specifications.
- C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
 - 1. Fire alarm and detection operations.
 - 2. Control and monitoring of elevators, smoke control equipment, door hold-open devices, fire suppression systems, emergency power systems and other equipment as indicated in the drawings and specifications.

1.2 Acceptable Manufacturer

- A. Manufacturer: The equipment and service described in this specification are those supplied and supported by Notifier whose catalog numbers are used herein for establishing equipment criteria. Other acceptable manufacturers are Silent Knight, Honeywell, Cerberus Pyrotronics, Mircom or Simplex Grinnell.
- B. Equipment manufacturer shall have a service organization within 60 miles of the project site and be a U.L. certified company. All equipment and materials necessary for proper operation of the system shall be deemed part of these specifications even if not specifically listed or described in this document.

1.3 Related Documents

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 1 and 26 Specification Sections, apply to this section.
- B. The work covered in this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
 - 1. Division 26: "Common Work Results for Electrical."
 - 2. Division 26: "Control Voltage Electrical Power Cables."
- C. The system and all associated operations shall be in accordance with the following:
 - 1. Guidelines of the following Building Code: BOCA
 - 2. NFPA 72, National Fire Alarm Code

3. NFPA 70, National Electrical Code
4. NFPA 101, Life Safety Code
5. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
6. Other applicable NFPA standards
7. Local Jurisdictional Adopted Codes and Standards
8. ADA Accessibility Guidelines

1.4 System Description

- A. System shall be a microprocessor based, double supervised, closed circuit fire alarm system of modular design utilizing addressable technology for remote devices. Wiring shall be Class “B” for signaling and notification circuits. Smoke detectors shall be analog, addressable units with control panel adjustable sensitivity. All equipment shall be labeled by U.L. for fire alarm signaling use.
- B. Operation of any addressable manual or automatic fire alarm initiating device shall initiate the following:
 1. Sound a Code-3 temporal pattern audible alarm signal (pattern programmable at the main panel) and illuminate fire signal lights (strobes) in a synchronous mode until alarms have been silenced. Alarm may be silenced at the main fire alarm system control panel or at a remote annunciator panel by means of an “alarm silence” switch or if the initiating device returns to normal and a system “reset” switch is manually actuated.
 2. Display the alarm condition on integral LCD display in the main control panel and remote annunciator(s). Display shall indicate the alarming device and its location. All alarm initiating devices shall be individually addressed.
 3. Print the assigned message with time and date at the control panel (or remote printer, if specified). Activate control-by-event functions listed in these specifications.
 4. Initiate a separate trouble and alarm signal for connection to remote monitoring service organization via dedicated telephone line(s) or as directed by Owner.
 5. Release all electromagnetic door holders.
- C. In the event of an operating power failure or an open or a grounded circuit in the system, a trouble signal and a trouble light shall be activated until the problem is corrected and the system is restored to normal. The trouble event shall be recorded in the system history log and printed on the system printer (when applicable). The trouble may be silenced by means of a button on the main control panel. Upon restoration of the system to a normal condition, the trouble light shall extinguish.

1.5 Submittals

- A. General: Submit two (2) sets of the following to the Architect/Engineer for review for conformance with the Bid Documents prior to submission to the AHJ for permit:
 1. Product data sheets for system components highlighted or marked to indicate the specific products, features or functions required to meet this specification. Alternate or as-equal

products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds or does not comply with this specification.

2. Wiring diagrams from Manufacturer's Vendor.
3. Shop drawings showing system details including location of FACP, all devices, circuiting and details.
4. System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, NAC, relay, sensor and auxiliary control circuits.
6. Operating instructions for FACP.
7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type of product, including all features and operating sequences, both automatic and manual. Provide the names, addresses and telephone numbers of service organizations.
8. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with specified requirements.

- B. Submission to Authority Having Jurisdiction: After Architect/Engineer review of routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make re-submissions if required to make clarifications or revisions to obtain approval.

1.6 Quality Assurance

- A. Installer Qualifications: Installer(s) shall meet State of Ohio and local Municipality requirements for certification and as a minimum, have one installer certified as a NICET Level 2. In addition, the fire alarm system supplier shall have on staff, one NICET Level 3 certified individual and be an UL certified company.
- B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by UL Inc. and shall bear the UL label.

1.7 Extra Materials

- A. General: Furnish extra materials, packaged with protective covering for storage and identified with labels clearly describing contents as follows:
1. Strobe units: Furnish two (2) units, plus 50 ft. of wire for each device, installed at the Engineer's direction.
 2. Horn/Strobe units: Furnish two (2) units, plus 50 ft. of wire for each device, installed at the Engineer's direction.
 3. Smoke Detectors or Sensors: Furnish two (2) units.
 4. Detector or Sensor Base(s): Furnish two (2) units of each type installed, plus 50 ft. of wire for each, installed at the Engineer's direction.

5. Pull station(s): Furnish two (2) units, plus 50 ft. of wire for each device, installed at the Engineer's direction.
6. Addressable Circuit Interface Modules: Furnish two (2) units, plus 50 ft. of wire for each, installed at the Engineer's direction.

PART 2 - PRODUCTS

2.1 Control Unit

- A. Control unit shall contain all necessary components to provide complete control, testing and indicating facilities for the entire fire alarm system. Relays, where utilized, shall be pluggable type, sealed in dustproof containers to prevent failure from dust, dirt, tampering and accidental contact. Unit shall facilitate silencing of alarm from one addressable device and shall resound on subsequent alarm from another addressable device. Unit shall be double supervised, individually annunciated by addressable point with the following features: test switch, silencing switch(es), reset switch(es), control switch(es), power "on" lamp, minimum of 80 character LCD display, "Alarm" lamp and a means to simultaneously test all indicator lamps (LED's). "Trouble" signal shall be in integrally mounted alert signal with a SPL of 80 db at 4 ft. Trouble alarm silence switch (button) shall have ring back feature.
- B. An alarm shall be displayed on a two line, minimum 80 character LCD display. Display shall indicate alarms, supervisory service conditions and any trouble conditions. The top line of characters shall be the address/point label and the second line shall be the device type identifier. The system ALARM red LED shall flash on the main control panel and remote annunciator panels until the alarm has been acknowledged at any of the panels. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another point, after acknowledged, shall flash the system ALARM red LED on the control panels. The LCD display shall show the new alarm information. A pulsing alarm tone shall occur within the control panel and the remote annunciator panels until the alarm is acknowledged.
- C. The control panel shall be sized to accommodate 250 addressable devices, expandable to 2000 addresses thru the addition of Idnet card(s) within this control panel. Power supplies shall be supplied with 100% capacity including provisions for 20% additional strobe lights and 20% additional audible devices. Provisions for spare capacity shall include additional data loop cards or signaling cards to support the specified capacity. Audible signals shall be master controlled from the fire alarm panel or permit master coded signaling in a Code-3 temporal pattern, panel selectable without making any modifications to remote devices. All visual alarm signals (strobe lights) shall be synchronized at the fire alarm panel. Notifier NFS2-3030 series with all necessary accessories.
- D. Cabinet shall be modular construction, shall be semi-flush mounted and shall accommodate all modules, cards, relays, terminal connections, batteries, etc., necessary for system operation. The outer door and frame assembly shall be equipped with a keyed lock and shall have a transparent door panel to enable viewing all alarm and trouble lights, as well as LCD display, without opening door. Provide manufacturer's standard enamel finish.
- E. The control panel shall communicate individually with addressable initiating and control devices. Each device shall be individually annunciated at control panel.
 1. Annunciation shall include the following:

- a. Alarm
 - b. Trouble
 - c. Open
 - d. Short
 - e. Device missing/failed
2. All addressable devices shall be capable of being disabled or enabled individually.
 3. Smoke detectors shall utilize “Alarm Verification” operation.
 4. Smoke sensor sensitivity shall be field-adjustable from the control panel for the analog style detectors. Control panel shall have a self-test function such that each sensor is automatically tested once every 24 hours. Sensor shall notify control panel when maintenance is required. System shall automatically compensate for variations in environmental conditions.
- F. The control panel shall have a “Walk Test” feature.
- G. Operating power shall be supplied from a 120 volt, 60 Hz circuit while the supervisory power shall be supplied from an integral DC power supply. The low voltage DC power shall consist of power limited, filtered and regulated power supplies with maintenance-free, lead-calcium battery back-up with automatic recharger. Indication for normal power supply and power supply trouble shall be provided. Provide remote cabinet for batteries where size dictates need. Batteries shall be sized to maintain system operation, including trouble alarm, for 24 hours with sufficient reserve capacity to power all alarm sounding devices for 5 minutes. Battery capacities shall be sized to include provisions for the spare strobe light and audible devices in Para. 1.7. Door holders are not required to be maintained by the standby batteries. All batteries shall be supervised.
- H. Provide surge suppressors ahead of all 120 volt power connections to the fire alarm equipment. Locate suppressors within equipment enclosure or in a junction box directly above/adjacent to the unit. Suppressors shall be Leviton #51020-WM or equal. These suppressors are in addition to internal protection provided with the fire alarm system’s internal electronics.
- I. Provide surge suppressors on all initiating and notification circuits that enter or leave the building to/from remote locations.
- ## 2.2 Remote System Components
- A. Miniplex transponders will communicate with the Main Fire Alarm Control Unit to provide for centralized control of alarm and trouble signaling as well as output signaling. The transponder shall be capable of limited stand-alone operation in the even the communication link to the central system is lost. Each transponder shall be furnished with all necessary controls, power supplies and battery back-up.
- B. Manual stations shall be addressable communicating devices, shall be non-coded, single action with break rod operation (glass rod not required to reset station), red finish semi-flush mounted with keyed reset switch. Notifier #NBG-12LX.
- C. Fire signal lights (strobe lights) for synchronized operation shall provide visual indication of all alarms and shall illuminate in a flashing mode whenever system is in alarm state. Fire signal lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and 110 candela in all other areas unless specifically designated otherwise. Semi-flush

mount signal lights on walls where shown on the drawings. Lens shall be installed in a horizontal alignment on a red back plate labeled “FIRE” and shall produce one flash per second. Strobes shall be System Sensor L Series. Exterior units shall be gasketed and labeled for exterior use, System Sensor SpectrAlert series UL 1638 compliant).

- D. Horns shall be semi-flush mounted, with red grille and field selectable output levels of 85 or 91 dB at 10 ft. (based on UL 464 reverberant test requirements). Horn operating power levels shall be set initially at 85 dB and adjusted upward as required for proper sound coverage during the final check-out. Power calculations shall be made using the current draw for all units operating at 91 dB. Outside assemblies shall be weatherproof. Combination (audible/visible) horn and fire signal lights shall utilize a compact, combination mounting base assembly. Horns shall be labeled “FIRE”. System Sensor L Series (utilize the continuous horn signal setting) with mounting accessories. Exterior units shall be gasketed for weatherproof rating. Combination strobe/horn signal units shall be factory assembled, System Sensor L Series.
- E. Combo horns with fire signal lights (strobe lights) for synchronized operation shall provide both audible and visual indication of all alarms and shall illuminate in a flashing mode whenever system is in alarm state. Fire signal lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and 110 candela in all other areas unless specifically designated otherwise. Semi-flush mount horn/signal lights on walls where shown on the drawings. Lens shall be installed in a horizontal alignment on a red back plate labeled “FIRE” and shall produce one flash per second. Horns shall have a red grille with field selectable output levels of 85 or 91 dB at 10 ft. (based on UL 464 reverberant test requirements). Horn operating power levels shall be set initially at 85 dB and adjusted upward as required for proper sound coverage during the final check-out. Power calculations shall be made using the current draw for all units operating at 91 dB. All strobes shall be synchronized throughout the entire building utilizing control circuitry within the main fire alarm panel (and extender panels, if used). Exterior units shall be gasketed and labeled for exterior use, System Sensor L Series.
- F. Surface mounted fire alarm devices mounted on walls-such as manual stations, horns, strobes, etc. shall utilize finished backboxes. These backboxes shall be red metal and shall be field punched for conduit entrance (boxes shall not be stamped KO construction).
- G. Individual addressable monitor module shall be an addressable module used for monitoring N.O. contact devices such as water flow, tamper switches, kitchen hood ansul system, elevator shunt-trip power monitor, etc. Notifier #FMM-101.
- H. Programmable relay control module shall be an individual addressable module used for control of auxiliary functions such as elevator control, door release, smoke damper shutdown, air handling unit shutdown, etc. Notifier #FRM-1.
- I. Photo-electric type, addressable, ceiling mounted smoke detectors, shall utilize all solid state components operating on the light scatter principle and shall have adjustable sensitivity set at the transponder to detect smoke at 0.5% to 3.7% light obscuration per foot. The sensors shall communicate actual smoke chamber sensitivity to the system control where it is constantly monitored. Each addressable detector is individual adjustable thru the control panel and environmentally adjusted. The system will indicate when individual sensors need cleaning. Detector head shall have a white finish and contain an integrally mounted LED pilot lamp that indicates detector status. Notifier #FSP-951 with B300 base. Provide remote LED alarm indicators when indicated on plans.

- J. Photo-electric type, addressable, duct mounted smoke detectors, shall utilize all solid state components operating on the light scatter principle and shall have adjustable sensitivity set at the transponder to detect smoke at 0.5% to 3.7% light obscuration per foot. The sensors shall communicate actual smoke chamber sensitivity to the system control where it is constantly monitored. Each addressable detector is individual adjustable thru the control panel and environmentally adjusted. The system will indicate when individual sensors need cleaning. Detector head shall have a white finish and contain an integrally mounted LED pilot lamp that indicates detector status. Notifier #DNR/FSP-951/DST/FRM-1. A remote LED “status” light shall be flush mounted at 54” mounting height in a convenient location within sight of air handling unit, Notifier #RA-400Z.
- K. Ceiling mounted heat detectors shall be addressable, combination rate-of-rise and fixed temperature type set to alarm at 135 degrees F. or on a temperature rise of 15 degrees F. per minute. Unit shall be capable of low temperature monitoring. Detector shall be white and low profile style, Notifier #FST-951 with #B300 base.
- L. Waterflow switches shall indicate the continuous flow of water in sprinkler pipes where indicated on drawings. Unit shall be equipped with retard mechanism, adjustable up to two minutes, to minimize false alarms due to pressure changes. Retard mechanism and allowable time delay shall be subject to local AHJ requirements. Unit shall be supplied and installed by the Fire Suppression Contractor and wired to the fire alarm system by the E.C. via a monitor module with a dedicated address.
- M. Gate valve switches (OS&Y) shall monitor the status of sprinkler valves where indicated on drawings and shall signal a trouble alarm when respective valve is closed. Unit shall be supplied and installed by the Fire Suppression Contractor. Each gate valve switch shall be wired to the fire alarm system by the E.C. via a monitor module with a dedicated address.
- N. Magnetic door holders shall be multi-voltage selectable for 24 VDC or 24/120VAC operation. Flush wall mounted, Notifier #FM-998; semi-flush mounted, Notifier #FM-997 for new construction or surface wall mounted, Notifier #FM-996 for remodel applications on existing walls. Floor mount models for single door, Notifier #FM-980 or double door, two Notifier #FM-980, where shown on plans or application requires such use.
- O. Remote Annunciator and Operator Control Panels shall be flush wall mounted where shown on plans. Each shall consist of an 80 character LCD display with control features similar in appearance and orientation as the main fire alarm control panel. Control buttons shall be locked behind a window (keyed the same as the main fire alarm control panel) to prevent unauthorized operation.
- P. Notification appliance power extender control panels shall be provided where shown on the drawings. These panels shall communicate with and be completely supervised from the main fire alarm control panel. They shall be capable of powering additional synchronized visual alarm signals (strobes) and/or audible alarm signal circuits. Each panel shall include supervisory modules, power supplies, batteries and chargers. At the Contractor’s option, additional extender panels may be utilized if deemed acceptable by and locations are coordinated with the Architect/Engineer during the bidding phase. Notifier #FCPS-24 Series panel with accessories.
- Q. A digital communicator shall be located within the main fire alarm control panel to automatically transmit designated alarms, supervisory and trouble signals to a central station monitoring service via dedicated telephone lines. The main fire alarm panel shall have all provisions for the installation of a digital communicator furnished and installed by the owner

contracted Central Monitoring Service. The digital communicator shall be connected to one telephone line and a cellular dialer, shall supervise both means of communication and shall be capable of sending alarm signals on both means of communications to the Central Monitoring Service. The fire alarm panel shall indicate a trouble alarm on any digital communicator equipment failure (including loss of telephone line connection for longer than 45 seconds). The digital and cellular dialer shall be powered and maintained by the main fire alarm control panel standby battery power supply. Provide surge suppression on the 120 volt power supply and on one telephone lines. Provide both digital and cellular dialers and one year of UL monitoring.

The digital communicator shall transmit the following event level information:

1. Fire Alarm Condition
 2. Supervisory Condition
 3. Trouble Condition
 4. Daily Test Signal
- R. Provide a recessed Knox-Box rapid entry system where indicated on drawings. Extend wiring from the Knox-Box tamper switch to a monitor module to signal a trouble to the building fire alarm system.

PART 3 - EXECUTION

3.1 Installation, General

- A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

3.2 Equipment Installation

- A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes and all other necessary material for a complete operating system. Wall mounted devices shall utilize manufacturer recommended rough-in boxes with bushed conduit stubbed above accessible ceiling (as a minimum).
- B. If the building has a legally required standby power generator or power system, the E.C. shall provide a 20 Amp-120 Volt emergency circuit from the nearest Life-Safety emergency panel to the main fire alarm panel and any additional Notification Appliance (Power Extender) Panels required by the system.
- C. Coordinate door holder equipment connections and installation with door hardware supplier.
- D. Locate duct mounted smoke detectors per UL and manufacturer's guidelines for accurate air sampling and to permit easy access for maintenance and testing. Coordinate installation with the H.C. Where required, provide access panels. The E.C. shall ensure accessibility to the entire assembly.

- E. Provide a system smoke detector at the location of each fire alarm control unit (this includes the main panel and extender panels/auxiliary control panels where initiation/notification circuits originate).

3.3 Wiring Installation

- A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AHJ) and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electrical Code (NEC).
- B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- C. Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuit wiring and a different color code for supervisory circuits. Color code notification appliance circuits differently from alarm initiating circuits. Paint fire alarm system junction boxes, conduit fittings and box covers red.
- D. The following wiring and conduit shall also be included in the fire alarm system work:
 - 1. Empty conduit with pull wire from the digital communicator to the main telephone backboard. Telephone wiring from the telephone backboard to the digital communicator is the Owner's responsibility (or provided under a separate contract). The E.C. shall assist in making the final connections at the digital communicator and verify transmission and receipt by the Central Station prior to final testing.
 - 2. From duct mounted smoke detector, control relay module or fire alarm panel to each air handling unit and exhaust fan for shutdown where required by OBC (606).
 - 3. From electro-mechanical door holders to associated smoke detectors and/or fire alarm panel or control relay.
 - 4. Wiring to supervisory monitor and control points.
- E. **Wire shall be plenum rated, install cabling in a separate J-hook system where accessible. Install conduit in areas that are inaccessible when construction is complete.**

3.4 Field Quality Control

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pre-testing, testing and adjustment of the system.
- B. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing. Test the system according to the procedures outlined in NFPA 72.

- C. Report of Tests and Inspections: Provide a written record of inspections, tests and detailed test results in the form of a test log.
- D. Final Test, Certificate of Completion and Certificate of Occupancy:
 - 1. Test the system as required by the Authority Having Jurisdiction (AHJ) in order to obtain a certificate of occupancy.
- E. Revise all wiring diagrams and floor plans to reflect final accepted “As-built” conditions for the project and include in the O&M Manuals for the owner’s use. In addition, the supplier shall include an electronic copy of the system’s operating program on a CD.

3.5 Cleaning and Adjusting

- A. Cleaning: Remove paint splatters and other spots, dirt and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions, in compliance with NFPA 72. Provide up to three (3) visits to the site for this purpose.

3.6 Training

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner’s designated personnel for a minimum of 4 hours training on-site.

END OF SECTION 26 6101

27

TECHNOLOGY

DIVISION

(This page intentionally left blank)

SECTION 270500 - BASIC COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 GENERAL

- A. All provisions of the Division 00 and Division 01, apply to all work in Division 27.
- B. The description of the project below is intended to be a summary of the work to be provided under this contract. The Contractor(s) shall refer to all specification sections this Division, as well as, the associated Telecommunications Drawings.
- C. The Communications/Technology package has work (labor and/or materials) to be provided by the General, Electrical, Technology, Plumbing, Fire Suppression or HVAC Contractor or their sub-contractors contractor for communications pathways, grounding, cable tray, etc. The Contractors shall refer to the specifications and drawings for items identified as provided by others on the contract documents and drawings. Understanding that the contractors for mechanical and electrical work could be sub-contractors to the (General) Contractor, such assignments are not intended to restrict the Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work. All other items as per these contract documents shall be provided by the Telecommunications Contractor.
- D. The prime contractor responsible for Division 27 Specifications and Drawings must participate with the Owner on the FCC E-Rate program if required by the Owner. Contact the Owner representative and verify if the requirements for E-Rate submissions affect this contract and if so, provide documentation to the Architect and the Construction Manager on scheduled submission dates and anticipated installation windows.
- E. Drawings and Specifications are to be considered as supplementing each other and shall be included within the contract documents. Work described on either document shall be provided and incorporated into the project whether or not it is specifically identified on the corresponding document.

1.3 CONTRACT DOCUMENTS

- A. The drawings accompanying these specifications are complementary each to the other and what is called for by one shall be as if called for by both. When a discrepancy exists between the Drawings and Specifications, whichever has a greater cost in value must be included for bidding purposes. Questions should be submitted prior to bidding for any such discrepancies in order to achieve the correct costs within the bid.

- B. Consult all Contract Drawings that may affect the location of equipment, and cabling and make minor adjustments in location to secure coordination.
- C. Coordinate layout of work with other trades. Make minor adjustments in location required for coordination.
- D. All changes, with the exception of minor adjustments, shall be submitted to the Construction Manager and/or Architect for approval before proceeding with the work.

1.4 PERMITS AND REGULATIONS

- A. All electrical work shall be inspected and approved by the local jurisdictional authority.
- B. All electrical work shall be inspected and approved by the Ohio Division of Industrial Compliance who will issue the inspection certificate.
- C. General: All telecommunications systems shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over the telecommunications systems and the Project.
- D. Contractor shall obtain and pay for all licenses, permits, and inspection fees required by local agencies and/or other agencies having jurisdiction.
- E. Contractor agrees to furnish any additional labor or material required to comply with all local and other agencies having jurisdiction at no additional cost.
- F. Contractor shall obtain certificates of inspection and approval from all authorities having jurisdiction, and forward copies of same to Owner's Representative prior to request for Project acceptance inspections, completion inspections, substantial completion inspections, and acceptance testing/demonstrations.
- G. All required permits and inspection certificates shall be made available at the completion of the telecommunications system installation and commissioning.
- H. Any portion of the telecommunications work which is not subject to the requirements of an electric code published by a specific AHJ shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association (NFPA).
- I. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).

1.5 EXAMINATION

- A. General: Prior to submitting a proposal, Contractor shall examine site, review Project drawings and specifications, and determine exact extent of work required. Contractor shall include in their proposals all materials, labor, and equipment required to complete required work indicated. Work that is necessary to obtain complete and usable Project as specified herein shall be included in Contractor's proposal, even if not indicated or specified.

- B. Bidders' questions: Should bidders have questions as to intent of drawings and specifications, quality of materials to be used, and work to be performed, questions shall be submitted in writing to Owner's Representative in manner dictated by Owner's Representative. All answers and clarifications to drawings and specifications will be issued in writing.
- C. Extra payment will not be allowed for claims for due to unfamiliarity with work to be performed by other trades, existing conditions at job site, local or state laws and codes, and alterations due to field conditions.

1.6 ADDITIONAL COSTS

- A. General: Project acceptance inspections, completion inspections, substantial completion inspections, and acceptance testing/demonstrations shall be conducted after verification of system operation and completeness by Contractor.
- B. Inspections and testing: For Project acceptance inspections, final completion inspections, substantial completion inspections, and/or testing/demonstrations that require more than one site visit by Owner's Representative or Architect/Engineer to verify Project compliance for same material or equipment, Owner reserves right to obtain compensation from Contractor to defray cost of additional site visits that result from Project construction or testing deficiencies/incompleteness, incorrect information, or non-compliance with Project provisions. Owner's Representative will notify Contractor of hourly rates and travel expenses for additional site visits, and will issue an invoice to Contractor for additional site visits. Payment of additional site visit costs by Contractor is required within 30 days of invoicing. Owner reserves right to deduct additional costs defined herein that are indicated on past due invoices from Project amount due Contractor.
- C. Exclusions: Contractor shall not be eligible for extensions of Project schedule or additional charges resulting from additional site visits that result from Project construction or testing deficiencies/incompleteness, incorrect information, or non-compliance with Project provisions.

1.7 SUMMARY OF WORK

- A. This project provides for the complete installation of various communication systems.
- B. The scope of the Communications work includes furnishing, installing, testing and warranty of all Communications work and complete Communications systems shown on the Communications drawings and specified herein.
- C. Items of labor, material, and equipment not specified in detail or shown on the drawings, but required or necessary for a complete and operational installation of the below systems or work described herein, shall be furnished as if called for by the specifications and the detailed drawings.
- D. The Electrical Contractor and Telecommunications Contractor shall coordinate all device locations prior to installation.
- E. Owner personnel training on all systems installed.
- F. Testing and Commissioning of all systems.

1.8 The Work includes work that is primarily electrical in nature and also includes all equipment, cable and terminations associated with systems. Contractor shall utilize conduit runs and boxes installed by electrical contractor. Contractor shall provide face plates on all boxes as required. Contractor shall provide any supplementary systems required to meet the performance requirements of the system as part of the bid.

1.9 ADDITIONAL REQUIREMENTS

- A. **Integration:** Responsibility for overall telecommunications system integration and coordination of work among trades, subcontractors, and suppliers shall rest with Contractor named in construction contract issued by Owner's Representative. Work covered by this division of specifications shall be coordinated with related work indicated on drawings or specified elsewhere under project specifications. Work related to telecommunications system shall be performed under direct supervision of telecommunications system installer in a manner approved by product manufacturer.
- B. **Coordination of work:** Contractor shall be responsible for coordination of work among project specification divisions and contractor/subcontractors involved in this project. This coordination of Work Includes following instructions provided the Construction Manager or General Contractor if project is managed by such.
- C. **General compliance requirements:** Provide a complete and operable system in compliance with project drawings, specifications, referenced standards, applicable building codes, and Authority Having Jurisdiction (AHJ) requirements. Scope of this contract includes planning, design, materials, equipment, labor, configuration, programming, testing, startup and commissioning services, and documentation costs for complete and operable system that meets all requirements indicated on drawings or contained in specifications. Comply with all contract documents, specifications, drawings, manufacturer's instructions, and Owner and AHJ requirements. In case of conflict among applicable documents or standards, contractor shall notify owner's representative in writing of apparent conflict, and then comply with most stringent requirements unless otherwise directed in writing from owner's representative. Work Includes all items required for complete system whether or not identified in specification or drawings.
- D. Information about general construction and architectural features and finishes shall be derived from structural and architectural drawings and specifications only.
- E. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.
- F. Work related to telecommunications system shall be installed by an SCS manufacturers authorized or certified trained installer and supervised an SCS manufacturers authorized or certified SCS Engineer. Owner reserves the right to review and approves any personnel assigned to this project in a supervisory or managerial role.
- G. SCS contractor shall have had at least 10 years of comparable experience with telecommunications projects. As part of the proposal, SCS installer shall submit at least three (3) comparable Project reference descriptions with reference contacts. Comparable projects shall equal or exceed size and complexity of work on drawings.
- H. Administrative and coordination responsibilities for entire project.

- I. Temporary Facilities related to general work as specified in the “Temporary Facilities” section of these specifications.
- J. Patching materials and surfaces disturbed by new work to match adjacent existing materials and surfaces.
- K. Restoration of site disturbed by this work to its original condition.

1.10 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification: Project consists of furnishing and installing electronic communications equipment at:

Owner:

Tri County Recovery Board

Architect:

Freytag and Associates

Technology Consultant
BCL IT Consultants
8505 Park Place Circle
West Chester, Ohio 45069

1.11 CONTRACTOR USE OF PREMISES

- A. General: Each Prime Contractor shall limit his use of the premises to the work indicated, so as to allow for Owner occupancy and use by the public. The work is to be conducted to provide the least possible interference to the activities of the Owner’s personnel, students, other building occupants and the general public. The normal order of owner business shall be maintained throughout the duration of the project.
- B. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.
- C. Owner Occupancy: Allow for Owner occupancy and use by the public.
- D. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner’s employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- E. Materials and Equipment: Do not unreasonably encumber the site with materials or equipment. Confine stockpiling of materials and location of storage sheds to the area indicated. If additional storage is necessary obtain and pay for such storage off-site.

- F. Vehicles: Lock automatic type vehicles such as passenger cars and trucks and other types of mechanized or motorized construction equipment, where parked and unattended, so as to prevent unauthorized use. Do not leave such vehicles or equipment unattended with the motor running or the ignition key in place.
- G. Contractor Use of the Existing Building: Maintain the existing building in a safe and weather tight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

1.12 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 27/28-division format and CSI/CSC's "MasterFormat" numbering system.
- B. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of sections in the Contract Documents.
- C. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
- D. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
- E. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
- F. The words "shall," "shall be," or "shall comply with," depending on the context, are implied to mean that the equipment or system MUST be configured and/or installed as stated.

1.13 USE OF TECHNOLOGY AND THE INTERNET

- A. This project will take full advantage of the benefits of the Internet, e-mail and other electronic documentation. Contractors are encouraged to use this technology.

1.14 RELATED DOCUMENTS AND DRAWINGS

- A. General: The project drawings and general conditions of Contract shall apply to this section.
- B. Coordination: Coordinate with work specified in other sections and divisions of specifications.

- C. Reference: Codes and standards may define additional specifications or requirements not specifically called out within this division. However, contractor shall adhere to most stringent requirements as defined herein.
- D. Architectural and Engineering specifications may have additional conditions or requirements that affect the work defined by this division of specifications. Contractor shall be responsible for the coordination of all conditions and other trade requirements that may impact schedule, scope of work, work progress, or other factors that may affect the overall ability for contractor to execute the requirements of this division of specifications.

1.15 CODES AND STANDARDS

- A. General: All work, including but not limited to: cabling, pathways, support structures, wiring, equipment, installation and workmanship shall comply with the latest editions of the requirements of the Authority Having Jurisdiction (AHJ), National Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Contractors Association (NECA) Standard of Installation. In case of discrepancy or disagreement between the documents noted above, the Contractor shall satisfy the most stringent requirements.
- B. Other sections of this document contain References to Codes and Standards that are applicable to the section.

1.16 CODES

- A. Insulated Cable Engineers Association (ICEA)
- B. ANSI/ICEA S-80-576-2002, Category 1 & 2 Individually Unshielded Twisted-Pair Indoor Cables for Use in Communications Wiring Systems
- C. ANSI/ICEA S-84-608-2002, Telecommunications Cable, Filled Polyolefin Insulated Copper Conductor
- D. ANSI/ICEA S-90-661-2002, Category 3, 5, & 5e Individually Unshielded Twisted-Pair Indoor Cable for Use in General Purpose and LAN Communication Wiring Systems
- E. ICEA S-102-700-2004, ICEA Standard for Category 6 Individually Unshielded Twisted- Pair Indoor Cables for Use in LAN Communication Wiring Systems Technical Requirements, 2004
- F. National Fire Protection Association (NFPA) NFPA 70, National Electrical Code® (NEC®)
- G. NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, NFPA 72, National Fire Alarm Code®
- H. NFPA 75, Standard for the Protection of Electronic Computer/Data Processing Equipment NFPA 76, Recommended Practice for the Fire Protection of Telecommunications Facilities NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
- I. NFPA 101, Life Safety Code®

- J. NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials
- K. NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
- L. NFPA 780, Standard for the Installation of Lightning Protection Systems NFPA 5000™, Building Construction and Safety Code

1.17 **REFERENCE STANDARDS**

- A. Telecommunications Industry Association (TIA)
- B. ANSI/NECA/BICSI 568-2006, Standard for Installing Telecommunications Systems ANSI X3T9.5, Requirements for UTP at 100 Mbps
- C. TIA-569-E, Telecommunications Pathways and Spaces
- D. ANSI/TIA-526.7-A, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
- E. ANSI/TIA-568.0-D, Generic Telecommunications Cabling for Customer Premises ANSI/TIA-568.1-D, Commercial Building Telecommunications Cabling Standard
- F. ANSI/TIA-568.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard
- G. ANSI/TIA-568.3-D, Optical Fiber Cabling and Components Standard ANSI/TIA-568-C.4, Broadband Coaxial Cabling and Components Standard ANSI/TIA-569-D, Telecommunications Pathways and Spaces
- H. ANSI/TIA-606-C, Administration Standard for Telecommunications Infrastructures ANSI/TIA-862-B, Structured Cabling Infrastructure Standard for Intelligent Building Systems ANSI/TIA-942-B, Telecommunications Infrastructure Standard for Data Centers
- I. **TIA-607**, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- J. **ANSI/TIA-526-14-C**, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant TIA-598-D, Optical Fiber Cable Color Coding
- K. TIA-604.3-B, FOCIS 3—Fiber Optic Connector Intermateability Standard, Type SC TIA-604.10-B, FOCIS 10—Fiber Optic Connector Intermateability Standard, Type LC
- L. TIA TSB-125, Guidelines for Maintaining Optical Fiber Polarity Through Reverse-Pair Positioning
- M. TIA-758-B, Customer-owned Outside Plant Telecommunications Infrastructure Standard
- N. TSB-155-A, Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T

Commented [BH1]: Do you want to add TIA-569-E Telecommunications Pathways and Spaces to this list?

- O. BICSI Outside Plant Design Reference Manual (COOSP), current edition.
- P. BICSI Electronic Safety and Security Reference Manual (ESSDRM), current edition
- Q. BICSI Information Transport Systems Installation Methods Manual (ITSIM), current edition
- R. BICSI Network Design Reference Manual (NDRM), current edition
- S. BICSI Telecommunications Distribution Methods Manual (TDMM), current edition
- S.T. BICSI Wireless Design Reference Manual (WDRM), current edition
- T.U. Institute of Electrical and Electronic Engineers (IEEE) National Electrical Manufacturers Association (NEMA)
- U.V. Underwriters Laboratories (UL) Cable Certification and Follow Up Program

1.18 ABBREVIATIONS, ACRONYMS AND DEFINITIONS

- A. Abbreviations and Acronyms
 1. ACD Automatic Call Distribution
 2. AFF Above Finished Floor
 3. AWG American Wire Gauge
 4. BICSI Building Industry Consulting Services International
 5. CAT5 Category 5 Copper Cable
 6. CAT5e Category 5e Copper Cable
 7. CAT6 Category 6 Copper Cable
 8. CAT6A Category 6A Copper Cable
 9. CDDI Copper Distributed Data Interface
 10. CMP Communications Multipurpose Plenum: cable rating
 11. CMR Communications Multipurpose Riser: cable rating
 12. EIA Electronic Industries Association
 13. ELFEXT Equal-Level Far-End Crosstalk
 14. FEXT Far End Crosstalk
 15. Gbps Gigabits per second
 16. HSM High Speed Migration
 17. HVAC Heating, Ventilation, and Air Conditioning
 18. IDF Intermediate Distribution Frame - Termination frames, relay racks, and cable management
 19. IEEE Institute of Electrical and Electronics Engineers
 20. IM Information Management
 21. ISDN Integrated Services Digital Network
 22. LAN Local Area Network
 23. Mbps Megabits per second
 24. MDF Main Distribution Frame, consisting of carrier entrance rooms and head-end
 25. MMF Multi-mode fiber optics, 50 or 62.5-micron laser optimized core
 26. MUTOA Multi-User Telecommunications Outlet Assembly
 27. NEXT Near End Cross Talk
 28. NRTL Nationally Recognized Testing Laboratories
 29. OSHA Occupational Safety and Health Act

30. PBX- Private Branch Exchange: telephone switch
31. PDS Premises Distribution Systems (See SCS)
32. PoE Power over Ethernet (IEEE 802.3af)
33. POP Point of Presence
34. PSACR Power Sum Attenuation-to-Crosstalk Ratio
35. PSAFEXT Power Sum Alien Far-End Crosstalk
36. PSAELFEXT Power Sum Alien Equal Level Far-End Crosstalk
37. PSANEXT Power Sum Alien Near-End Crosstalk
38. PSELFEXT Power Sum Equal Level Far-End Crosstalk
39. PSNEXT Power Sum Near-End Crosstalk
40. SCC Security Command Center
41. SCS Structured Cabling System, or Structure Connectivity System; a complete cabling system
42. SFF Small Form Factor
43. SMF Single-mode fiber optics, 8.3-micron core
44. TC Telecommunications Closet
45. TE Telecommunications Enclosure
46. TEF Telecommunications Entrance Facility
47. TIA Telecommunications Industry Association
48. TR Telecommunications Room
49. TO Telecommunications Outlet
50. UPS Uninterruptible Power Supply
51. UTP Unshielded Twisted Pair
52. VoIP Voice over Internet Protocol
53. WAO Work Area Outlet
54. WAN Wide Area Network

1.19 DEFINITIONS

- A. Access Floor - A floor system that has removable floor panels.
- B. Building Backbone Cabling – Cabling used to connect Floor Distributors (FD) or other local collection points to the Building Distributor (BD). Building backbone cabling typically carries aggregate traffic and, as such, impacts multiple network devices and users.
- C. Building backbone cabling may include either fiber optic or copper cabling or both.
- D. Building Distributor (BD) – Termination point from which all building backbone cabling emanates and interconnection point for the network backbone. Commonly referred to as BDF in Americas, Main Comm Rooms in EMEA and Communication Room, IT Lab or IT Room in AsiaPac. Referred to as BD in international and European industry standards and Intermediate Cross-connect (IC) in American industry standards. There is one BD for each building and it feeds all FD's in the same building. The BD should be located so that all FD's served are within 300 cable meters (984 cable feet). All BD's are linked to the
- E. Campus Backbone Cabling – Cabling used to connect Building Distributors (BD) or other key network segments to the Campus Distributor (CD). With rare exceptions, campus backbone cabling carries aggregate traffic and typically impacts entire buildings worth of network devices and users and, as such, link redundancy with diverse routing is highly recommended. Campus

backbone cabling almost exclusively consists of fiber optic cabling. Copper cabling may be used in short-distance (< 90m) applications. In such cases, lightning protection will usually be required by code.

- F. Campus Distributor (CD) – Termination point from which all campus backbone cabling emanates and highest-level interconnection point for the network backbone. Commonly referred to as NOC in Americas and Main Comm Rooms in EMEA. Referred to as CD in international and European industry standards and Main Cross-connect (MC) in American industry standards. On smaller campuses, there is one CD for the campus. On larger campuses, there might be several CD's with each CD serving several buildings. Besides linking to each of the BD's it serves, the CD is also the network interconnection point for data center links and links to service providers.
- G. Category 3 (Cat 3) – A category of transmission performance, defined in TIA standards, that specifies electrical properties up to 10 MHz. Cat 3 is the minimum performance grade permissible and is used typically for analog voice distribution.
- H. Category 6 (Cat 6) / Class E – A category/class of transmission performance that specifies electrical properties up to 250 MHz. Refer to the TIA--568-~~C~~D family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class E requirements. Also, refer to CENELEC EN50173.
- I. Category 6A (Cat 6) / Class EA– A category/class of transmission performance that specifies electrical properties up to 500 MHz and capable of supporting data applications operating at 10Gbps. Refer to the TIA-568-~~C~~D family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class EA requirements.
- J. Category 7 – backward compatible with Class D/Category 5e and Class E/Category 6. Class F features even stricter specifications for crosstalk and system noise than Class E. To achieve this, shielding has been added for individual wire pairs and the cable as a whole.
- K. Category 8 – ratified by the TR43 working group under ANSI/TIA 568-~~C.2-1~~D. It is defined up 2000 MHz and only for distances from 30 to 36m depending on the patch cords used. ISO is expected to ratify the equivalent in 2018 but will have 2 options: Class I channel, Category 8.1 cable and Class II channel, Category 8.2 cable. Category 8 is designed only for data centers where distances between switches and servers is short. It is not intended for general office cabling.
- L. Certification – The testing and documentation of the transmission performance (e.g., Category 5e / Class D) of a permanent link or channel, based on sweep frequency (where applicable) testing of numerous parameters with results compared to a range of acceptable values. This project requires 100% certification (with documentation) of all permanent link cabling at the time of installation. Channel certification is optional and is the responsibility of the group using the channel.
- M. Channel – The entire physical pathway between active equipment ports, inclusive of all patch cords, patch panels, jacks and cabling segments.
- N. Class C – A category of transmission performance, defined in ISO and EN standards, that specifies electrical properties up to 16 MHz
- O. Conduit - A raceway of circular cross-section.

- P. Entrance Facility (EF) – Termination point of service provider cables that have entered the building and location of service demarcation point (MPOE) and interconnection point to the network. Commonly referred to as Telco Room in Americas, POP Room in EMEA and Building Entrance in AsiaPac. Referred to as Building Entrance Facility in international and European industry standards and Entrance Facility (EF) in American industry standards. The EF is linked to the CD, where present, or to the BD.
- Q. Floor Distributor (FD) – Termination point for horizontal cabling and interconnection point for network access. Commonly referred to as IDF in Americas and AsiaPac and as Sub Comms Room in EMEA. Referred to as Floor Distributor (FD) in international and European industry standards and Horizontal Cross-connect (HC) - FD quantities and locations are determined by building size and geometry so that all points served are within 90 cable meters (295 cable feet) of an FD. The FD feeds all Telecommunications Outlets (TO's) in its service zone. All FD's in a building are linked to the building's Building Distributor (BD) via backbone cabling.
- R. Horizontal Cabling – Cabling used to connect individual work area outlets to local Floor Distributors (FD) or other collection points. Unlike backbone cabling, horizontal cabling does not typically carry aggregate traffic and, as such, impacts only single network devices or users. In buildings, horizontal cabling almost exclusively consists of copper cabling. Fiber optic cabling may be used where situations dictate but, unlike horizontal copper cabling, horizontal fiber optic cabling is not installed in advance as default building facilities. At this writing, horizontal copper cabling in many networks is capable of supporting Gigabit (1Gb/s) Ethernet applications as well as other applications of similar bandwidth.
- S. Permanent Link – A stationary cabling segment, consisting of the permanently installed cable and the permanently affixed jack at both ends (typically at the outlet faceplate and closet patch panel, or on a patch panel on both ends). The concept assumes that, while patch cords might be disconnected or moved over time, the permanent cable and jacks will not be disturbed and the electrical characteristics of the permanent link will remain unaltered.
- T. Plenum -A space within the building designed for the movement of environmental air; i.e., a space above a suspended ceiling or below an access floor.
- U. Raceway - Any channel designed for holding wires or cables; i.e. conduit, electrical metal tubing, busways, wireways, ventilated flexible cableway.
- V. Spine – also called a backbone, the main communications cables in an IDF.

1.20 DRAWINGS AND SPECIFICATIONS

- A. General Drawing Specifications: Detail and elevation drawings shall be (36" x 42") with a minimum scale of 1/4" = 1'0" or larger. ER, TR and other enlarged detail floor plan drawings shall be D size (24" x 36") with a minimum scale of 1/4" = 1'0" or larger. Building composite floor plan drawings shall be D size (24" x 36") with a minimum scale of 1/8" = 1' 0".
- B. Building composite floor plans: Provide building floor plans showing outlet locations and jack configuration, types of jacks, run distance for each jack cable, and cable routing/locations. Identify TO's that, according to location and available pathway systems, require cable length greater than allowed by standards. Recommend alternatives for Owners Representative's consideration.

- C. Telecommunications space plans/elevations: Include enlarged floor plans of TRs indicating layout of equipment and devices, including receptacles and grounding provisions. Submit detailed plan views and elevations of telecommunications spaces showing racks, termination blocks, and cable paths.
- D. Logical Drawings: Provide logical riser or schematic drawings for all systems. Include schematic symbol key.
- E. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word “provide”, as used, shall mean “furnish and install”. If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.
- F. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- G. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any error, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having cable pathways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient because to avoid making offsets and minor changes as may be necessary to install wireways, fittings and equipment.
- H. Where there are quantity discrepancies of equipment shown on drawings and/or specifications, the Contractor shall provide the greater quantity.
- I. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.
- J. Equipment, ductwork, piping and communications wiring shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces about Electrical Equipment – 600 Volts Nominal or Less. For equipment rated over 600 volts nominal – 110.32 Work Space about Equipment – 110.33 Entrance and Access to Work Space – 110.34 Work Space and Guarding. The Communications Contractor shall caution other trades to comply with this stipulation.
- K. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect’s decisions shall be final in regard to the arrangement of conduit, etc., where conflict arises.
- L. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the

system. Each contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

- M. Should overlap work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

1.21 SUBSTITUTIONS

- A. Substitution requests: Substitution requests will be considered only if submitted to Owner's Representative not less than 7 working days prior to project bid date. Acceptance or rejection of proposed substitution is at Owner's Representatives sole discretion. No exceptions. Requests for substitutions shall be considered not approved unless approval is issued in writing by Owner's Representative.
- B. Rejection: For equipment, cabling, wiring, materials, and all other products indicated or specified as no substitutions or no alternates, Owner does not expect nor desire requests for substitutions and alternate products other than those specified. Owner reserves right for Owner's Representative to reject proposed substitution requests and submissions of alternates without review or justification.

1.22 PRE-INSTALLATION MEETING

- A. General: After award, convene a pre-installation meeting at least 14 calendar days prior to commencing SCS and related work. The meeting must be scheduled at least 14 days in advance. Require attendance of parties directly affecting work of this section, including other trades and utilities if necessary. Review conditions of operations, procedures and coordination with related work.
- B. Agenda: Comply with following agenda specifications:
- C. Tour, inspect, and discuss building conditions relating to telecommunications system cabling and equipment, coordination with Telephone Utility Company, Owner's telecommunications system requirements, and coordination with existing conditions and other work in contract.
- D. Review exact location of each item within building construction, casework, and fixtures, and their requirements.
- E. Review required submittals, both completed and yet to be completed.
- F. Review drawings and specifications.
- G. Review proposed equipment, cabling, and related work.
- H. Review and finalize construction schedule related to telecommunications system and verify availability of materials, personnel, equipment, and facilities needed to make progress and avoid delays.

- I. Review required inspections and testing.
- J. Review cable routing and support provisions.

1.23 ASBESTOS MATERIALS

- A. Abatement, removal or encapsulation of existing materials containing asbestos is NOT included in the Communications Contract. Necessary work of this nature will be arranged by the Owner to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.
- B. If, in performance of the Communications work, materials are observed which are suspected to contain asbestos, the Communications Contractor shall immediately inform the Architect/Engineer who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

1.24 INSPECTION

- A. All work shall be subject to inspection of Federal, State, and local agencies as may be required, and of the Architect and Engineer.
- B. Final inspection certification shall be obtained by the Contractor and given to the Owner.

1.25 RECORD DRAWINGS

- A. The Communications Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work and to other systems where the installation varies to a degree which would justify recording the change.

1.26 OPERATING AND MAINTENANCE MANUALS

- A. Two electronic copies of each of operating and maintenance manuals shall be assembled for the Communications work by the Contractor.
- B. All shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Major items of equipment shall consist of not less than the following:
 - 1. Data Cable Distribution System

2. Security Management System
 3. CCTV System
 4. Integrated Telephone System
 5. Monitors/TVs
 6. Digital Enterprise Media System
 7. Interactive AV Equipment
 8. Network Electronics
 9. Paging Systems
 10. Sound Systems
 11. UPS Systems
 12. Misc. Multi-Media Equipment
- C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instructions are not available.
- D. These shall be assembled into indexed PDF files. An index and tabs to separate the sections shall be included. These shall be submitted to the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.
- E. O&M Manuals shall contain the following information at a minimum:
1. Copies of all approved shop drawings with the Engineer's stamp.
 2. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures or copies of website prints. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. The Contractor can supply this information electronically in an indexed PDF format.
 3. Communications drawings updated with final as-built information. This shall be in the form of a complete set of Communications drawings with as-built information indicated in color based upon actual field conditions. These must be in electronic format. Hand drawings will not be accepted.
 4. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types. These shall be submitted in electronic format. Hand drawings will not be accepted.
 5. Rack elevations for all systems with rack mounted equipment.
- 1.27 FINAL INSPECTION AND PUNCH LIST
- A. As the time of work completion approaches, the Contractor shall survey and inspect his work and develop his own punch list to confirm that it is complete and finished. He shall then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.
- B. Requests to the Architect, Engineer, or Owner for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for competing these; this in the interest of expediting acceptance for beneficial occupancy.

- C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.28 CONTRACTOR'S WARRANTY

- A. General requirements: Comply with additional requirements in contract general requirements and extended warranties required in other specification sections. Refer to all other 27xxx sections for specific additional warranty requirements that exceed or are in addition to those of this section.
- B. Contractor warranty: Provide all services, materials and equipment necessary for successful operation of entire telecommunications system and SCS system for a period of one year after system acceptance. Scope of warranty includes all equipment, devices, wiring, accessories, software, hardware, installation, programming, and configuration required to maintain a complete and operable system. Provide manufacturer's published recommended preventative maintenance procedures during warranty period. This shall apply to all items except those specifically excluded, or items wherein a longer period of service and warranty is specified or indicated. All warranties shall be effective for one year, minimum, from date Certificate of Final Acceptance is issued. Use of systems provided under this section for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by Owner and shall not institute warranty period. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to Owner's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty. Additional warranty responsibilities are:
 - C. Obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's designated name. Replace material and equipment that require excessive service during guarantee period as determined by Owner.
 - D. Provide 2-business day service beginning on date of Substantial Completion and lasting until termination of warranty period. Service shall be at no cost to Owner. Service can be provided by installing contractor or by a separate service organization. Choice of service organization shall be subject to Owner's approval. Submit name and a phone number that will be answered on a 24-hour basis each day of week, for duration of service.
 - E. Submit copies of equipment and material warranties to Owner before final acceptance.
 - F. At end of warranty period, transfer manufacturers' equipment and material warranties still in force to Owner.
 - G. If warranty work problems cannot be corrected immediately to Owner's satisfaction, advise Owner in writing, describing efforts to correct situation, and provide analysis of cause for problem. If necessary to resolve problem, provide at no cost services of manufacturer's engineering and technical staff at site in a timely manner to analyze warranty issues, and develop recommendations for correction, for review and approval by Owner.
 - H. Owner's rights: This section shall not be interpreted to limit Owner's rights under applicable codes and under this Contract.

- I. Pathways Material and Installation warranty: Provide all services, materials and equipment necessary to warrant the installation and performance of all pathway materials for a period of one year after beneficial use. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.
- J. Grounding and Bonding Material and Installation warranty: Provide all services, materials and equipment necessary for successful operation of GBS for a period of one year after beneficial use. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.
- K. Firestopping Material and Installation warranty: Provide all services, materials and equipment necessary to warrant the performance of all Firestopping material for a period of one year after beneficial use, or longer if required by the local AHJ. Scope of warranty includes all equipment, devices, installation and other work required to maintain a complete and operable system. Provide manufacturers published recommended preventative maintenance procedures during warranty period.
- L. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include, but are not limited to replacement of malfunctioning equipment and adjusting special equipment and communications systems to obtain optimum performance.
- M. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.
- N. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.

1.29 SCS MANUFACTURERS EXTENDED WARRANTY

- A. SCS Systems will be covered by a two-part certification program provided by a single manufacturer and that manufacturer's certified vendor. Manufacturer shall administer a follow-on program through the Vendor to provide support and service to the purchaser. The first part is an assurance program, which provides that the certified system will support the applications for which it is designed, during the 20- year warranty of the certified system.
- B. The second portion of the certification is a 20-year warranty provided by the manufacturer and the vendor on all products within the system (cords, telecommunications outlet/connectors, cables, cross-connects, patch panels, etc.).
- C. If the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading, the manufacturer and vendor shall commit to promptly implement corrective action.
- D. Documentation proving the cabling system's compliance to the End-to-End Link Performance recommendations, as listed in ANSI/TIA-568-~~CD~~ shall be provided by the Vendor prior to the structured cabling system being installed.

- E. The cabling system must conform to the current issue of industry standard TIA-568. All performance requirements of this document must be followed. As well, workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) ITSIM manual.
- F. Purchaser demands strict adherence to the performance specifications listed in ANSI/TIA-568-C series standards.
- G. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacturer the product used in this cabling system.

1.30 COMPLETENESS OF WORK

- A. Complete and usable work: The contractor is responsible for providing complete and usable work per contract documents. All materials and equipment shall be provided with all accessories and additional work required for field conditions, as well as additional work and accessories required for complete, usable, and fully functional construction and systems, even if not explicitly specified or indicated. Telecommunications system in this Contract shall be provided as complete and operable systems in full compliance with requirements on drawings and specification requirements. Drawings are diagrammatic and specifications are performance-based, and Contractor shall provide all work required to comply with drawings and specifications, even if not explicitly indicated or specified. Contractor shall be responsible for coordinating installation of electrical systems with all field conditions and work of other trades. Minimum clearances and work required for compliance with NFPA 70, National Electrical Code® (NEC®), and manufacturer's instructions shall be provided. Comply with additional requirements indicated for access and clearances. Contractor shall verify all field conditions and dimensions that affect selection and provision of materials and equipment, and shall provide any disassembly, reassembly, relocation, demolition, cutting and patching required to provide work specified or indicated, including relocation and reinstallation of existing wiring and equipment. Contractor shall protect from damage resulting from Contractor's operations existing facility, equipment, and wiring. Extra charges for completion and contract time extension will not be allowed because of field conditions or additional work required for complete and usable construction and systems. Comply with additional requirements indicated for access and clearances.
- B. Drawings and specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Except where explicitly modified by a specific notation to contrary, it shall be understood that indication or description of any item, in drawings or specifications or both, carries with it instruction to furnish and install item, provided complete.
- C. Terms: As used in this specification, provide means furnish and install. Furnish means "to purchase and deliver to project site complete with every necessary appurtenance and support," and install means "to unload at delivery point at site and perform every operation necessary to establish secure mounting and correct operation at proper location in project."
- D. Authority approvals: Give notices, file plans, obtain permits and licenses, pay fees, and obtain necessary approvals from authorities that have jurisdiction as required to perform work per all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

- E. Supplementary items: Provide supplementary or miscellaneous items, appurtenances, devices and materials necessary for a sound, secure and complete installation. Examine project drawings and other Sections of specifications for requirements that affect work of this section. Completely coordinate work of this section with work of other Sections and provide a complete and fully functional installation. Refer to all other drawings and other specifications sections that indicate types of construction in which work shall be installed and work of other sections with which work of this section must be coordinated
- F. Quantities: Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

1.31 PROJECT CONDITIONS

- A. Field verification: Carefully verify location, use and status of all material, equipment, and utilities that are specified, indicated, or deemed necessary for removal. Verify that all materials, equipment, and utilities to be removed are completely inactive and will not be required or in use after completion of project. Replace with equivalent any material, equipment and utilities that were removed by Contractor that are required to be left in place.
- B. Existing utilities: As applicable, do not interrupt utilities serving facilities occupied by Owner or others unless permitted under following conditions and then only after arranging to provide temporary utility services per requirements indicated:
- C. Notify owner in writing at least 14 days in advance of proposed utility interruptions. Do not proceed with utility interruptions without Owner's written permission.
- D. Equipment installation:
 - 1. Determine suitable path for moving unit substation into place; consider Project conditions.
 - 2. Verify clearance requirements and locate equipment to meet installation tolerances.
 - 3. Revise locations and elevations from those indicated to those required to suit Project.

1.32 DELIVERY STORAGE AND HANDLING

- A. General: Contractor shall be responsible for the deliveries, storing and handling of all materials relative to the SCS systems, including materials supplied by others that are part of the SCS installation contract. Material shall be stored and protected per manufacturer's instructions. Contractor shall be responsible for the security of all material during installation. For all material provided by contractor, or delivered to contractor on site, contractor assumes full responsibility and liability for any material shortages, damage or loss due to storage and handling methods.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

SECTION 270503 – TECHNOLOGY SYSTEMS WARRANTIES & GUARANTEE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide complete documented Contractor, Installation, Performance and Manufacturer's warranties and guarantees as indicated on the Drawings, Specified or as otherwise required.

PART 2 - PRODUCTS

2.1 CONTRACTOR GUARANTEE

- A. The Contractor shall guarantee the installation to be free from inherent defects in installation, workmanship and material. The installation shall function properly and continuously under all operating conditions required, specified or reasonably implied in the contract documents. The Contractor shall replace, at no expense to the Owner, all equipment, materials or any component thereof, found defective, within three (3) years from date of final inspection and written acceptance by the Owner and Engineer.
- B. The Contractor shall provide a manufacturer's certified and warranted installation with an extended guarantee. The warranty shall be based fully upon the design criteria contained herein, meeting all specifications and standards for installation and materials. The warranty shall include shop drawings and cut sheets on all equipment and materials, documentation verifying the Contractor's certification by the manufacturer, details of the manufacturer's certification program, and full details of the extended warranty.

2.2 CONTRACTOR SUBMITTALS

- A. Within ten (10) days of the bid opening the Contractor shall provide from manufacturer a "Letter of Intent" to the Owner stating manufacturer's intent to maintain the Contractor as a registered and certified Manufacturer installer, authorized to support and maintain the installation for the duration of the project.
- B. Submit Manufacturer Warrantee prior to Owner's acceptance of the Manufacturer Structured Connectivity Solution.
- C. The Contractor shall forward all completed and implemented manufacturer's warranties and guarantees, and supporting documents, on equipment and materials not covered by the Manufacturer Warranty.

2.3 EQUIPMENT AND MATERIALS WARRANTY

- A. All equipment and material manufacturers shall replace, at no expense to the Owner, all equipment and materials or any component thereof, found defective within the manufacturers standard warranty period or three years minimum from date of final inspection and written acceptance by the Owner. The equipment and/or material manufacturer shall provide a written warranty document.
- B. Primary responsibility for initiating and implementing the manufacturer's warranty shall be the installing contractor under his guarantee.

2.4 STRUCTURED CONNECTIVITY SOLUTION EXTENDED PRODUCT WARRANTY AND APPLICATION ASSURANCE PROGRAM

- A. The following warranty verbiage applies only to Manufacturer Structured Connectivity Solution (SCS) products purchased and used in the United States of America and registered with Manufacturer as evidenced by a numbered Registration Certificate issued by Manufacturer. The Manufacturer SCS installation must be comprised entirely of a Manufacturer SCS certified end-to end channel of products and installed by a certified Manufacturer Reseller.

1. Extended Product Warranty

- a. The extended product warranty covers product defects for all passive Manufacturer components. Passive components are defined as those exhibiting no gain or contributing no energy. Manufacturer warrants, from the original installation completion date, provided a registration Certificate is issued by Manufacturer to the end-user, the following:
 - 1) That the passive products that comprise the registered Manufacturer solution will be free from manufacturing defects in material or workmanship under normal and proper use.
 - 2) That all Manufacturer approved passive cabling products that comprise the registered Manufacturer solution meet or exceed the relevant component specification of the TIA 568-~~BD~~ Series and ISO/IEC 11801: 2002.
 - 3) That the Registered MANUFACTURER SCS compliant links/channels will meet or exceed the applicable requirements of the TIA 568-~~BD~~ Series, and ISO/IEC 11801: 2002 standards for cabling links/channel configurations specified in these standards.
 - 4) That the Registered MANUFACTURER SCS compliant channels will additionally meet or exceed the Guaranteed Channel Performance in the MANUFACTURER SCS Performance Specification Addendum in effect at the time of installation.
- b. This extended Product Warranty is applicable to the Manufacturer SCS only on the original site of installation. Under the Extended Product Warranty, Manufacturer will either repair or replace the defective product itself (or will authorize a MANUFACTURER Business Partner to) at Manufacturer cost. And in the U.S.A. Manufacturer will pay an authorized reseller for the cost of labor to repair or replace any such defective product on behalf of Manufacturer.

2. Application Assurance

- a. Application Assurance covers failure of the Manufacturer SCS to operate the applications which the system was designed to support, as well as additional

application(s) defined below. Manufacturer warrants that the registered Manufacturer SCS solution will be free from defects which prevent operation of the specific applications for which the original Manufacturer SCS was designed as long as the design was in conformance with the MANUFACTURER SCS Performance Spec for said applications and is in compliance of all other terms and conditions of the warranty.

- b. The Application Assurance Program also covers the following additional applications:
 - 1) Those identified in the current (at the time of installation) Manufacturer SCS Performance Specifications; and in accordance with application standards specifications, any applications introduced in the future by recognized standards or user forums that use TIA/EIA 568-~~BD~~ or ISO/IEC 11801 current Edition components and link/channel specifications for cabling, to the extent that such applications are defined to operate over the guaranteed channel performance and/or the installed channel topologies.
3. Term of Warranty
 - a. For twenty (20) years from the date of issuance of the Registration Certificate or installation, whichever is earlier.
4. Persons / Entity Covered
 - a. This Limited Warranty shall be for the benefit of the person or entity to whom the Manufacturer Registration Certificate is issued and any successor (Transferable) in interest to the site in which such system was originally installed by Manufacturer or an authorized Manufacturer Reseller.
 - b. If Manufacturer repairs the product, it may use new or reconditioned replacement parts. If Manufacturer chooses to replace the product, Manufacturer may replace it with a new or reconditioned one of the same or similar design. Any such repair or replacement will be warranted for either (a) 90 days or (b) the remainder of the original 20-year warranty period, whichever is longer.

2.5 WARRANTY REPAIR PROCEDURES TECHNOLOGY EQUIPMENT/SERVICES

- A. The contractor will be notified by Owner of all technology related issues in an agreed upon method created at the close of the project.
 1. The contractor will identify group members and their contact information (email address and phone number) for notification within 10 days before the warranty period begins.
 2. The contractor shall configure network equipment, routers and switches, to allow for 24-hour monitoring; UPS units (SNMP) by Owner.
 3. In case of an alarm, a ticket is automatically generated by the Owner.
 4. The Owner will verify there is power to the equipment.
 5. Once it is established that there is power to the equipment, a trouble ticket will be sent to the contractor. They will be notified via email from the Owner.
- B. Response Priorities
 1. **Priority 1:** The contractor is expected to respond immediately to a building outage. Response shall be within 1 hour if the alarm is related to the Local Area Network (LAN) core switch (hardware and software) causing a network outage for the entire building.

- a. The respondent(s) shall update the trouble ticket acknowledging their awareness to the issue.
 - b. The respondent(s) shall update the trouble ticket as the status changes, when a cause is determined and an estimated resolution time is established.
 - c. The respondent(s) shall update the trouble ticket immediately after network connectivity is restored to the building.
2. **Priority 2:** The contractor shall respond within 24 hours for all other technology related issues, including instructional technology, i.e. interactive projectors, Interactive TVs, etc.
- a. The respondent(s) shall update the trouble ticket acknowledging their awareness to the issue.
 - b. The respondent(s) shall update the trouble ticket as the status change, when a cause is determined and an estimated resolution time is established.
 - c. The respondent(s) shall update the trouble ticket immediately after the issue(s) has been resolved.
- C. The contractor shall provide to the Owner within 24 hours of repair, a detailed written report describing steps taken to resolve the issue.
- D. The contractor will maintain a technology ticket log and schedule a quarterly meeting with the Owner to discuss all trouble tickets generated during that period and any ongoing issues.
- E. 11 Month Walk Through / Final Hand Over: The CMR and contractor will schedule a meeting with Owner during the 11th month of the contract to discuss all technology related issues that have occurred.

PART 3 - EXECUTION

3.1 IMPLEMENTATION

- A. The Contractor shall provide a Letter of Guarantee for a period of three (3) years on Company Letterhead, dated and signed by the Contractor Representative.
1. In the event that the Installing Contractor is a Subcontractor to the Primary Contractor, both contractors shall provide a Letter of Guarantee, acknowledging and accepting responsibility and liability for the others installation and performance under Division 27 Specifications in the event of default by the other.
- B. The Contractor shall be responsible for the coordination and implementation of all equipment and material manufacturer's guarantees and warranties.
1. The Contractor shall provide copies of all guarantees and warranties which shall be signed and dated by the manufacturer's representative.
 2. All completed warranty and guarantee documents shall be provided with the close out documentation, See Section 270802
- C. The contractor will be notified by Owner of all technology related issues in an agreed upon method created at the close of the project.

1. The contractor will identify group members and their contact information (email address and phone number) for notification within 10 days before the warranty period begins.
2. The contractor shall configure network equipment, routers and switches, to allow for 24-hour monitoring; UPS units (SNMP) by Owner.
3. In case of an alarm, a ticket is automatically generated by the Owner.
4. The Owner will verify there is power to the equipment.
5. Once it is established that there is power to the equipment, a trouble ticket will be sent to the contractor. They will be notified via email from the Owner.

D. Response Priorities

1. **Priority 1:** The contractor is expected to respond immediately to a building outage. Response shall be within 1 hour if the alarm is related to the Local Area Network (LAN) core switch (hardware and software) causing a network outage for the entire building.
 - a. The respondent(s) shall update the trouble ticket acknowledging their awareness to the issue.
 - b. The respondent(s) shall update the trouble ticket as the status changes, when a cause is determined and an estimated resolution time is established.
 - c. The respondent(s) shall update the trouble ticket immediately after network connectivity is restored to the building.
2. **Priority 2:** The contractor shall respond within 24 hours for all other technology related issues, including instructional technology, i.e. interactive projectors, Interactive TVs, etc.
 - a. The respondent(s) shall update the trouble ticket acknowledging their awareness to the issue.
 - b. The respondent(s) shall update the trouble ticket as the status change, when a cause is determined and an estimated resolution time is established.
 - c. The respondent(s) shall update the trouble ticket immediately after the issue(s) has been resolved.

- E. The contractor shall provide to the Owner within 24 hours of repair, a detailed written report describing steps taken to resolve the issue.
- F. The contractor will maintain a technology ticket log and schedule a quarterly meeting with the Owner to discuss all trouble tickets generated during that period and any ongoing issues.
- G. 11 Month Walk Through / Final Hand Over: The CMR and contractor will schedule a meeting with Owner during the 11th month of the contract to discuss all technology related issues that have occurred.

(This page intentionally left blank)

SECTION 270504 – COMMUNICATION SYSTEMS SUBMITTALS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Prepare required submittals of contractor qualifications, references, certifications, registrations, cut-sheets, shop drawings, etc. in a timely manner and submit through the Construction Manager, Architect, Owner and Engineer for review and approval prior to the start of work or installation as indicated on the Drawings, specified or as otherwise required.
- B. Materials and equipment installed in this project shall meet all requirements of the contract documents and no materials or equipment shall be ordered until submittals are reviewed and approved by the Architect, Engineer and the Owner.
- C. Submit complete copies of the catalog data or shop drawings for each manufactured item of equipment and all components to be used in the work, including specific performance data, material description, ratings, capacity, working pressure, dimensional data, material gauge or thickness, outside diameter of cables, wiring diagrams, brand name, catalog, material and product numbers, and general type.
- D. Catalog data for equipment reviewed by the Engineer and the Owner shall not take precedence over the requirements of the Contract Documents. The review by the Engineer and the Owner shall not relieve the Contractor from the responsibility for deviations from the Drawings or Specifications, nor from the responsibility for providing proper clearance and coordination with other Trades.
- E. When submitting for review, all shop drawings shall bear the Contractor's RCDD signed certification that he/she has reviewed, checked, and approved the shop drawings, that they have been coordinated with the requirements of the project and with the provisions of the Contract Documents, and that she/he has verified all field measurements and construction criteria, materials, catalog numbers and all information that is part of the submittal package.
- F. Each copy of a required Specification Section submittal shall be bound PDF folder with all pertinent project information on the cover or on a title sheet. Multiple Specification sections submittals may be bound in the same folder when by the same Manufacturer (i.e.: Legrand cable, jacks patch panels, etc.).

1.2 CONTRACTOR RESPONSIBILITIES

- A. Complete review of all shop drawings, product data, and samples prior to submission.
- B. Determine and verify:
 - 1. Field Measurements
 - 2. Field Construction Criteria
 - 3. Catalog Numbers and Similar Data
 - 4. Conformance with Specifications

5. Lead time for any item from the date the Contractor orders the item to the date the item will be delivered to the site by the Manufacturer or Supplier
- C. Coordinate each submittal with requirements for the work and the Contract Documents.
 - D. Notify the Architect in writing, at the time of submission, of any deviations in the submittals from the requirements of the Contract Documents. There will be no deviations from components of the Structured Cable System.
 - E. Make submittals and resubmittals, if necessary, promptly in accordance with the approved schedule and in such sequence as to cause no delay in the work or in the work of any other Contractor, or the project as a whole.
 - F. Make any corrections or changes in rejected submittals as required by the Architect, Engineer and /or the Owner and resubmit until approved.
 - G. Begin no fabrication or work which requires submittals until approved submittals are returned.
 - H. The Contractor shall make and distribute as many photocopies or blue-line prints of approved stamped submittals as needed for manufacturers, subcontractors, record and information manuals, etc.
 - I. Submit a complete copy of all submittals to the Owner in addition to any required by the Architect and Engineer.
- 1.3 INCORPORATION OF SUBMITTALS INTO RECORD AND INFORMATION MANUALS
- A. Refer to Section 270802 Documentation and Closeout for Communication Systems.
- 1.4 CERTIFICATIONS
- A. Provide:
 1. Test Agency results verifying capacities, operations and power requirements at design conditions.
 2. Manufacturer's Statement of Compliance with Standards discussed in individual Specification Sections.
 3. Equipment labels indicating Certification requirements.
 4. Quality standard designations on each unit piece.
 5. Typed verification that noted mixes, chemical compositions, and testing procedures were complied with
 6. Other Certifications listed in other Sections of the Specifications
- 1.5 REQUIRED SUBMITTAL INFORMATION
- A. Submittal Transmittal
 1. Provide the following information on the Transmittal Form for each submittal:
 - a. Project name and address.

- b. Specification number, as listed for each submittal item required in Paragraph 1.05 below.
 - c. Item description, as listed for each submittal item required in Paragraph 1.05 below. Where equipment is identified by number or tag on the documents, same shall be indicated on the submittal.
 - d. Specification number and item description (b and c, above) for each submittal if more than one submittal is sent under one transmittal form.
 - e. Name, address and telephone number of Contractor.
 - f. Bid package number (if applicable).
2. Submittal Transmittal Forms not properly identified with the above information will be returned (without review) to the Contractor.

B. Refer to the following letter Key for required submittals listed in attachment at end of section:

Required Submittal Information:

1	Shop Drawings and/or layout drawings – copies shall be submitted on those drawings which are in electronic PDF format. Where they are submitted on C, D or E size sheets; two (2) sets of electronic PDF prints and one (1) set of electronically reproducible shop drawings shall be provided. The reproducible set will be returned to the Contractor, who will make and distribute as many copies as needed, only prints with the approved stamp printed on them shall be permitted on the site.
2	Product Data Sheets
3	Color Samples
4	Product Samples
5	Typed Statement
6	Typed Verification of Compliance with Certification Requirements
7	Required Manufacturer Certification of the Contractor and the Contractor’s Employees
8	Resumes and training certificates of the Contractor’s employees
9	Motor Efficiencies and Power Factor
10	Wiring Diagrams
11	Installation, Operation, and Maintenance Instructions
12	Reports of Tests
13	Delivery Lead Time (date of order to date item is on site)

Section #	Section Title	Submittals Required
Section 270525	Communication Systems Fire stopping	2, 5, 6;
Section 270526	Grounding for Communication Systems	1, 2, 5, 6, 10, 11, 12;
Section 270528	Pathways	1, 2, 3, 6, 11, 13;
Section 270529	Hangers and Supports for Communications Systems	1, 2, 3, 6, 11, 13;
Section 270536	Cable Tray	1, 2, 3, 6, 11, 13;
Section 270544	Sleeves	1, 2, 3, 6, 11, 13;

Section 270553	Identification	2, 4;
Section 270801	Testing of Cable for Communication Systems	2, 5, 6, 7, 12;
Section 270802	Documentation and Closeout	1, 2, 5, 6, 7, 8, 10, 11, 12;
Section 271100	Communications Equipment Room Fittings	1, 2, 5, 10, 11, 13;
Section 271323	Optical Fiber Backbone Cabling	2, 6, 12, 13;
Section 271513	Copper Horizontal Cabling	2, 6, 12, 13;
Section 272100	Data Communications Network Equipment	1, 2, 5, 10, 11, 13;
Section 272133	Data Communications Wireless Access Points	1, 2, 5, 10, 11, 13;
Section 273123	IP Telephone System	2, 4, 10, 11, 13;
Section 273244	Emergency Responder Testing	5, 6, 12;
Section 274118	Conference Room AV	2, 4, 10, 11, 13;
Section 274119	AV	2, 4, 10, 11, 13;
Section 281300	Access Control System	1, 2, 4, 6, 7, 8, 10, 11, 12, 13;
Section 281353	Video Intercom System	2, 10, 11, 13;
Section 282100	Video Surveillance Cameras	2, 4, 6, 7, 8, 10, 11, 12, 13;
Section 282300	Video Surveillance System	2, 4, 6, 7, 8, 10, 11, 12, 13

- C. After approval, one (1) copy shall be returned to the Contractor. Contractor shall make prints of the approved transparencies and productions of all other shop drawing information as necessary for his/her use and for inclusion in the Record and Information Manuals.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

SECTION 270520 - BASIC COMMUNICATIONS MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section..

1.2 GENERAL REQUIREMENTS

- A. General: Sequence, coordinate, and integrate various elements of telecommunications system, materials, and equipment. Comply with following requirements as a minimum.
- B. Coordinate systems, equipment, and materials installation with other building components.
- C. Verify all dimensions by field measurements.
- D. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for wiring, cabling, and equipment installations.
- E. Coordinate installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- F. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of Work. Give particular attention to large equipment requiring positioning prior to closing in building.
- G. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom and access for service and maintenance as possible.
- H. Coordinate connection of materials, equipment, and systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- I. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by Contract Documents, recognizing that portions of Work are shown only in diagrammatic form. In case of conflict among individual system requirements, request direction in writing from Owner's Representative.
- J. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed in both exposed and un- exposed spaces.
- K. Install cabling, wiring, and equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- L. Provide access panel or doors where units are concealed behind finished surfaces.

- M. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- N. Comply with all requirements and work indicated on drawings.
- O. Avoid interference with structure and with work or other trades, preserving adequate headroom and clearing doors and passageways to satisfaction of Owner and per code requirements.
- P. Install equipment and cabling/wiring to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof-mounted equipment shall be installed and supported on structural steel or roof curbs as appropriate.
- Q. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall and ceiling mounting of equipment as required.
- R. Provide steel supports and hardware for proper installation of hangers, anchors, guides, and other support hardware.
- S. Obtain and analyze catalog data, weights, and other pertinent data required for proper coordination of equipment support provisions and installation.
- T. Structural steel and hardware shall conform to ASTM standard specifications. Use of steel and hardware shall conform to requirements of AISC Code of Practice: Section Five.
- U. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly that would void warranty.

1.3 EQUIPMENT INSTALLATION

- A. General: Install equipment per manufacturer's written instructions. Install equipment level and plumb. Install wiring and cabling between equipment and all related devices.
- B. Mounting: If neither the Owner's Instructions nor the individual section call out the required hardware mounting, use the following.
- C. For equipment at walls, bolt units to wall or mount on structural steel channel strut bolted to wall
 1. For equipment not at walls, provide freestanding racks fabricated of structural steel members and slotted structural steel channel strut
 2. Use feet consisting of 0.25-inch thick steel plates, 6 square inch, bolted to floor
 3. Use feet for welded attachment of vertical posts not over 3 feet on center
 4. Connect posts with horizontal U channel steel strut and bolt control equipment to channels
- D. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally using methods and materials as recommended by manufacturer.
- E. Connections: Tighten wiring connectors, terminals, bus joints, and mountings, to include lugs, screws and bolts per equipment manufacturer's published torque tightening values for equipment connectors. In absence of published connection or terminal torque values, comply with torque values specified in UL 486A and UL 486B.

1.4 TEMPORARY TELECOMMUNICATIONS SERVICES

- A. The temporary communications for construction is provided by the Communications Contractor. Refer to Division 01—General Requirements.
- B. The use of the permanent telecommunications system for temporary services during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period.
- C. Warranty periods on equipment, materials and systems shall commence upon Owner acceptance of the building or systems. Temporary use shall not jeopardize or alter warranty requirements.
- D. The complete temporary service shall comply with Telephone or Internet Companies, Owner Facility, OSHA and all applicable Codes.

1.5 CONTINUITY OF SERVICE

- A. Work shall be so planned and executed as to provide reasonable continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch-over, the Owner shall be notified in advance and outages schedules at the Owner's reasonable convenience.
- B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish this work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect/Engineer to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.
- C. Shutdown of systems and work undertaken during shutdowns shall be BID as being done during NORMAL working hours. If the Owner should require such work be performed outside of normal working hours, reimbursement shall be made for premium time expenses only, without mark-up.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Consultant shall have the right to stop the work if highest quality workmanship is not maintained.

- B. Electrical work associated with the Communications work shall be performed by a licensed Electrical Contractor in accordance with requirements of the jurisdiction.
- C. Communications work shall be performed by BICSI certified installers, technicians, and/or RCDDs in accordance with the respective specification and system requirements.

3.2 PROTECTION

- A. The Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Consultant.
- B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 ACCESS PANELS

- A. Ceiling and wall access panels shall be provided where indicated on the drawings or where otherwise requires gaining access to concealed junction boxes, pulling boxes, devices and equipment requiring service or adjustment.
- B. Access panels (refer to paragraph C. below for more specialized drywall ceiling access panels) shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and floor with screwdriver lock. Panels shall be 18" x 18" size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:
 - C. Standard flush type with overlapping flange for masonry and tile walls.
 - D. Recessed type having the floor recessed to accept a drywall panel insert, for drywall ceilings and walls.
 - E. Standard flush type for drywall ceilings and walls.
 - 1. Access panels in drywall ceiling shall be glass reinforced gypsum drywall lay-in panels with flush mounting frames. Corners of panels shall be rounded. Panels shall be 18" x 18" unless larger panels are shown or required.
 - 2. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.
 - 3. Materials used in plenums shall be rated for plenum use conforming to the 25/50 smoke development and flame spread restrictions.
- F. Access panels shall be turned over to the General Contractor for installation.
- G. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, and full shoulder clearance beside the device to be inspected, adjusted or repaired.

- H. Panels with recessed doors are to be fitted with insert panels of drywall or, those for plaster, infilled with plaster. Caution the Installing Contractor to provide appropriate framing with drywall or plaster beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall/ceiling.
- I. All access panel locations shall be coordinated with the architect.

3.4 CUTTING AND PATCHING

- A. Plan the work well ahead of the general construction. Where conduits, wireways, cable trays, etc. are to pass thru walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Contractor to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, saw cut or core drill holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by the Consultant. Any damage caused to the building in this work shall be repaired or rectified.
- B. All sleeves and openings shall be closed to prevent passage of smoke and fire.
- C. General: Perform cutting and patching per contract general requirements. In addition, following requirements apply:
 - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to uncover existing infrastructure to provide access for correction of improperly installed existing or new Work.
 - 2. Remove and replace defective Work.
 - 3. Remove and replace Work not conforming to requirements of Contract Documents.
 - 4. Remove samples of installed Work as specified for testing.
 - 5. Install equipment and materials in existing structures.
- D. Demolition and removal: Cut, remove, and legally dispose of selected equipment, components, and materials as indicated, including but not limited to removal of material, equipment, devices, and other items indicated to be removed and items made obsolete by new Work. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
- E. Protection of work: Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. During cutting and patching operations, protect adjacent installations. Patch finished surfaces and building components using new materials specified for original installation and experienced Installers.

3.5 PENETRATIONS AND SLEEVES

- A. General: Coordinate work with other sections. SCS Installation Contractor shall be responsible for the provision of cabling sleeves and conduits unless specifically provided by the Electrical Contractor. SCS Installation Contractor shall coordinate with Electrical Contractor to determine exact requirements.
- B. When required, set sleeves in forms before concrete is poured. Provide core drilling as necessary if walls are poured or otherwise constructed without sleeves and wall penetration is required. Do not penetrate structural members. Provide sleeves and packing materials at all penetrations of

foundations, walls, slabs (except on-grade), partitions, and floors. Sleeves shall meet requirements of pertinent specifications. Lay out penetration and sleeve openings in advance, to permit provision in work. Set sleeves and conduit in forms before concrete is poured. Provide remedial work where sleeves and conduits are omitted or improperly placed.

- C. Sleeve fill: Sleeves that penetrate outside walls, basement slabs, footings, and beams shall be waterproof.
 - 1. Fill slots, sleeves and other openings in floors or walls if not used.
 - 2. Fill spaces in openings after installation of conduit or cable.
 - 3. Fill for floor penetrations shall prevent passage of water, smoke, fire, and fumes.
 - 4. Fill shall be fire resistant in fire floors and walls, and shall prevent passage of air, smoke and fumes. See section 27 05 32 - Firestopping for Telecommunications Systems.
 - 5. Sleeves through floors shall be watertight and shall extend 2 inches above floor surface.
 - 6. Where raceways passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling, and wall finishes.
- D. Conduit sleeves:
 - 1. Annular space between conduit and sleeve shall be at least 1/4 inch.
 - 2. Sleeves shall not be provided for slabs-on-grade unless specified or indicated otherwise.
 - 3. For sleeves through rated fire walls and smoke partitions, comply with requirements for firestopping. See section 27 05 32 - Firestopping for Telecommunications Systems.
- E. Supports: Do not support piping risers or conduit on sleeves.
- F. Future use: Identify unused sleeves and slots for future installation.

3.6 CORE DRILLING

- A. General: Core drilling shall be avoided where possible. Where core drilling is unavoidable, locate all required openings prior to coring.
- B. Coordinate openings with other trades and utilities, and prevent damage to structural reinforcement.
- C. Thoroughly investigate existing conditions in vicinity of required opening prior to coring.
- D. Set sleeves prior to installation of structure for passage of pipes, conduit, ducts, etc. Protect all areas from damage.

3.7 CLEANING

- A. Contractor is responsible for cleanup of debris daily. Cost of cleanup is the responsibility of the Contractor.
- B. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition. Perform cleaning and washing required to provide acceptable appearance and operation of equipment to satisfaction of Owner's Representative.

- C. After completion of Project, clean exterior surface of all equipment, including concrete residue, dirt, and paint residue. Final cleaning shall be performed prior to Project acceptance by Owner's Representative.

3.8 PAINTING

- A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in the technology package:
 - 1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
 - 2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
 - 3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
 - 4. Apply Z.R.C. Cold Galvanizing Compound, or equal by Clearco or Rustoleum, for touch-up of previously galvanized surfaces.
 - 5. Each backboard shall be painted with a minimum of two coats of flame retardant paint, all sides; gray enamel primer with gray matte enamel finish.
- B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 of the Specifications. All rust must be removed before application of paint.
- C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and patching paragraph in this Section for finishing requirements.

3.9 BACKBOARDS

- A. Where shown on the drawings/on all walls in each TR, backboards shall be provided for wall mounting of communications equipment.
- B. General
 - 1. Backboards shall be normally 4 ft. x 8ft. mounted 6" above floor. Where other sizes are required, they will be noted on the drawings.
 - 2. Backboards shall be 0.75" thick waterproof flame retardant plywood secured to structure.
 - 3. Each board shall be painted light-gray.

3.10 CEILING GRID AND TILE

- A. Technology contractors are responsible for any damage to ceiling tile or grid that they cause during above ceiling work. It is suggested that digital photos be taken in those areas that have

ceiling grid and/or tile installed before any work is done. These photos should be dated and given to the CM or Consultant. Damage done to ceilings will be charged to the offending contractor.

3.11 PRODUCT COORDINATION

- A. Equipment cabinets and racks shall be coordinated with the contractors after contract award. Matching cabinets and racks will be utilized for all vendors.

3.12 STARTUP AND OPERATIONAL TESTING

- A. General: Owner maintains right to have access to entire project site to prepare facility for occupancy and operation. Completion of startup and field testing shall be accomplished as a prerequisite for substantial completion. Operate and maintain systems and equipment until final acceptance by Owner. All guarantees and warranties shall not begin until final acceptance of systems and equipment by Owner. Acceptance requires, at a minimum, complete systems startup and testing.

3.13 SPECIAL RESPONSIBILITIES AND INFORMATION

- A. Coordination of information: Cooperate and coordinate with work of other sections in executing work of this section. Perform work such that progress of entire project, including work of other sections, shall not be interfered with or delayed. Provide information as requested on items furnished under this section, which shall be installed under other sections. Obtain detailed installation information from manufacturers of equipment provided under this section.
- B. Information gathering: Obtain final rough-in dimensions or other information as needed for complete installation of items furnished under other sections or by Owner. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under this and other sections. Give full information so that openings required by work of this section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information in proper time, provide cutting and patching or have same done, at no expense to Owner.
- C. Housekeeping pads: Provide information as requested as to sizes, number and locations of concrete housekeeping pads necessary for floor mounted equipment
- D. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.
- E. Use of premises: Use of premises shall be restricted as directed by Owner's Representative and as required below:
 - 1. Cleaning and rubbish removal: Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of Owner's Representative.

2. Rubbish Removal: Provide for the removal from the site of all spoils, debris, boxes, packaging, crates, and trash generated from the work.
 3. Storage: Store materials maintaining an orderly, clean appearance. If stored on site in open or unprotected areas, all equipment and material shall be kept off ground by means of pallets or racks, and covered with tarpaulins.
- F. Protection of fireproofing:
1. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, if possible, prior to start of spray fire proofing work.
 2. Conduits and other items that would interfere with proper application of fireproofing shall be installed after completion of spray fire proofing work.
 3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this section shall be performed by installer of fireproofing and paid for by section responsible for damage and shall not constitute grounds for an extra to Owner.
- G. Temporary utilities: Refer to contract general requirements regarding requirements.
- H. Movement of materials: Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving equipment on and around site, in building or on roof.

3.14 DIVISION OF WORK

- A. General: Division of work responsibility matrix at the end of this section is for Contractor's reference to clarify roles of various manufacturers, installers, subcontractors, and trades involved in telecommunications system Project.
- B. Contractor holding contract with Owner is responsible for coordinating work of all subcontractors to provide a complete and usable Project complying with contract provisions of Project documents.
- C. Failure to coordinate work by subcontractors and suppliers will not be considered justification for additional compensation or extension of schedule.

(This page intentionally left blank)

SECTION 270525 - FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 DEFINITIONS

- A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.3 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

- A. Only tested firestop systems shall be used in specific locations as follows: Penetrations for the passage of cables, conduit, and other electrical equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

1.4 RELATED WORK OF OTHER SECTIONS

- A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:
 - 1) Section 03300 - Cast-In-Place Concrete
 - 2) Section 04200 - Masonry Work
 - 3) Section 07840 – Firestopping
 - 4) Section 09250 - Gypsum Drywall Systems
 - 5) Section 13080 - Sound, Vibration and Seismic Control
 - 6) Section 13900 - Fire Suppression and Supervisory Systems
 - 7) Section 16050 - Basic Electrical Materials and Methods
 - 8) Section 15300 - Fire Protection

1.5 REFERENCES

- A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops"
- B. Test Requirements: UL 1479, "Fire Tests of Through-Penetration Firestops"
- C. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
 - 1. UL Fire Resistance Directory:

- a. Firestop Devices (XHJI)
 - b. Fire Resistance Ratings (BXRH)
 - c. Through-Penetration Firestop Systems (XHEZ)
 - d. Fill, Voids, or Cavity Material (XHHW)
 - e. Forming Materials (XHKU)
- D. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments
 - E. Inspection Requirements: ASTM E 2174, “Standard Practice for On-site Inspection of Installed Fire Stops.”
 - F. ASTM E 84, “Standard Test Method for Surface Burning Characteristics of Building Materials.”
 - G. All major building codes: ICBO, SBCCI, BOCA, and IBC.
 - H. NFPA 101 - Life Safety Code
 - I. NFPA 70 - National Electric Code

1.6 QUALITY ASSURANCE

- A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- B. Firestop System installation must meet requirements of ASTM E 814 or UL 1479 tested assemblies that provide a fire rating equal to that of construction being penetrated.
- C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
- D. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.
- E. For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

1.7 SUBMITTALS

- A. Submit Product Data: Manufacturer’s specifications and technical data for each material including the composition and limitations, documentation of UL firestop systems to be used and manufacturer's installation instructions to comply with Section 1300.
- B. Manufacturer's engineering judgment identification number and drawing details when no UL system is available for an application. Engineering judgment must include both project name and contractor’s name who will install firestop system as described in drawing.
- C. Submit material safety data sheets provided with product delivered to job-site.

1.8 INSTALLER QUALIFICATIONS

- A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer’s products per specified requirements. A manufacturer’s willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.
- C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature limitations.
- D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- E. Do not use damaged or expired materials.

1.10 PROJECT CONDITIONS

- A. Do not use materials that contain flammable solvents.
- B. Scheduling:
 - 1. Schedule installation of CAST IN PLACE firestop devices **after** completion of floor formwork, metal form deck, or composite deck but **before** placement of concrete.
 - 2. Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.
- C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

- D. Weather Conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.
- E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 2 - PRODUCTS

2.1 FIRESTOPPING GENERAL

- A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

2.2 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with through penetration firestop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:
 - 1. STI
 - 2. Hilti
 - 3. 3M
 - 4. Substitution requests shall be considered in accordance with contract provisions

2.3 MATERIALS

- A. Use only firestop products that have been UL 1479 or ASTM E 814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
- B. Pre-installed firestop devices for use with noncombustible and combustible pipes (closed and open systems), conduit, and/or cable bundles penetrating concrete floors and/or gypsum walls
- C. Sealants, foams or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing (EMT)
- D. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including PVC jacketed, flexible cable or cable bundles, and plastic pipe
- E. Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles

- F. Non curing, re-penetrable intumescent putty or foam materials for use with flexible cable or cable bundles
- G. Wall opening protective materials for use with U.L. listed metallic and specified nonmetallic outlet boxes
- H. Materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways
- I. Non curing, re-penetrable materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways
- J. For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected
- K. Provide a firestop system with a "F" Rating as determined by UL 1479 or ASTM E 814 which is equal to the time rating of construction being penetrated.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
 - 1. Verify penetrations are properly sized and in suitable condition for application of materials.
 - 2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
 - 3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
 - 4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
 - 5. Do not proceed until unsatisfactory conditions have been corrected.

3.2 COORDINATION

- A. Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

3.3 INSTALLATION

- A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory.
- B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration materials.

1. Seal all holes or voids made by penetrations to ensure an air and water-resistant seal.
2. Protect materials from damage on surfaces subjected to traffic.

3.4 FIELD QUALITY CONTROL

- A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
- B. Keep areas of work accessible until inspection by applicable code authorities.
- C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, “Standard Practice for On-Site Inspection of Installed Fire Stops” or other recognized standard.
- D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

3.5 ADJUSTING AND CLEANING

- A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.
- B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

3.6 WORKMANSHIP

- A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Consultant shall have the right to stop the work if highest quality workmanship is not maintained.
- B. Electrical work associated with the Communications work shall be performed by a licensed Electrical Contractor in accordance with requirements of the jurisdiction.
- C. Communications work shall be performed by BICSI certified installers, technicians, and/or RCDDs in accordance with the respective specification and system requirements.
- D. Installation of all material and assemblies shall be in accordance with UL assembly drawings and the manufacturer’s instructions.

3.7 PROTECTION

- A. The Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Consultant.
- B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.8 CUTTING AND PATCHING

- A. Plan the work well ahead of the general construction. Where conduits, wireways, cable trays, etc. are to pass thru walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Contractor to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, saw cut or core drill holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by the Consultant. Any damage caused to the building in this work shall be repaired or rectified.
- B. All sleeves and openings shall be closed to prevent passage of smoke and fire.

3.9 PAINTING

- A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in the technology package:
 - 1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
 - 2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
 - 3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
 - 4. Apply Z.R.C. Cold Galvanizing Compound, or equal by Clearco or Rustoleum, for touch-up of previously galvanized surfaces.
 - 5. Each backboard shall be painted with a minimum of two coats of flame retardant paint, all sides; gray enamel primer with gray matte enamel finish.
- B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 of the Specifications. All rust must be removed before application of paint.
- C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and patching paragraph in this Section for finishing requirements.

(This page intentionally left blank)

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 SCOPE OF WORK

- A. Work includes the provision of the technical grounding system including requirements for complete telecommunications grounding and bonding system.
- B. Work includes bonding of technology pathways and equipment to the technical grounding system.
- C. This section includes the minimum requirements for the equipment and cable installations in communications equipment rooms (Telecommunications Closets).
- D. Included in this section are the minimum composition requirements and installation methods for the following:
 - 1. Grounding Electrode System
 - 2. Busbars
 - 3. Bonding accessories

1.3 SYSTEM

- A. Grounding/bonding system shall be installed throughout the building to serve telecommunications raceways, electronics and components.
- B. The Primary Bonding Busbar (PBB) formerly called the Telecommunications Main Ground Bar (PBB) shall be electrically bonded to the Building Main Electrical Service Ground with a minimum insulated, #3/0, copper grounding conductor.
- C. Utilize the Primary Bonding Busbar (PBB) in MER.
- D. Utilize the Secondary Bonding Busbar (SBB) formerly called the Telecommunications Main Ground Bar (TGB) in each TR. This SBB shall be electrically bonded to the Equipment Racks, telephone and CATV service entrance points.
- E. Provide a Telecommunications Bonding Conductor (TBC) from each SBB to a local electrical panelboard ground. The bonding conductor shall consist of a minimum #6 bare copper grounding conductor. Provide a warning label attached to each TBC at each end stating "WARNING: Building telecommunications grounding system. Do not remove or disconnect without prior approval from building Telecommunications Department."

- F. Provide bonding between all joints of cable tray and ladder rack. Provide bonding to all conduit sleeves. Provide bonding to all technology equipment racks and cabinets within each wiring closet.
- G. Provide bonding from the Technology grounding system to the telephone and CATV DEMARC equipment and protector panels. Coordinate this grounding prior to installation of telephone and CATV services.
- H. All work shall be in compliance with NEC, Article 250 and ANSI/TIA-607-C.
- I. Comply with all applicable Federal, State, and Local laws and regulations.
- J. The Electrical Contractor shall install:
 - 1. Ground conductor and connection from the main electrical ground to the PBB and from each ground bar to the local receptacle panel.
 - 2. Ground cables from each ground bar to building steel.
 - 3. Connection to building main ground.
- K. The Telecommunications Contractor shall install:
 - 1. All grounding busbars and bonding conductors within and between the telecommunications rooms, as well as make all the final connections to the SBBs, and the telecommunications infrastructure/equipment.
 - 2. The Communications Contractor shall connect all racks, components, cables, conduits, and communications systems in each communications room to the ground bar in the respective communications room.

1.4 QUALITY ASSURANCE

- A. All work shall be installed in compliance with the latest edition of the EIA/TIA, BICSI Standards, applicable NEC code sections, and Ohio Building Codes (OBC).
- B. All equipment shall be UL listed.
- C. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- D. Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- E. Material and work specified herein shall comply with the applicable requirements of the current revision of the following:
 - 1. ANSI/TIA-568 Commercial Building Telecommunications Cabling Standard ANSI/TIA-569 Telecommunications Pathways and Spaces

2. ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure BICSI – Telecommunications Distribution Methods Manual
3. J-STD-607-A Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
4. NFPA 70 – National Electric Code

1.5 SUBMITTALS

- A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.
- B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.6 COORDINATION

- A. Coordinate ground connections to electrical system with Electrical Engineer

1.7 Relevant Standards

- A. The Telecommunications Grounding Installation shall comply with the following at a minimum:
 1. All local, state and national codes
 2. The National Electric Code (NEC)
 3. The National Electrical Safety Code (NESC)
 4. Electronic Industries Alliance (EIA) / Telecommunications Industry Association (TIA) 606, 607 and all applicable and current Technical Service Bulletins (TSB).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Products: Standard of quality for ground components are Legrand or Caddy. Approved equals must demonstrate product equivalency.
 1. Erico
 2. Panduit
 3. Chatsworth
- B. Approved equals for ground cables are:
 1. The Aconite Company.
 2. South wire.
 3. Pirelli.

2.2 PRIMARY BONDING BUSBAR (PBB):

- A. PBB shall be installed in the Main Equipment room (MER).
- B. PBB shall be a minimum of 0.25 inches thick x 4 inch high x 36 inch long insulated copper ground bar having a minimum of 95% conductivity when annealed with pre-drilled holes for standard sized lugs and must be UL listed. Provide final length as required to accommodate grounding lug attachments.
- C. Bar shall include all bolts, washers, brackets, and insulators required for mounting on the wall.
- D. Ground bars shall be provided with insulated stand-off brackets for wall mounting providing a minimum of 2" wall clearance. Insulators shall have a minimum voltage rating of 300mV and a minimum Short Time Electrical Strength of 55kVv.
- E. All connections shall be made with double-bolted, compression style grounding lugs.

2.3 SECONDARY BONDING BUSBAR (SBB):

- A. SBB shall be installed in each telecommunications room (TR) unless otherwise noted on the drawings.
- B. SBB shall be 0.25 inch thick x 4 inch high x minimum 12" inch long with pre-drilled holes for standard-sized lugs and must be UL listed. Provide final length as required to accommodate grounding lug attachments.
- C. SBB shall include all bolts, washers, brackets, and insulators required for mounting on the wall.
- D. Ground bars shall be provided with insulated stand-off brackets for wall mounting providing a minimum of 2" wall clearance. Insulators shall have a minimum voltage rating of 600V and a minimum Short Time Electrical Strength of 55kVv.
- E. All connections shall be made with double-bolted, compression style grounding lugs.

2.4 TELECOMMUNICATIONS BONDING BACKBONE (TBB):

- A. Provide telecommunications bonding backbone (TBB) between all SBBs and the PBB.
- B. All TBB connections to be made with double bolted, compression style, rounding lugs.
- C. The TBB shall be a minimum of No.3 AWG copper bonding conductor. Where TBB is run through Plenum spaces, bare cable shall be used. Wrap each end of the bare cable with green tape.
- D. All connections shall be made with double-bolted, compression style grounding lugs.

2.5 TELECOMMUNICATIONS BONDING CONDUCTOR (TBC)

- A. Ground wire shall be 3/0, No.6 AWG for all ground connections. Ground wire in plenum areas shall be bear with no insulation. All other ground wires shall have green insulation.

- B. Exothermic ground connections shall be used. Contractor shall bond ground conductor to building steel.
- C. Ground testing shall be completed with a certified grounding tester.
- D. All telecommunications riser conduits shall be fitted with a grounding bushing at the communications closet.
 - 1. Ground bushing shall be sized for the conduit and ground cable that will be attached.
 - 2. Ground wedge shall be sized for the conduit and ground cable that will be attached.
- E. All cable trays shall have a continuous No. 2 AWG minimum ground cable installed.
 - 1. The ground cable shall connect to each individual section of the cable tray with an approved grounding connector.
 - 2. Grounding cable in the cable tray shall terminate on the PBB in the main telecommunications room.
 - 3. Cable trays that are UL listed as grounded/bonded will eliminate the need for the continuous No. 2 AWG ground cable used to bond each section together. Conductor shall be minimum #6AWG and may be stranded or solid, insulated or bare.
- F. All connections shall be made with double-bolted, compression style grounding lugs.
- G. Conductors shall not decrease in size as the grounding path moves closer to earth, and the size of the conductor is not intended to account for the reduction or control of EMI.

2.6 BONDING ACCESSORIES

- A. Two Mounting Hole Ground Terminal Block
 - 1. Ground terminal block shall be made of electroplated tin aluminum extrusion.
 - 2. Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
 - 3. The conductors shall be held in place by two stainless steel set screws.
 - 4. Ground terminal block shall have two 1/4" (6.4 mm) holes spaced on 5/8" (15.8 mm) centers to allow secure two-bolt attachment to the rack or cabinet.
 - 5. Ground terminal block shall be UL Listed as a wire connector.
- B. Compression Lugs
 - 1. Compression lugs shall be manufactured from electroplated tinned copper.
 - 2. Compression lugs shall have two holes spaced on 5/8" (15.8 mm) or 1" (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbars.
 - 3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0, as stated below.
 - 4. Compression lugs shall be UL Listed as wire connectors.
- C. Antioxidant Joint Compound
 - 1. Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.
- D. C-Type, Compression Taps
 - 1. Compression taps shall be manufactured from copper alloy.

2. Compression taps shall be C-shaped connectors that wrap around two conductors forming an irreversible splice around the conductors; installation requires a hydraulic crimping tool
 3. Compression taps shall be sized to fit specific size conductors, sizes #2 AWG to 4/0, as stated below.
 4. Compression taps shall be UL Listed.
- E. Pedestal Clamp with Grounding Connector
1. Pedestal clamp shall be made from electroplated tinned copper or bronze. Installation hardware will be stainless steel.
 2. Pedestal clamps shall be sized to fit a specific size conductor, size #6 and/or 2/0, as stated below.
 3. Pedestal clamp installation hardware shall be sized to attach to round and/or square raised access floor pedestals that are 1-1/8" to 1-3/4" in diameter, as stated below.
 4. Pedestal clamp shall provide straight (in-line) or cross (intersection) support for up to two conductors.
 5. Pedestal clamp shall be UL Listed as grounding and bonding equipment.
- F. Pipe Clamp with Grounding Connector
1. Pipe clamp shall be made from electroplated tinned bronze. Installation hardware will be stainless steel.
 2. Pipe clamp shall be sized to fit up to two conductors ranging in size from #6 to 250 MCM; conductors must be the same size.
 3. Pipe clamp installation hardware shall be sized to attach to pipes, sizes 1" to 6" (.75" to 6.63" in diameter), as stated below.
 4. Pipe clamp shall be UL Listed as grounding and bonding equipment.
- G. Equipment Ground Jumper Kit
1. Kit includes one 24" L insulated ground jumper with a straight two-hole compression lug on one end and an L-shaped two-hole compression lug on the other end, two plated installation screws, an abrasive pad and a .5 once tube of antioxidant joint compound.
 2. Ground conductor is an insulated green/yellow stripe #6 AWG wire
 3. Lugs are made from electroplated tinned copper and have two mounting holes spaces .5" to .625" apart that accept 1/4" screws.
 4. Jumper will be made with UL Listed components

PART 3 - EXECUTION

3.1 GENERAL

- A. The telecommunications grounding system shall provide an electrically continuous, low impedance path for all connected telecommunications equipment and pathways.
- B. When using grounding conductors installed in rigid, ferrous metallic conduit, both ends of the bonding conductor must be bonded to the conduit ends.
- C. The bonding conductors shall have no splices or connections.

- D. The bonding conductor shall be connected to the building main electrical grounding system through the use of exothermic weld, listed lugs, listed pressure connectors, listed clamps, or other listed means.
- E. All metallic telecommunications pathways and equipment within telecommunications spaces shall be bonded to the local SBB/PBB utilizing Bonding Conductors (BC).
- F. Location of the ground bar shall be finalized in the communications room prior to installation.
- G. Locate and note all equipment to be connected to the ground system. Routes for ground cables shall be planned prior to final location of the ground bar.
- H. Identify location of main electrical distribution panel, local receptacle panel, and building steel. Connections from the ground bar to all of these are required for a complete ground system.
- I. If any changes from the drawings are required, the Contractor shall submit a proposed layout of the communications room and a diagram of the ground connections to the Engineer for approval prior to installation.

3.2 WIRING

- A. In large buildings with multiple floors and multiple riser closets per floor, the TGB in the closets at the top floor and every third floor shall be joined with the Grounding Equalizer (GE).
- B. The drawings do not indicate specific routes for telecommunications grounding cables. The telecommunications Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adhere to specific codes and standards developed for the installation of such cables.
- C. Where the use of existing cable management systems and pathways would cause the grounding system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Telecommunications Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.
- D. MER shall be provided with the PBB. The PBB shall be bonded to the building electrical system ground and shall be bonded to one additional building electrical system ground (such as building steel).
- E. Each TR/TE shall be provided with a SBB.
- F. Provide a TBC from each SBB.

3.3 PREPARATION

- A. Plan routes of all ground cables.
- B. For components that are to be connected to the ground system, remove paint from the connecting point and attach to the ground cable with a star washer.

3.4 INSTALLATION

- A. Ground bars shall meet all applicable codes, and shall be located such that they are accessible for maintenance.
1. All grounding conductors shall be continuous without splice from service drop neutral to ground electrode.
 2. All grounding electrodes and all metallic piping systems shall be bonded together. In no instance should local metallic piping systems be depended upon as the sole means of grounding the communications system.
 3. Metal boxes, cabinets and fittings, or noncurrent carrying metal parts of other fixed equipment, if metallically connected to grounded cable armor or metal raceway, are considered to be grounded by such connection. If not connected, they shall be grounded in 1 of the following ways:
 - a. By a grounding conductor run with circuit conductors, this conductor may be Uninsulated. But if it is provided with an individual covering, the covering should be finished to show a green color.
 - b. By a separate grounding conductor installed the same as grounding conductor for conduit and the like.
 4. Metal raceways, cable armor, cable sheath, enclosures, frames, fittings, and other metal non-current-carrying parts that are to serve as grounding conductors shall be effectively bonded where necessary to assure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them. Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces or be connected by means of fittings so designed as to make such removal unnecessary.
 5. Continuity of metal raceway or metallic sheathed cable shall be assured throughout the system.
 6. NEC shall be used as guide for grounding in hazardous areas.
 7. Make connections of ground cables to structural members by exothermic process.
 8. Terminate ground cables on ground busses with copper compression fittings.
- B. Ground cables shall be installed in a neat and workmanlike manner.
1. All cables shall be supported or routed against a wall and attached to the wall. No free floating cables between components will be allowed.
 2. Connect all communications riser conduits to ground cables via the grounding bushings.
 3. All cable tray ground cables shall be installed outside of the tray. Ground cables installed inside the tray may cause harm to the low voltage cable during installation.
 4. Fully support ground cable so that it does not sag between connections along the cable tray.
- C. To make a complete grounding/bonding system, all components must be connected. That includes, but is not limited to:
1. Racks and cable ladder. Each section shall be bonded to the next to create a completely bonded system.
 2. Cable tray.
 3. Local receptacle panel that provides power for the communications room.
 4. PBB via a No. 6 AWG ground wire.
 5. Protected entrance terminals (PET).
 6. Splice cases.
 7. Video and audio systems.

8. Telecommunications riser conduits.
 9. Building steel via a No. 2 AWG ground wire.
 10. Cabinets.
 11. Cable Shields
 12. Communications devices
 13. Raised floors
- D. Riser conduits shall only be connected to the ground at 1 end.
1. Ground cables shall not be routed through conduits longer than 24 inches.
 2. If it is necessary to route a ground cable through a conduit longer than 24 inches, the conduit shall have ground bushings at each end attached to the ground cable.
 3. Installing ground cables in conduits that are used for data cabling is not allowed.
 4. Connections to building steel shall be done via an exothermic weld.
 5. The Contractor shall make sure that any smoke or fumes from the weld process will not harm any persons, or set off the fire alarm/sprinkler system.
 6. This may cause the Contractor to do the work during off hours or on a weekend. A member of the facilities department may need to be present. The Contractor shall schedule all work with the Owner, and no additional compensation will be allowed for off hours work.
- E. Ground systems shall be tested after installation to ensure proper installation and connectivity.
1. Test procedures shall be fully spelled out. They shall minimally include, the time and date of the test, name of tester, device used to test ground potential, and test results.
- F. The Contractor shall provide test results, to the Engineer for final approval and sign off.
- G. Outdoor grounding and bonding connections.
1. All outdoor grounding and bonding (earthing) connections shall be accomplished using exothermic welding.
- H. Wall-Mount Busbars
1. Attach busbars to the wall with appropriate hardware according to the manufacturer's installation instructions.
 2. Conductor connections to the PBB or TGB shall be made with two-hole bolt- on compression lugs sized to fit the busbar and the conductors.
 3. Each lug shall be attached with stainless steel hardware after preparing the bond per manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
 4. The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.
- I. Rack-Mount Busbars and Ground Bars
1. When a rack or cabinet supports active equipment or any type of shielded cable or cable termination device requiring a ground connection, add a rack-mount horizontal or vertical busbar or ground bar to the rack or cabinet. The rack- mount busbar or ground bar provides multiple bonding points on the rack for rack and rack-mount equipment.
 2. Attach rack-mount busbars and ground bars to racks or cabinets per the manufacturer's installation instructions.
 3. Bond the rack-mount busbar or ground bar to the room's PBB or TGB with appropriately sized hardware and conductor.

- J. Ground Terminal Block
 - 1. Every rack and cabinet shall be bonded to the PBB or TGB.
 - 2. Minimum bonding connection to racks and cabinets shall be made with a rack-mount two-hole ground terminal block sized to fit the conductor and rack and installed per manufacturer recommendations.
 - 3. Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.

- K. Pedestal Clamp
 - 1. At minimum, bond every sixth raised access floor pedestal with a minimum #6 AWG conductor to the PBB or TGB using a pedestal clamp sized to fit the pedestal and the conductor and installed per the manufacturer's recommendations.
 - 2. If pedestal clamps are used to construct a signal reference grid, bond the signal reference grid to the PBB or TGB and bond each rack and/or cabinet to the signal reference grid using a compression tap or similar non-reversible bonding component sized to fit both conductors.
 - 3. Remove paint between the pedestal and pedestal clamp, clean surface and use antioxidant between the pedestal and the clamp to help prevent corrosion at the bond.
 - 4. Remove insulation from conductors where wires attach to the pedestal clamp.

- L. Pipe Clamp
 - 1. Bond metal pipes located inside the data center computer room with a minimum #6 AWG conductor to the PBB or TGB using a pipe clamp sized to fit the pipe and the conductor and installed per the manufacturer's recommendations.
 - 2. Remove paint between the pipe and pipe clamp, clean surface and use antioxidant between the pipe and the clamp to help prevent corrosion at the bond.
 - 3. Remove insulation from conductors where wires attach to the pipe clamp.

- M. Equipment Ground Jumper Kit
 - 1. Bond equipment to a vertical rack-mount busbar or ground bar using ground jumper per the manufacturer's recommendations.
 - 2. Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount busbar or ground bar to help prevent corrosion at the bond.

3.5 LABELING

- A. The Contractor shall be responsible for labeling all telecommunications grounding equipment, cable, etc. in accordance with the guidelines as described herein.
- B. All ground cables shall be labeled that bond equipment within a space to the PBB or SBB.
- C. All Telecommunications Bonding Backbone (TBB) cables shall be labeled.
- D. Labeling shall conform to ANSI/TIA/EIA-606-B
- E. Label all SBB's and the PBB with the following: "WARNING! IF THE CONNECTION OR CABLE IS LOOSE OR MUST BE REMOVED PLEASE CALL THE TELECOMMUNICATIONS DEPARTMENT. WARNING: Building telecommunications grounding system. Do not remove or disconnect without prior approval from building Telecommunications Department."

3.6 TESTING GENERAL

- A. The Contractor shall be responsible for testing the complete technology grounding system.
- B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.
- C. Test reports shall be provided to indicate.
 - 1. Impedance values across each TBB from the PBB to the SBB.
 - 2. Impedance values across the TBC from the PBB to the main electrical service ground.
 - 3. Impedance values across each GE between SBB on a common floor.
- D. System testing shall be performed with final test results turned over to the Owner' prior to acceptance of the system. Missing or incomplete test results will not be reviewed and the system will not be commissioned by the Owner / Architect / Engineer.
- E. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application.
- F. Instruments required for tests shall be furnished by the Contractor.

3.7 AS BUILT DOCUMENTATION

- A. Refer to section 270500 for submittal requirements.
- B. Copies of all approved shop drawings with the Engineer's stamp.
- C. Copy of all test reports
- D. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.
 - 1. System schematic and clock diagrams for technology grounding system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

3.8 WARRANTY

- A. The entire grounding and bonding system shall be guaranteed against defects in workmanship and materials for a period of (3) three years as described herein.
- B. Period shall commence after system has been commissioned by the Owner, Engineer and Architect.
- C. The installing contractor shall provide the initial warranty service.
- D. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All provisions of the Division 00 and Division 01, apply to all work in Division 27

1.2 SCOPE OF WORK

- A. Work consists of pathways to carry communication wiring of all descriptions including empty conduits, conduit sleeves, cable tray, ladder rack, basket tray, cable management systems, innerduct, etc.
- B. Work includes support equipment for telecommunications cabling including backboards, rough-in boxes and cabinets.
- C. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete device box system as hereinafter specified and/or shown on the Contract Documents. The device box system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS) as specified in Division 27 - Communications Horizontal Cabling. These requirements supersede any Division 26 device box requirements.
- D. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the Contract Documents but which are necessary to make a complete working device box system.
- E. Install empty raceway system, including underfloor and overhead distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cable troughs, service poles, miscellaneous and positioning material to constitute complete system, as indicated for distribution of Telecommunications wiring which includes cables for Data, Voice, Video, Audio, Security and future signal requirements.
- F. The location at which all new telecommunications wiring will terminate is called a Telecom Outlet (TO). There are several styles of outlets:
 - 1. New construction
 - 2. Existing construction typical
 - 3. Existing construction variations
 - 4. Telephone (Voice) only
 - 5. Data only
- G. Furnish and install split channel raceway and outlet boxes as specified in the Drawings and as specified herein.
- H. Furnish and install conduit stubs in walls and floors for cable routes.

1.3 REFERENCES

- A. ANSI/TIA-568 Commercial Building Telecommunications Cabling Standard ANSI/TIA-569 Telecommunications Pathways and Spaces
- B. ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure ANSI C80.1 Rigid Steel Conduit - Zinc Coated
- C. ANSI C80.4 Fittings for Rigid Metal Conduit
- D. ANSI/NFPA 70/318 – National Electric Code – Cable Trays
- E. ANSI/NFPA 70/770 – National Electric Code – Optical Fiber Cables and Raceways ASI/NFPA 70/250 - National Electric Code – Ground and Bonding
- F. ASTM A 510 - Specifications for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
- G. ASTM B 633 - Specifications for Electrodepositing Coatings of Zinc on Iron and Steel, Sections SC2 and SC3
- H. ASTM A653 - Specifications for Steel Sheet, Zinc-Coated (Galvanized) by Hot Dip Process
ASTM A123 - Specifications for Zinc (Hot Galvanized) Coatings on Iron and Steel
- I. ASTM – A276-06 Standard Specification for Stainless Steel Bars and Shapes ASTM A580/A580M-06 Standard Specification for Stainless Steel Wire
- J. BICSI Electronic Safety and Security Reference Manual (ESSDRM), current edition
- K. BICSI Information Transport Systems Installation Methods Manual (ITSIM), current edition
BICSI Network Design Reference Manual (NDRM), current edition
- L. BICSI Telecommunications Distribution Methods Manual (TDMM), current edition BICSI Wireless Design Reference Manual (WDRM), current edition
- M. CANSI/NFPA 70/645 – National Electric Code – Information Technology Equipment
- N. NEMA VE 2-2006 Cable Tray Installation Guidelines
- O. NEMA VE-1/CSA C22.2 No 126 1-02 Metal Cable Tray Systems UL and cUL E209183

1.4 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

- B. Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- C. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
- D. Material and work specified herein shall comply with the applicable requirements of the current revision of the following:
 - 1. ANSI/TIA-568 Commercial Building Telecommunications Cabling Standard ANSI/TIA-569 Telecommunications Pathways and Spaces
 - 2. ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure BICSI – Telecommunications Distribution Methods Manual
 - 3. J-STD – 607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - 4. NFPA 70 – National Electric Code
 - 5. NFPA 70B, “Recommended Practice for Electrical Equipment Maintenance” pertaining to cable tray systems.
- E. Communications pathways and support equipment shall be closely coordinated with other trades to provide adequate access, appropriate clearances and required separation between systems.
- F. Listing and Labeling: Provide boxes specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NEC, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
 - 3. Intertek ETL - <http://www.intertek.com/>
- G. Comply with NECA’s “Standard of Installation” and with NEC Quality assurance

1.5 SUBMITTALS

- A. Product Data: For features, ratings, and performance of each component specified.
- B. Submit manufacturer’s instructions for storage, handling, protection, examination, preparation, operation, and installation of products. Include application conditions or limitations of use stipulated by any product testing agency. Submit for the following:
 - 1. Wall Boxes
 - 2. Raceway
 - 3. Conduit
 - 4. Conduit Bushings
- C. For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
- D. Samples: For wireways, nonmetallic wireways, and surface pathways and for each color and texture specified, 12 inches (300 mm) long.

- E. A complete list of materials with model and part numbers and references to Part 2 specifications paragraph numbers.
- F. Manufacturer's data sheets of all product and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.
- G. Shop Drawings:
 - 1. Component List: List manufacturer, part number, and quantity of each component.
 - 2. Include dimensioned plan and elevation views of equipment rooms, labeling each individual component. Show raceway assemblies, method of field assembly, workspace requirements, and access for cable connections.

1.6 DRAWINGS

- A. The drawings, which constitute a part of these bid documents, indicate the general route of the pathways to carry communication wiring systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc. is directed.
- B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.
- C. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- D. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

1.7 RELATED REQUIREMENTS:

- A. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

- B. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
 - C. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.
 - D. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
 - E. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing UTP data cabling.
 - F. Material and work specified herein shall comply with the applicable requirements of:
 - G. ANSI/TIA-568-C Commercial Building Telecommunications Cabling Standard
 - H. ANSI/TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
 - I. ANSI/TIA-606-B Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - J. ANSI/TIA-607-B Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2012
 - K. NFPA 70 – National Electric Code
 - L. BICSI – Telecommunications Distribution Methods Manual
 - M. NEMA – VE-1 – Metal Cable Tray Systems
 - N. NEMA – VE-2 – Metal Cable Tray Installation Guidelines
 - O. NEC 300.11—Securing and Supporting
- 1.8 DELIVERY AND STORAGE
- A. Delivery: Deliver materials to site in manufacturer's original un-opened containers and packaging, with labels clearly indication manufacturer and material.
 - B. Storage: Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions.
 - C. Handling: Protect materials and finishes during handling and installation to prevent damage.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48”.
- B. Cable management devices must be sized to accommodate 100% spare capacity of the final installed cable base.
- C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters.
- D. Bridle Rings SHALL NOT be acceptable.
- E. All exposed cabling shall be in enclosed metal conduits.

2.2 TELECOM OUTLETS

- A. New construction TO consists of one (1) 4-11/16" square by 2-1/8" deep flush mounted box. Each outlet box shall have a EMT conduit stubbed above the drop ceiling or extended into the hallway cable tray. Conduits size is as follows:
 - 1. For Outlets with 3 or less cables, use a 1” EMT conduit
 - 2. For Outlets with 3-6 cables, use a 1.25” EMT conduit
 - 3. For all other sizes, calculate fill ratio at 40% for proper sized conduit
- B. Existing surface-mounted construction TO typically consists of surface-mounted raceway including base, cover, end fitting, entrance end fitting, and (2) 1" EMT conduits stubbed out top of entrance end fitting to above ceiling or out to nearest hallway distribution system. Size of the raceway is site dependent based on number of conductors to be installed.
- C. The intent of the installation of the TOs which consist of the raceway is as follows:
 - 1. Where ceilings are accessible, the raceway and entrance end fitting shall extend above the ceiling and the conduits installed above the ceiling in the room to the nearest hallway distribution system.
 - 2. Where ceilings are partially accessible, or if the Drawings and/or Specifications indicate installation of access panels, the raceway shall extend above the ceiling and the conduits installed above the ceiling in the room to the nearest hallway distribution system.
 - 3. Where ceilings are inaccessible or no ceilings exist, the raceway shall extend up as close to the ceiling as practical to allow installation of conduits as high as possible to the nearest hallway distribution system.

2.3 HORIZONTAL DISTRIBUTION SYSTEMS

- A. Conduit System

1. Provide conduits secured to wall above corridor ceilings as shown on the Drawings or as specified herein for installation of telecommunications cables. Any exposed conduit
2. Corridor conduits shall be 4" EMT, furnished in 10-foot lengths wherever possible, with no sharp edges, reamed as necessary, evenly supported at two locations per 10-foot section spacing. Conduits shall be sized and quantified to account for handling cables in all TO conduits at 40% fill back to the TR and/or ER rooms. Verify size prior to installation. Bushings and/or connectors on ends of EMT are required.
3. All conduits shall be installed stacked and attached to walls unless conditions exist which prohibit this type of installation. When this condition exists, mount conduits side-by-side supported with 3/8" rod attached to building structure utilizing Unistrut channel to form a trapeze. Double nut the top and bottom at the Unistrut. Utilize conduit clamp to secure conduits to Unistrut.
4. Provide measured pull line in each conduit rated at 1200 lbs. minimum. Increments must be in 12" steps.
5. Grounding of conduits is not required per NEC #250-33, Exception No. 2. shall be painted except conduit above suspended ceilings or in mechanical, electrical or telecommunication rooms. Color to match that of surface installed upon or as directed by Owner's Representative. Coordinate with other trades prior to painting.
6. Provide restorable fire stops inside and around conduits as recommended by UL1479 or ASTM E814 for all conduits penetrating fire-rated construction. Fire rated construction to be verified with AHJ. See Section 27 05 32 for more firestopping information.

B. Corridor Cable Tray System

1. Complete wall mounted or suspended aluminum cable tray system and necessary accessories shall be provided as shown on plans. Install entire cable tray system in accordance with manufacturer's minimum installation practices and all local governing codes.
2. Coordinate installation of cable tray with other trades to allow a minimum of 12" above, 12" in front, and 12" below of clearance from piping, conduits, ductwork, etc. Allowance must be provided for access to the tray with reasonable room to work. Obstructions to the tray must be minimized and cannot block more than 6 feet of the tray at any point in the run.
3. Submittal drawings, in the form of 8 1/2"x 11" catalog cut sheets, shall be provided for the following items: cable tray, fittings, accessories and load data.
4. Cable tray shall not be loaded beyond 60% of manufacturer's recommended load capacity.
5. Install wall mounted cable tray on both sides of hallway as shown on drawings and where applicable.
6. Where a new cable tray distribution system encounters a wall, install sufficient 4" EMT sleeves through the wall so cabling does not exceed 20% fill.
7. Where cable tray is exposed below ceiling, install the appropriate solid bottom inserts to conceal cables.
8. Install cable tray dropouts where large quantities of cables exit the distribution system.
9. Cable tray must be sized to facilitate sufficient growth capacity for migration cable plant to coexist in same tray as existing cable plant, wherever possible.
10. Cat 6A cable may be placed in the same tray with Cat 6, 5e, and other category-rated cables. In addition, its product performance regardless of whether strict combing or randomizing dressing methods are used. As with all cable runs, large or heavy cable bundles should be positioned under other cable to prevent crushing. Cable trays should be loaded no more than six inches deep. Follow NEC code for separating power and data cables. To maintain
11. Cat 6A performance, minimum bend radius should be 4x OD for UTP and shielded cable. This radius is significantly larger than Cat 6 and 5e. For example, Cat 6 cables at 4x OD is

0.904", whereas Cat 6A is 1.21". Plan carefully to ensure there is sufficient space throughout cable runs to maintain proper bend radius.

- C. Telecommunication Room Cable Tray System
 - 1. TR cable tray shall completely wrap all walls within the room. Cable tray shall extend over all equipment frames.
 - 2. Cable tray shall be a minimum width of 2" high x 12" wide. Cable tray may be sized upwards if fill ratio requirements need to be met based on cable quantities.
 - 3. Manufacturer of tubular ladder type cable tray in telecommunication rooms shall be CommScope.
 - 4. Cable tray shall be 12-inch cable runway.
 - 5. Rectangular steel tubing cross members welded at 12-inch intervals. Finish in black enamel. CommScope, Part Number CR-SLR-10L-12W (760085647) or equivalent.
 - a. 12-inch Wall Angle Assembly Kit – CommScope Part Number CR6-12WRSK (760084145) or equivalent.
 - b. 3-inch Channel Rack-To-Runway Mounting Plate - CommScope Part Number CRR2RRMK (760084053) or equivalent.
 - c. End Closing Tube - CommScope Part Number CRPECK (760084012) or equivalent.
 - d. Corner Clamp - CommScope Part Number CRTJSK (760084046) or equivalent (2 required per End Closing Tube to complete assembly).
- D. All open pathway/trays shall be installed a minimum of six (6) inches away from any light fixture or other source of EMI (Electromagnetic Interference).
- E. All pathways shall be grounded per NEC Article 250.
- F. Provide external grounding strap at expansion joints, sleeves and crossover and at other locations where pathway/tray continuity is interrupted.
- G. Support all pathways from building construction. Do not support pathways from ductwork, piping, or equipment hangers.
- H. Install cable tray level and straight unless noted on the construction drawings

2.4 STATION CONDUITS

- A. Station conduit is defined as conduit that originates at the TO and rises within the walls or is exposed from a raceway and extends up into the drop ceiling or over to the hallway distribution system.
- B. Provide station conduits from TOs to above the drop ceiling or extend over to the hallway distribution systems consisting of 1" EMT minimum or appropriate size as shown on the Drawings or as specified herein for installation of telecommunications cables.
- C. Provide an insulating press fit bushing on all telecommunications conduits including interconnecting nipples and stub to distribution system. To prevent conflicts with other cables or conduits to cable tray, the conduit shall be stubbed not less than 6" above or below conduit/cable tray center line. Where space permits, every effort shall be made to bend station conduits down such that the flow of installed cables promotes the minimum length back to the TR and the least

amount of bends in the cables. Bushings must be rated to be used in an environmental air handling space (Plenum).

- D. Manufacturer of insulating bushing on all telecommunication conduits shall be:
- E. Provide measured pull line in 12” increments in each empty conduit to hallway distribution system.
- F. Indelibly mark station conduit at hallway distribution end with Room # that conduit serves.
- G. The use of 90-degree electrical pulling elbows is prohibited.
- H. Do not include more than two 90-degree bends between pulling points when installing station conduit runs. If the path of the station conduits requires more than 180 degrees of total bends, installation of an appropriate sized junction box is required. See section 2.4 for junction box requirements.
- I. Place an appropriate sized junction box in each individual station conduit run that exceeds 100 feet in length.
- J. The use of a third bend in a conduit is only acceptable if:
 - 1. The total conduit run is reduced by 15%.
 - 2. The conduit size is increased to the next trade size.
 - 3. One of the bends is located within 12” of the cable feed end.

2.5 JUNCTION BOX REQUIREMENTS FOR STATION CONDUITS

- A. If the station conduit route exceeds the 180 degree of total bends limitation, an appropriate sized junction box is required within a straight section of the conduit run.
- B. Each station conduit run requires a separate junction box. The sharing of a junction box by multiple conduits is prohibited.
- C. A junction box shall not be used in place of a bend. All junction boxes in station conduit paths shall be installed within a straight section of the conduit run.

2.6 SERVICE ENTRANCE CONDUITS

- A. Minimum of (4) 4” IMC conduits shall be installed from the nearest utility tunnel on outside of the building as shown on the Drawings. Terminate entrance conduits entering ER rooms from below grade to extend 4" above finished floor. Location of entrance conduits shall be within 12” of room corners.
- B. Terminate entrance conduits entering ER rooms from above ceiling height to extend 4" below finished ceiling or 12” above cable tray.
- C. Terminate entrance conduits entering an ER rooms from below ceiling height to extend 4" into the room.

- D. Entrance conduits shall be continuous into the building and to the ER. Securely fasten all entrance conduits to the building to withstand any cable placing operation. Do not include more than two 90-degree bends between pulling points when installing entrance conduits.
- E. On exterior wall penetrations, seal both sides of the wall around outside of conduit with hydraulic cement to prevent water from entering the building. Seal the inside of the conduit on both sides with conduit plugs, water plugs, or duct sealer to prevent water, vapors, or gases from entering the building.

2.7 PATHWAY REQUIREMENTS FOR ENTRANCE CONDUITS

- A. If the entrance conduits exceed the 180 degree of total bends limitation, an appropriate sized junction box, manhole, or handhole is required.
- B. As-built drawings of entrance conduit path required to be submitted to Owner's Representative before covered with soil.

2.8 RISER CONDUITS

- A. Riser conduits shall only be used when noted on the Construction Documents for special applications only. As a rule, riser conduits are not required for the riser system. However, when required:
- B. Minimum of (2) 4" conduits shall be installed between the ER room and each TR room as shown on the Drawings.
- C. Conduits entering ER and TR rooms shall be reamed or bushed and terminated not more than 4" from entrance wall and within 12" of room corners.
- D. Conduits entering ER and TR rooms from below floor shall be terminated not more than 4" above finished floor.
- E. Conduits for riser cables shall be continuous and separate from all other conduit or enclosed raceway systems. Do not include more than two 90-degree bends between pulling points when installing riser conduits. Where junction boxes are required, locate in accessible areas, such as above suspended ceilings in hallways.
- F. Conduits shall not be less than 4" trade size and be equipped with a measured pull line at 12" increments rated at a minimum 1200-pound test.
- G. Provide restorable fire stops inside and around conduits as recommended by UL1479 or ASTM E814 for all conduits penetrating fire-rated construction. Fire-rated construction to be verified with AHJ. See Section 27 05 32 for more firestopping information.
- H. Provide an insulating press fit bushing on all telecommunications riser conduits. Bushings must be rated to be used in an environmental air handling space (Plenum).
- I. Riser conduits shall not be used for the distribution of horizontal cables.

2.9 FIRESTOPPING

- A. In all buildings, floor/ceiling assemblies, stairs, and elevator penetrations must be sealed with a 2-hour fire stop assembly at a minimum, unless otherwise noted.
- B. Contact Owner's Representative to identify walls which are fire-rated construction. Walls must be sealed with a 2-hour fire stop assembly at a minimum.
- C. Communication pathways requiring fire stopping shall utilize removable/re-usable fire stopping putties for ease of Moves, Adds, and Changes.
- D. All fire stopping penetrations shall conform to the recommended practices listed in UL1479 or ASTM.
- E. See Section 27 05 32 - Firestopping for Telecommunications Systems

2.10 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- B. Exterior Innerduct—Flexible corrosion-resistant innerduct with corrugated interior and crush resistant construction. Innerduct to be available in a variety of multi-cell construction colors and shall range in individual cell size from ½" to 2" I.D.
- C. Interior Innerduct—UL listed, plenum rated, flexible innerduct, corrugated with pull line.

2.11 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Wireways shall be metal trough with a removable hinged cover and generous knockout arrangement. Provide necessary ells, tees and fittings for a complete installation. All components shall be hot dip galvanized after fabrication or provided with a rust inhibiting phosphatizing coating and finished in baked enamel. All hardware shall be plated to prevent corrosion.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4 or Type 12 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.
 - 2. Comply with TIA-569-B.
- C. 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.
- D. Wireway Covers: Hinged type unless otherwise indicated.

- E. Finish: Manufacturer's standard enamel finish.

2.12 SURFACE PATHWAYS

- A. General Requirements for Surface Pathways:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
 - 3. All surface pathways shall be steel conduit.
- B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finishes in color selected by Architect.
- C. Tele-Power Poles:
 - 1. Material: Galvanized steel with ivory baked-enamel 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.

2.13 CABLE MANAGEMENT SYSTEM

- A. Provide pre-manufactured cable supports. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support of 48”.
- B. Cable management devices must be sized to accommodate 100% spare capacity of the final installed cable base.
- C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crusted or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

2.14 ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-B.
 - 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Extension Rings: Box covers, suitable to reduce front opening of box for faceplate mounting. Also called “mud rings” or “plaster rings”.
 - 1. All extension rings shall have the following characteristics:

- a. Materials:
 - 1) Steel, 0.0625 in (1.59 mm) thickness (minimum)
 - 2) Galvanized zinc coating, 0.0005 in (0.013 mm) (minimum) thickness on both sides of extension ring.
- b. Outside Dimensions:
 - 1) 5 in (127 mm) Width
 - 2) 5 in (127 mm) Height
- c. Construction:
 - 1) Cleanly punched knockouts
 - 2) Softened edges (no sharp edges)
 - 3) Stamped/Drawn fabrication
 - 4) Mounting/Attachment Features:
- d. Attachable directly to Device Box or to Box Support Bracket
 - 1) Centerline and mid-line markings for device box installation
 - 2) 4 screw slots (2 straight and at least 2 angled), suitable to mount on screws that are already in place.
 - 3) At least 2 faceplate mounting tabs, with tapped holes (6-32) to receive faceplate screws. For 4 Square Extension ring, the tapped holes shall be 8-32.
 - 4) Precision screw-hole positioning for reliable device mounting within +/- 5 thousandths.
- e. Reversible: Extension Rings shall be capable of being mounted in multiple orientations.
- f. Testing / Listing

C. Metal Floor Boxes:

1. Material: Cast metal or 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.

D. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

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.

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

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

G. Device Box Dimensions: Gangable boxes are allowed.

1. 5 in. Square x 2.875 in. Deep Metal Box with Cable Management
2. Volume: 64 in³
3. Side Knockouts: (1) 1" (1) 1-1/4" each side
4. Back Knockouts: (1) 1/2"

H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4 or Type 12 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:
 - a. Material: Plastic.
 - b. Finished inside with radio-frequency-resistant paint.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. Cabinets:
 - 1. NEMA 250, Type 1, Type 3R, or Type 12, 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.

2.15 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

- 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.
 - 3. Comply with TIA-569-B.
- 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, "COMMUNICATIONS."
 - 6. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.16 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Refer to drawings for pathway types, locations and routing.
- B. Cable pathways shall provide the following minimum clearances:
 1. Motors and transformers – 4 ft.
 2. Conduit and cable used for electrical power distribution – 1 ft.
 3. Fluorescent lighting – 6 inches
 4. Power lines up to 5 kV – 6 inches
 5. Power lines over 5Kv – 24 inches
- C. Backboards and cabinets shall be installed in telecommunications rooms to support telecommunications equipment and wiring. Coordinate locations of backboards and cabinets with Owner prior to installation.
- D. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means.
- E. Provide necessary pathways in areas that have exposed structure or plastered ceilings to provide a wiring path for cables from areal above suspended ceilings to respective backboards.
- F. No non-metallic or combustible materials shall be installed in ceiling or other plenums used for circulating room air used for heating, ventilation or cooling.

3.2 CONDUIT SYSTEMS

- A. Coordinate with Division 26 Contractor to ensure that conduit systems installed for telecommunications cabling shall conform to the following:
- B. No section of conduit shall be longer than 100 feet between pull points.
- C. No more than two 90 degree bends in a section of conduit between pulling points.
- D. Each section of conduit shall be labeled for length, destination closet and origination closet.
- E. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.
- F. Conduit and wiring above accessible ceilings shall be run as high as possible, above piping and ductwork, so as to not interfere with mechanical trades, access to mechanical and electrical devices and to allow freedom to remove ceiling panels.

- G. Provide a No. 12 AWG pull wire or nylon pull cord in each empty conduit run.

3.3 WIREWAYS

- A. Wireways shall be supported with factory made hangers designed expressly for the purpose and 0.375” diameter solid hanger rods approximately 5 ft. on center or approved strap hangers for surface mounting.

3.4 CABLE MANAGEMENT SYSTEM

- A. The drawings do not indicate specific routes for telecommunications cables. The Telecommunications Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables.
- B. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Telecommunications Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.
- C. In areas where there is not an installed raceway system (conduit or cable tray) and a cable support system is required, this contract shall be responsible for providing a cable management system.
- D. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is minimum sag of 4 inches every 4 foot of horizontal run.
- E. Cable pathways shall provide the following minimum clearances:
 - 1. Motors and transformers—4 ft.
 - 2. Conduit and cable use for electrical power distribution—1 ft.
 - 3. Fluorescent lighting—6 inches
 - 4. Power lines up to 5kVA—6 inches
 - 5. Power lines over 5kVA—24 inches
- F. Cable management system support components shall be designed with wide support surfaces that do not cause cable to be bent, crushed or otherwise deformed when installed within component loading parameters.
- G. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

3.5 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: IMC.
 - 2. Concealed Conduit, Aboveground: EMT.

3. Underground Conduit: RNC, direct buried, or concrete encased.
 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT or RNC.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: IMC. Pathway 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. Damp or Wet Locations: IMC.
 6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
 7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway.
 8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: Plenum-type, optical-fiber-cable pathway Plenum-type, communications-cable pathway, or EMT.
 9. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel or nonmetallic in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. 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 applies in thickness and number of coats recommended by manufacturer.
 3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.6 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

- B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Device Boxes:
 - 1. Provide device boxes and covers as shown on the Contract Documents and as needed. Verify that the appropriate cover type and depth is provided for each type of wall and finish.
 - 2. Paint device boxes as required to meet Code or Owner's requirements.
 - 3. Coordinate box locations with building surfaces and finishes to avoid bridging wainscots, joints, finish changes, etc.
 - 4. Install boxes in dry locations (not wet, corrosive, or hazardous).
 - 5. Attach boxes securely to building structure with a minimum of two fasteners. Provide attachments to withstand a force of 22.6 kg minimum, applied vertically or horizontally.
 - 6. Install boxes at heights indicated on the drawings.
 - 7. Recessed mounted outlet boxes:
 - a. Recess boxes in wall and ceiling surfaces in finished areas. Set boxes plumb, level, square and flush with finished building surfaces to within one-sixteenth inch for each condition. Set boxes so that box openings in building surfaces are within one-eighth inch of edge of material cut-out and fill tight to box with building materials. Openings shall extend at least to the finished wall surface and extend not more than 1/8 inch beyond the finished wall surface. Provide backing for boxes using structural material to prevent rotation on studs or joists.
 - b. Install floor boxes level and adjust to finished floor surface.
- J. Box Support Brackets:
 - 1. Provide box support brackets as required.
 - 2. Mount brackets level and square with finished building surfaces to within one-sixteenth inch for each condition. Align device boxes and extension rings using centerline and mid-line markings.
 - 3. Securely fasten brackets to studs. Securely fasten device boxes and extension rings to brackets.
- K. Extension Rings:
 - 1. Provide extension rings as required.

2. Align extension rings to boxes and brackets using centerline and mid-line markings.
 3. Securely fasten extension rings to device boxes and box support brackets.
- L. Pathways Embedded in Slabs:
1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange pathways to keep a minimum of 2 inches (50 mm) 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 RNC, Type EPC-40-PVC, or IMC before rising above floor.
- M. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- P. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- R. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- S. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
- T. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- U. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
 - 2. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- V. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
- W. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- X. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- Y. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion 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.
- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.
- AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.7 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
 2. Install backfill as specified in Section 312000 "Earth Moving."
 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
 4. Install manufactured 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 (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.8 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 (12.5-mm) sieve to No. 4 (4.75-mm) 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 (25 mm) above finished grade.
- D. Install handholes with bottom below frost line.

3.9 INSTALLATION OF J-HOOKS, CABLE HANGERS

- A. Locate main path for all cables and install J-hooks where cable tray is not provided.
- B. Coordinate with other trades to install a clear, straight path down major corridors for the routing of user cables back to the communications closet.
- C. All cables shall route neatly in the ceiling. Whether they route in cable tray or J-hooks, the cables shall be neat and orderly.
- D. There shall be no more than 50 cables in each J-hook. Provide additional J-hooks as required.
- E. Support cables at a minimum of every 5 feet. When forming cables around a 90 degree bend, additional J-Hooks may be required in the cable bend radius to keep cables from bending the J-hooks out-of-plumb.
- F. To avoid chafing cables, laying the bundle of cables in the J-Hooks, as opposed to pulling the bundle of cables through the J-hooks, is the preferred method of installation.
- G. The Contractor shall make himself aware of the drawings that show cable tray routes and other cable support systems. For all areas that do not show cable tray the contractor shall provide cable support as specified herein.
- H. J-Hooks shall not be installed in any exposed areas.

3.10 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.11 GROUNDING/BONDING:

- A. Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, WAC, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
- B. Bond metallic raceway together and to the nearest TGB (as provided under Division 27 Section — "Grounding and Bonding for Communications Systems"). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.

3.12 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means.

3.13 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.14 INNERDUCT

- A. Innerduct shall be installed with pull string in each innerduct to facilitate placement of future cables.

3.15 IDENTIFICATION AND LABELING

- A. All continuous communications pathways such as conduit, cable tray, etc., shall be labeled to indicate origination and destination.
- B. Labels shall be applied every 50 feet wherever accessible or subject to administration.
- C. Coordinate label information with Owner.

- D. Label shall consist of mechanically printed, permanent adhesive label, applied to cleaned/prepped area of raceway.

3.16 AS-BUILT DOCUMENTATION

- A. Provide a complete set of architectural floor plan drawings indicating final communications pathway systems with accurate “as-built” locations to show the actual route for the communications systems pathways.
- B. Drawings shall indicate each pathway type and provide sizing information such as conduit/innerduct diameter, cable tray width, cable management ring size, etc.
- C. Component Service Manuals shall include information for testing, repair, troubleshooting, assembly, disassembly, and required/recommended maintenance intervals for all types of pathways.

3.17 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

SECTION 270529 – HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All provisions of the Division 00 and Division 01, apply to all work in Division 27

1.2 SCOPE OF WORK

- A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the system of non-continuous cable supports as described in this specification.
- B. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete device box system as hereinafter specified and/or shown on the Contract Documents. The device box system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS) as specified in Division 27 - Communications Horizontal Cabling. These requirements supersede any Division 26 device box requirements.
- C. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the Contract Documents but which are necessary to make a complete working device box system.
- D. This Section includes the minimum requirements for the support structures for the Communications Systems for the project as outlined in the Bid Document.
 - 1. Non-continuous cable supports (2.3A)
 - 2. Adjustable non-continuous cable support sling (2.3B)
 - 3. Multi-tiered non-continuous cable support assemblies (2.3C)
 - 4. Non-continuous cable support assemblies from tee bar (2.3D)
 - 5. Non-continuous cable support assemblies from drop wire/ceiling (2.3E)
 - 6. Non-continuous cable support assemblies from beam, flange (2.3F)
 - 7. Non-continuous cable support assemblies from C & Z Purlin (2.3G)
 - 8. Non-continuous cable support assemblies from wall, concrete, or joist (2.3H)
 - 9. Non-continuous cable support assemblies from threaded rod (2.3I)
 - 10. Raised floor non-continuous cable support assemblies (2.3J)
 - 11. Cantilever-Mounted Option for non-continuous cable supports (2.3K)
 - 12. Installation accessories for non-continuous cable supports (2.3L)

1.3 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based

upon the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

- B. Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- C. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
- D. Material and work specified herein shall comply with the applicable requirements of the current revision of the following:
 - 1. ANSI/TIA-568 Commercial Building Telecommunications Cabling Standard ANSI/TIA-569 Telecommunications Pathways and Spaces
 - 2. ANSI/TIA-606 Administration Standard for the Telecommunications Infrastructure BICSI – Telecommunications Distribution Methods Manual
 - 3. J-STD – 607 Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - 4. NFPA 70 – National Electric Code
 - 5. NFPA 70B, “Recommended Practice for Electrical Equipment Maintenance” pertaining to cable tray systems.
- E. Communications pathways and support equipment shall be closely coordinated with other trades to provide adequate access, appropriate clearances and required separation between systems.
- F. Listing and Labeling: Provide boxes specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NEC, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
 - 3. Intertek ETL - <http://www.intertek.com/>
- G. Comply with NECA’s “Standard of Installation” and with NEC Quality assurance

1.4 COORDINATION

Coordinate installation of hangers, supports and cables with other trades.

1.5 SUBMITTALS

- A. Submit product data on non-continuous cable support devices, including attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information. Manufacturer’s data sheets of all product and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.6 DRAWINGS

- A. The drawings, which constitute a part of these bid documents, indicate the general route of the pathways to carry communication wiring systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc. is directed.
- B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.
- C. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- D. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

1.7 RELATED REQUIREMENTS:

- A. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.
- B. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
- C. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.
- D. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

- E. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing UTP data cabling.
- F. Material and work specified herein shall comply with the applicable requirements of:
- G. ANSI/TIA–568-C Commercial Building Telecommunications Cabling Standard
- H. ANSI/TIA–569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- I. ANSI/TIA-606-B Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- J. ANSI/TIA-607-B Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2012
- K. NFPA 70 – National Electric Code
- L. BICSI – Telecommunications Distribution Methods Manual
- M. NEMA – VE-1 – Metal Cable Tray Systems
- N. NEMA – VE-2 – Metal Cable Tray Installation Guidelines
- O. NEC 300.11—Securing and Supporting

1.8 DELIVERY AND STORAGE

- A. Delivery: Deliver materials to site in manufacturer’s original un-opened containers and packaging, with labels clearly indication manufacturer and material.
- B. Storage: Store materials in a dry area indoors, protected from damage and in accordance with manufacturer’s instructions.
- C. Handling: Protect materials and finishes during handling and installation to prevent damage.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48”.
- B. Cable management devices must be sized to accommodate 100% spare capacity of the final installed cable base.

- C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters.
- D. Bridle Rings SHALL NOT be acceptable.
- E. All exposed cabling shall be in enclosed metal conduits.

2.2 REFERENCES

- A. ANSI/TIA-568 Commercial Building Telecommunications Cabling Standard ANSI/TIA-569 Telecommunications Pathways and Spaces
- B. ASTM B633 Standard Specification for Electro-Deposited Coatings of Zinc on Iron and Steel
- C. ASTM B 695-90 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel
- D. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- E. ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
- F. ASTM A109 Standard Specification for Steel, Strip, Carbon, Cold-Rolled
- G. ASTM A167 Standard Specification for Stainless and heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- H. ASTM A480/A480M Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
- I. ASTM A568 Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low- Alloy Hot-Rolled and Cold-Rolled
- J. A653 G60-Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy- coated (Galvannealed) by the Hot-Dip process
- K. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- L. ASTM A682 Standard Specification for Steel, Strip, High-Carbon, Cold-Rolled, Spring Quality
ASTM A879 Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic
- M. Process for Applications Requiring Designation of the Coating Mass on Each Surface ASTM B117 Standard Method of Salt Spray (Fog) Testing
- N. ASTM D610 Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces
UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces

- O. NFPA 70 National Electrical Code®

2.3 NON-CONTINUOUS CABLE SUPPORT SYSTEMS

- A. Non-continuous cable supports
 - 1. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed
 - 2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables
 - 3. Non-continuous cable supports sized 1-5/16” and larger 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
 - 4. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments
 - 5. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply
- B. Adjustable non-continuous cable support sling
 - 1. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive environments. Rated to support Category 5e and higher cable, or optical fiber cable; cULus Listed.
 - 2. Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
 - 3. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces
 - 4. If required, assemble to manufacturer recommended specialty fasteners including beam clips, flange clips, C and Z purlin clips.
- C. Multi-tiered non-continuous cable support assemblies
 - 1. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; cULus Listed.
 - 2. If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.
- D. Non-continuous cable support assemblies from tee bar
 - 1. Tee bar support bracket with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
- E. Non-continuous cable support assemblies from drop wire/ceiling
 - 1. Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
- F. Non-continuous cable support assemblies from beam, flange
 - 1. Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
- G. Non-continuous cable support assemblies from C & Z Purlin

1. Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed
- H. Non-continuous cable support assemblies from wall, concrete, or joist
1. Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed
- I. Non-continuous cable support assemblies from threaded rod
1. Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed
 2. The multi-tiered support bracket shall have a static load limit of 300 lbs.
 3. U-hooks and Double J-hook shall attach directly to threaded rod using standard nuts
- J. Raised floor non-continuous cable support assemblies
1. Fastener to raised (access) floor pedestal with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments; cULus Listed
- K. Cantilever-Mounted cable supports
1. U-hook shall be able to be assembled to a wide variety of wall mount brackets.
 2. Spacing of individual U-hooks as needed, max of 4' to 5' apart.
 3. U-hooks may have the optional attachment of a cable roller for ease in pulling cables
- L. Installation accessories for non-continuous cable supports
1. Cable Pulley
 2. Non-continuous cable supports may be used as an installation tool when a removable pulley assembly is included. The pulley shall be made of plastic and be without sharp edges. The pin and bail assembly must be able to be secured to the J-Hook during cable installation. The pulley must remain secured while cables are being pulled.
 3. The pin and roller assembly must be removed after cables are installed.
- M. Cable Protector
1. The protective steel tube shall fit over threaded rod and be at least 4" in length.
 2. The tube shall prevent damage to cables placed in or pulled through CAT- CMTM U-hooks. The tube shall not inhibit the pulling of cables.
- N. Finishes
1. ASTM B633 Standard Specification for Electro-Deposited Coatings of Zinc on Iron and Steel ASTM B 695 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel
 2. on Iron and Steel
 3. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 4. ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
 5. Non-continuous cable supports used where only mildly corrosive conditions apply shall be stainless steel, AISI type 304.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Refer to drawings for pathway types, locations and routing.
- B. Cable pathways shall provide the following minimum clearances:
 - 1. Motors and transformers – 4 ft.
 - 2. Conduit and cable used for electrical power distribution – 1 ft.
 - 3. Fluorescent lighting – 6 inches
 - 4. Power lines up to 5 kV – 6 inches
 - 5. Power lines over 5Kv – 24 inches
- C. Backboards and cabinets shall be installed in telecommunications rooms to support telecommunications equipment and wiring. Coordinate locations of backboards and cabinets with Owner prior to installation.
- D. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means.
- E. Provide necessary pathways in areas that have exposed structure or plastered ceilings to provide a wiring path for cables from areal above suspended ceilings to respective backboards.
- F. No non-metallic or combustible materials shall be installed in ceiling or other plenums used for circulating room air used for heating, ventilation or cooling.

3.2 INSTALLATION OF J-HOOKS, CABLE HANGERS

- A. Locate main path for all cables and install J-hooks where cable tray is not provided.
- B. Coordinate with other trades to install a clear, straight path down major corridors for the routing of user cables back to the communications closet.
- C. All cables shall route neatly in the ceiling. Whether they route in cable tray or J-hooks, the cables shall be neat and orderly.
- D. There shall be no more than 50 cables in each J-hook. Provide additional J-hooks as required.
- E. Support cables at a minimum of every 5 feet. When forming cables around a 90 degree bend, additional J-Hooks may be required in the cable bend radius to keep cables from bending the J-hooks out-of-plumb.
- F. To avoid chafing cables, laying the bundle of cables in the J-Hooks, as opposed to pulling the bundle of cables through the J-hooks, is the preferred method of installation.
- G. The Contractor shall make himself aware of the drawings that show cable tray routes and other cable support systems. For all areas that do not show cable tray the contractor shall provide cable support as specified herein.

- H. J-Hooks shall not be installed in any exposed areas.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 GROUNDING/BONDING:

- A. Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, WAC, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
- B. Bond metallic raceway together and to the nearest TGB (as provided under Division 27 Section — "Grounding and Bonding for Communications Systems"). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means.

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.7 IDENTIFICATION AND LABELING

- A. All continuous communications pathways such as conduit, cable tray, etc., shall be labeled to indicate origination and destination.
- B. Labels shall be applied every 50 feet wherever accessible or subject to administration.
- C. Coordinate label information with Owner.
- D. Label shall consist of mechanically printed, permanent adhesive label, applied to cleaned/prepped area of raceway.

3.8 AS-BUILT DOCUMENTATION

- A. Provide a complete set of architectural floor plan drawings indicating final communications pathway systems with accurate “as-built” locations to show the actual route for the communications systems pathways.
- B. Drawings shall indicate each pathway type and provide sizing information such as conduit/innerduct diameter, cable tray width, cable management ring size, etc.
- C. Component Service Manuals shall include information for testing, repair, troubleshooting, assembly, disassembly, and required/recommended maintenance intervals for all types of pathways.

3.9 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 270529

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.
- B. Section 270526—Communications Grounding and Bonding
- C. Section 270528—Communications Pathways
- D. Section 271100—Communications Equipment
- E. Section 271300—Communications Backbone Cabling for insulation rating and barrier requirements of cables to be placed in cable trays.
- F. Section 271500—Communications Horizontal Cabling for insulation rating and barrier requirements of cables to be placed in cable trays.
- G. Section 280513—Conductors and Cables for Electronic Safety and Security for insulation rating and barrier requirements of cables to be placed in cable trays.

1.2 SCOPE

- A. Continuous, rigid, welded steel or stainless steel wire mesh cable management system.
- B. Cable tray systems are defined to include, but are not limited to, straight sections, supports and accessories.

1.3 SUMMARY

- A. Section Includes:
 - 1. Ladder cable trays.
 - 2. Wire-basket cable trays.
 - 3. Flexible cable trays.
 - 4. Associated connectors and supports.
- B. References
 - 1. ANSI/NFPA 70 – National Electrical Code (NEC) ANSI/TIA-569 - Telecommunications Pathways & Spaces
 - 2. ASTM A 510 - Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
 - 3. ASTM A 380 – Specification for Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

4. ASTM B 633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM A 123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
5. ASTM A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
6. IEC 61537 (2001) – Cable Tray Systems and Cable Ladder Systems for Cable Management
NEMA VE 1-2002/CSA C22.2 No. 126.1-02 – Metal Cable Tray Systems

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.
- B. Approval and Labeling: Provide cable trays and accessories specified in this Section that are approved and labeled.
 1. The Terms “Classified” pertaining to cable trays (rather than “Listed”) and "Labeled": As defined in NFPA 70, Article 100, including painted trays.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- C. Comply with NFPA 70, National Electrical Code, Article 392: Cable Trays; provide UL Classification and labels.
- D. Comply with IEC 61537, Cable Tray Systems and Cable Ladder Systems for Cable Management.
- E. Comply with NEMA VE 1/CSA C22.2 No. 126.1, Metal Cable Tray Systems, for materials, sizes, and configurations; provide cCSAus Certificate and labels.
- F. Provide documentation of the following certifications: ISO 9001 quality certification.
 1. American Bureau of Shipping (ABS) Product Design Assessment certification. Det Norske Veritas (DNV) certification.
 2. E 90 Fire Testing certification. VDE certification.
- G. Provide ETL test documentation showing cable compression/deformation testing.

1.5 COORDINATION

- A. Coordinate layout and installation of cable tray with other trades.
- B. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect.
- C. Storage and Handling: Avoid breakage, denting and scoring finishes. Damaged products will not be installed. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging with labels clearly indicating manufacturer and material.
- B. Storage: Store materials in a dry area, indoors, protected from damage, and in accordance with manufacturer's instructions.
- C. Handling: Protect materials and finishes during handling and installation to prevent damage.

1.7 SUBMITTALS

- A. Shop Drawings: Submit shop drawings indicating materials, finish, dimensions, accessories, layout, supports, splices, and installation details.
- B. Design Calculations: Verify loading capacities for supports.
- C. Field verification of all dimensions, routing, etc., is directed.
- D. Factory-certified test reports of specified products, complying with IEC 61537, NEC, and NEMA VE 1/CSA C22.2 No. 126.1.
- E. Submit manufacturer's certification indicating ISO 9001 quality certified.
- F. Submit training procedure for certifying cable tray installers.

1.8 DRAWINGS

- A. The drawings, which constitute a part of these bid documents, indicate the general route of the pathways to carry communication wiring systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc. is directed.
- B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.
- C. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 2. Vertical and horizontal offsets and transitions.
 - 3. Clearances for access above and to side of cable trays.
 - 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- D. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
 2. Component Importance Factor: 1.0.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- C. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48".
- D. Cable management devices must be sized to accommodate 100% spare capacity of the final installed cable base.
- E. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters.
- F. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
1. Source Limitations: Obtain cable trays and components from single manufacturer.
- G. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- H. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

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

2.3 MATERIAL AND FINISHES

A. Cable Tray Materials:

1. Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.

B. Cable Tray Finishes:

1. Finish for Carbon Steel Wire after welding and bending of mesh;
2. Electrodeposited Zinc Plating: ASTM B 633, Type III, SC-1.
3. Powder-Coated Trays – UL classified Black powder-coated surface treatment over Electrodeposited Zinc Plating (or plain steel) using ASA 61 black polyester coating.

C. Cable tray will consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray (including UL Classified painted tray) acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous Safe-T-Edge T-welded top side wire to protect cable insulation and installers.

D. Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.

1. Mesh: 2 x 4 inches (50 x 100 mm).
2. Straight Section Lengths: 118 inches (3,000 mm).
3. Wire Diameter: Patented design includes varying wire sizes to meet application load requirements; to optimize tray Strength; and to allow tray to remain lightweight.
4. Safe-T-Edge: Patented Safe-T-Edge technology on side wire to protect cable insulation and installers' hands.
5. Fittings: Wire mesh cable tray fittings are field-fabricated from straight tray sections, in accordance with manufacturer's instructions and Item 2.3.

E. CF Series Cable Tray Size:

1. Depth: Cable tray depth will be 4 inches
2. Width: Cable tray width will be 6, 12, 18, or 24 inches as shown on Telecommunications Drawings:
3. Length: Cable tray section length will be 118 inches (3000mm) unless otherwise shown on drawings.
4. Fill Ratio: Cable tray may be filled to total fill capacity per NEC. Minimum 20% spare capacity recommended to accommodate future cabling changes or additions.
5. Load Span Criteria:
 - a. Cable tray will be capable of carrying a uniformly distributed load of 50 pounds per foot on an 8-ft. support span, according to load tests of standard shown in Item A above.

2.4 CABLE TRAY SUPPORTS AND ACCESSORIES

- A. Fittings/Supports: Wire mesh cable tray fittings are field-fabricated from straight tray sections, in accordance with manufacturer's instructions. Supports will include the FAS (Fast Assembly System) where possible so that screws, bolts, and additional tools are not required for cable tray mounting; installation time is reduced; and tray path can adapt to installation obstacles without the need for additional parts. Place supports so that support span does not exceed that shown on the drawings.
1. FAS System support methods to mount from ceiling and wall structures with 1/4", 3/8" or 1/2" threaded rod, if applicable
 2. Splices, including those approved for electrical continuity (bonding), as recommended by cable tray manufacturer. Select one of the following splicing methods, if applicable:
 - a. UL Classified EDRN Fast Splice: No hardware required
 - b. UL Classified SWK Splice Washer Kit: Swaged set for splicing, turns, bends, tees
 - c. UL Classified ED Universal Splice Bar: Cut & bend to fit any configuration
 - d. Pre-click Splice: Bolted connection optional
 - e. UL Classified EDT Splice Plate: Bolted connection
 - f. UL Classified CE 25 & CE 30 Square Splice Washers: Use with EZ BN 1/4" Nut & Bolt
 - g. UL Classified CE 40 Square Splice Washer: Use with EZ BN 1/4" to splice trays on bends, adjustable tees
 - h. FASLock Splice: For sweeps and bends with tray 12" (300mm) and wider.
 - i. UL Classified EZ T 90 kit: For tees and 90s
 - j. UL Classified RADT90 kit: For 5-1/2" radius Tees and 90s
- B. Accessories: As required to protect, support, and install a cable tray system.

2.5 EQUIPMENT GROUNDING CONDUCTOR FUNCTION AND GROUNDING

- A. UL Classified cable trays (including painted tray) may act as Equipment Grounding Conductors.
- B. Use UL Classified splicing methods to ensure cable tray is electrically continuous and bonded as recommended.
1. Ground cable trays at end of continuous run.
- C. Test cable tray system per NFPA70B, Chapter 18 to verify grounding less than 1 ohm.
- D. Ground cable trays against fault current, noise, lightning, and electromagnetic interference by mounting grounding wire to each 10' cable tray section with grounding clamp.

2.6 LADDER CABLE TRAYS

- A. Description:
1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
 2. Rung Spacing: 9 inches (225 mm) o.c.
 3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
 4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
 5. No portion of the rungs shall protrude below the bottom plane of side rails.

6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.0, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
7. Minimum Usable Load Depth: 4 inches (100 mm)
8. Straight Section Lengths: 12 feet (3.6 m) except where shorter lengths are required to facilitate tray assembly.
9. Width: 18 inches (450 mm) unless otherwise indicated on Drawings.
10. Fitting Minimum Radius: 12 inches (300 mm).
11. Class Designation: Comply with NEMA VE 1, Class 12B.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.7 WIRE-BASKET CABLE TRAYS

A. Description:

1. Configuration: Wires are formed into a standard 2-by-4-inch (50-by-100-mm) wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
2. Materials: High-strength-steel longitudinal wires with no bends.
3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
4. Sizes:
 - a. Straight sections shall be furnished in standard 118-inch (3000-mm) lengths.
 - b. Wire-Basket Depth: 6-inch (150-mm) usable loading depth by 12 inches (450 wide).
5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
7. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316

2.8 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
4. Finish: Mill galvanized before fabrication.
 - a. Standard: Comply with ASTM A 653/A 653M, G90 (Z275).
 - b. Hardware: Galvanized, ASTM B 633.
5. Finish: Electrogalvanized before fabrication.
 - a. Standard: Comply with ASTM B 633.
 - b. Hardware: Galvanized, ASTM B 633.

6. Finish: Hot-dip galvanized after fabrication.
 - a. Standard: Comply with ASTM A 123/A 123M, Class B2.
 - b. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594
7. Finish: Epoxy-resin or Powder-coat enamel paint.
 - a. Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
 - b. Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
 - c. Epoxy-Resin Topcoat: Epoxy, cold-cured, gloss, MPI# 77.
 - d. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
8. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
9. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

B. Aluminum:

1. Materials: Alloy 6063-T6 according to ANSI H 35.1/H 35.1M for extruded components and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H 35.1/H 35.1M for fabricated parts.
2. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
3. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

C. Stainless Steel:

1. Materials: Low-carbon, passivated, stainless steel, Type 316L, ASTM F 593 and ASTM F 594.
2. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.9 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.10 WARNING SIGNS

- A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.11 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Refer to drawings for pathway types, locations and routing.
- B. Cable pathways shall provide the following minimum clearances:
 - 1. Motors and transformers – 4 ft.
 - 2. Conduit and cable used for electrical power distribution – 1 ft.
 - 3. Fluorescent lighting – 6 inches
 - 4. Power lines up to 5 kV – 6 inches
 - 5. Power lines over 5Kv – 24 inches
- C. Backboards and cabinets shall be installed in telecommunications rooms to support telecommunications equipment and wiring. Coordinate locations of backboards and cabinets with Owner prior to installation.
- D. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means.
- E. Provide necessary pathways in areas that have exposed structure or plastered ceilings to provide a wiring path for cables from areal above suspended ceilings to respective backboards.
- F. No non-metallic or combustible materials shall be installed in ceiling or other plenums used for circulating room air used for heating, ventilation or cooling.
- G. Cable management system support components shall be designed with wide support surfaces that do not cause cable to be bent, crushed or otherwise deformed when installed within component loading parameters.
- H. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

3.2 CABLE MANAGEMENT SYSTEM

- A. The drawings do not indicate specific routes for telecommunications cables. The Telecommunications Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables.
- B. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Telecommunications Contractor shall be

responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

- C. In areas where there is not an installed raceway system (conduit or cable tray) and a cable support system is required, this contract shall be responsible for providing a cable management system.
- D. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is minimum sag of 4 inches every 4 foot of horizontal run.

3.3 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems
- H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support bus assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- M. Support wire-basket cable trays with center support hangers or wall brackets.
- N. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

- O. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- P. Make changes in direction and elevation using manufacturer's recommended fittings.
- Q. Make cable tray connections using manufacturer's recommended fittings.
- R. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- S. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- T. Install cable trays with enough workspace to permit access for installing cables.
- U. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

3.4 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.5 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables

independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

- E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.6 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.4

3.7 FIELD QUALITY CONTROL

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

3.8 PROTECTION

- A. Protect installed cable trays and cables.

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

3.9 IDENTIFICATION AND LABELING

- A. All continuous communications pathways such as conduit, cable tray, etc., shall be labeled to indicate origination and destination.
- B. Labels shall be applied every 50 feet wherever accessible or subject to administration.
- C. Coordinate label information with Owner.
- D. Label shall consist of mechanically printed, permanent adhesive label, applied to cleaned/prepped area of raceway.

3.10 AS-BUILT DOCUMENTATION

- A. Provide a complete set of architectural floor plan drawings indicating final communications pathway systems with accurate “as-built” locations to show the actual route for the communications systems pathways.
- B. Drawings shall indicate each pathway type and provide sizing information such as conduit/innerduct diameter, cable tray width, cable management ring size, etc.
- C. Component Service Manuals shall include information for testing, repair, troubleshooting, assembly, disassembly, and required/recommended maintenance intervals for all types of pathways.

END OF SECTION 270536

(This page intentionally left blank)

SECTION 270544 - SLEEVES AND 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, Division 00 and Division 01 Specifications Sections, apply to this Section.
- B. Section 270526—Grounding and Bonding
- C. Section 270528—Pathways
- D. Section 270536—Cable Trays

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Grout.
 - 3. Silicone sealants.
- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
 - 2. Section 271100 "Communications Equipment Room Fittings for pathway requirements
 - 3. Section 271300 "Communications Backbone Cabling" for pathway requirements
 - 4. Section 271500 "Communications Horizontal Cabling" for pathway requirements

1.3 QUALITY ASSURANCE

- A. All components shall be supplied by the system manufacturer and/or approved for use by manufacturer.
- B. Sleeves shall be UL listed for fire rated floors/walls. For non-fire rated penetrations (smoke walls), a one (1) hour fire rated system is required.
- C. Work consists of pathways to carry communication wiring of all descriptions.
- D. Work includes support equipment for telecommunications cabling including backboards, rough-in boxes and cabinets.

- E. Communications pathways and support equipment shall be closely coordinated with other trades to provide adequate access, appropriate clearances and required separation between systems.

1.4 SUBMITTALS

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

1.5 DRAWINGS

- A. The drawings, which constitute a part of these bid documents, indicate the general route of the pathways to carry communication wiring systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc. is directed.
- B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

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.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) 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-steel sheet.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 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 (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable formulation for openings in floors and other horizontal surfaces that are not fire rated. Utilize self-leveling where needed for larger floor areas.
 - 2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. 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 CABLE MANAGEMENT SYSTEM

- A. The drawings do not indicate specific routes for telecommunications cables. The Telecommunications Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables.
- B. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Telecommunications Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.
- C. In areas where there is not an installed raceway system (conduit or cable tray) and a cable support system is required, this contract shall be responsible for providing a cable management system.
- D. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is minimum sag of 4 inches every 4 foot of horizontal run.

3.2 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1-2010
- 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 pathway or cable, using non-hardening joint sealant (firestop putty) 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 (6.4-mm)** annular clear space between sleeve and pathway 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.
- 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 silicone or LCI for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual pathways 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 (25-mm)** 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 (25-mm)** annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

SECTION 270553 - IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section

1.2 WORK INCLUDES

- A. Work covered by this Section shall consist of furnishing labor, equipment and materials necessary for the labeling of the telecommunications infrastructure as described on the Drawings and/or required by these specifications.

1.3 SCOPE OF WORK

- A. This Section includes the minimum requirements for the Identification and labeling of the Communications Systems for the project as outlined in the Bid Document.

1.4 SUMMARY

- A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.
- B. Administration of the telecommunications infrastructure includes documentation of cables, termination hardware, patching and cross-connection facilities, conduits, other cable pathways, Telecommunications Rooms, and other telecommunications spaces. All facilities shall apply and maintain a system for documenting and administering the telecommunications infrastructure.
- C. The owner maintains a campus wide labeling scheme for voice and data outlets and patch panels.
- D. Industry Labeling Standards and Conventions shall be used unless otherwise stated in the bid documents or by the Owner's Representative.
- E. Telecommunications Infrastructure Records must be maintained in a computer spreadsheet, or in a computer database. Paper records are encouraged, but are optional. A cable record is prepared for each backbone cable. The record will show the cable name, and must describe the origin point and destination point of the cable. The cable record will record what services and/or connections are assigned to each cable pair or strand. An equipment record is prepared for services distributed from a certain piece of equipment, such as a router, or a system such as the telephone system PBX.
- F. Installer shall maintain accurate, up-to-date Installation or Construction Drawings. At a minimum, the Installation Drawings shall show pathway locations and routing, configuration of

telecommunications spaces including backboard and equipment rack configurations, and wiring details including identifier assignments.

- G. Installer shall provide a complete and accurate set of as-built drawings. The as-built drawings shall record the identifiers for major infrastructure components including; the pathways, spaces, and wiring portions of the infrastructure which may each may have separate drawings if warranted by the complexity of the installation, or the scale of the drawings.
- H. Structured Cabling System
- I. Audiovisual System
- J. Audio/Visual Equipment
- K. Sound Reinforcement System
- L. Access Control System
- M. Video Intercom System

1.5 EQUIPMENT IDENTIFICATION

- A. Identify all the following items with laminated plates:
 - 1. Equipment Cabinets
 - 2. Equipment Racks
 - 3. Wall-Mounted Cabinets
- B. Nameplate shall indicate service origination and cable type.

1.6 QUALITY ASSURANCE

- A. All labels shall be installed in a neat and workmanlike manner. All methods of labeling that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative.
- B. Labels shall be of the quality and manufacture indicated. The labels and labeling equipment specified are based upon the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- C. Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data labeling.
- D. Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
- E. TIA-606-C Administration Standards for Telecommunications Infrastructure TIA-569 Telecommunications Pathway and Spaces

- F. TIA-568 Telecommunications Cabling Standard
- G. BICSI Telecommunications Distribution Methods Manual
- H. UL 969 - UL Standard for Safety for Marking and Labeling Systems
- I. All components shall be supplied by the system manufacturer and/or approved for use by manufacturer.
- J. Sleeves shall be UL listed.
- K. Communications pathways and support equipment shall be closely coordinated with other trades to provide adequate access, appropriate clearances and required separation between systems.

1.7 SUBMITTALS

- A. Provide product data for the following: Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

1.8 COORDINATION

- A. Coordinate installation of labels with other trades.
- B. Storage and Handling: Avoid breakage, denting and scoring finishes. Damaged products will not be installed. Store materials in original cartons and in a clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Nameplates shall be laminated phenolic with black surface and white core.
- B. The lettering shall be Condensed Gothic with space between the lines equal to the width of the letters.
- C. The lettering on the plate shall indicate the name of equipment, the specific MER/TR the equipment is being served from, and any other reference data pertinent to the operation.
- D. Names and numbers shall coincide with those listed on the drawings or issued in an addendum or bulletin after bid.

2.2 LABELS

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969
- B. Shall be preprinted or computer printed type. Hand written labels are not acceptable

- C. Where insert type labels are used provide clear plastic cover over label
- D. Outside plant labels shall be totally waterproof even when submerged
- E. The following shall be labeled:
 - 1. Equipment Room Copper, Fiber, and Coax Backbone Cable
 - 2. Equipment Room Copper, Fiber, and Coax Horizontal Cable
 - 3. Work Area Copper, Fiber, and Coax Riser Cable
 - 4. Patch Panel
 - 5. Telecommunications/Data Outlets

PART 3 - EXECUTION

3.1 IDENTIFICATION AND LABELING

- A. The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during the installation of and normal maintenance of the infrastructure.
- B. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.
- C. All labels shall be printed or generated by a mechanical device.

3.2 TELECOMMUNICATION IDENTIFIERS

- A. Refer to the University of Houston Information Technology Telecommunications Infrastructure Standards Manual for labeling practices
- B. Outside Plant cabling shall be clearly marked using permanent means. Outside plant shall use the following system of numbering and labeling:
- C. Fiber Optic:
 - 1. Identify: far-end building name, building number, fiber-type and strand-count
 - 2. Label at entrance and exit points of tunnel system and at conduit entry points between 12 inches and 36 inches from the conduit or at closet point that is clearly visible and long cable length in tunnel at 200 foot intervals.
 - 3. Label at termination panels at both ends
- D. Copper:
 - 1. Identify: far-end building name, building number and strand-count
 - 2. Label at entrance and exit points of tunnel system and at conduit entry points between 12 inches and 36 inches from the conduit or at closet point that is clearly visible and long cable length in tunnel at 200 foot intervals
 - 3. Riser cabling shall be clearly marked using permanent means. Riser cabling shall use the following system of numbering and labeling:
- E. Fiber Optic:

1. Identify: far-end EF / ER / TR, fiber-type and strand-count.
2. When small facilities are fed from a primary location and treated as an ER, riser shall be labeled similar to Outside Plant Fiber Optic

F. Copper:

1. Identify: far-end EF / ER / TR and pair-count
2. Termination points shall be labeled as to actual pair at every fifth (5th) pair-point.

3.3 LABELING PROCEDURES

A. To be consistent with ANSI/TIA standards and industry practices, it is important that both labeling and color coding be applied to all telecommunications infrastructure components. Labeling with the unique identifier will identify a particular component. Proper color coding will quickly identify how that component is used in the overall telecommunications infrastructure of the facility.

B. Visibility and durability:

1. The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during the installation of and normal maintenance of the infrastructure.
2. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.
3. Labels are generally of either the adhesive or insert type. All labels must be legible, resistant to defacement, and maintain adhesion to the application surface.
4. Outside plant labels shall be totally waterproof, even when submerged.
5. Labels applied directly to a cable shall have a clear vinyl wrapping applied over the label and around the cable to permanently affix the label.
6. Other types of labels, such as tie-on labels, may be used. However, the label must be appropriate for the environment in which it is used, and must be used in the manner intended by the manufacturer.

C. Mechanical generation

1. All labels shall be printed or generated by a mechanical device.
2. Hand written labels are NOT acceptable.

3.4 STRUCTURED CABLING SYSTEM

A. The Contractor shall be responsible for labeling all supplied telecommunications equipment, cable etc. in accordance with the guidelines as described herein.

B. The end of each cable, each jack, patch panel, cross-connect and rack/cabinet/backboard etc., be labeled utilizing a [permanent labeling system. Hand written label WILL NOT BE ACCEPTED.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application and system testing.

D. System tests shall reference the final labeling.

3.5 AUDIO/VISUAL EQUIPMENT

- A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served.
- B. Cables shall be tagged at both ends and at each point where the cable is administered.
- C. All labeling and recording shall be approved by Owner and the Engineer prior to application.

3.6 AUDIOVISUAL SYSTEM

- A. Label all cable lengths at each end and record the same on record drawings.
- B. Clearly and permanently label all jacks, controls and connections with permanent engraved laminated plastic labels or by engraving and filling mounting plates, unless otherwise noted.
- C. Attach laminated plastic labels with contact cement.
- D. Embossed or printed label tape, and pressed-on or lift-off lettering systems will not be accepted.
- E. All labeling shall be completed prior to final system inspections.
- F. If permanent labels cannot be furnished prior to system testing, temporarily label all controls with write-on tape.

3.7 NAMEPLATES

- A. Nameplates shall be secured with screws, one on each end.

SECTION 270801 – COMMUNICATION SYSTEMS CABLE TESTING

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.
- B. 260000 – Electrical Systems
- C. 270000 – Communications Systems
- D. 280000 – Security Systems

1.2 DESCRIPTION OF WORK

- A. Upon completion of the cabling installation, the contractor shall perform specified cable verification testing and test result documentation reports, to be submitted for approval as indicated on the drawings, specified or as otherwise required.

1.3 PURPOSE

- A. The purpose of the systems testing and verification requirements are twofold:
 - 1. To verify and document that the completed installation meets or exceeds minimum systems performance and quality standards as outlined herein.
 - 2. Established a base standard criteria against which the completed installation can be tested and compared to in the future, to facilitate troubleshooting and maintenance.

1.4 GENERAL REQUIREMENTS AND CONDITIONS

- A. Cable testing shall be conducted by an Engineer approved testing facility, utilizing a programmable microcomputer based automatic scanner/tester capable of generating complete alphanumerical and graphical printed test reports.
- B. The Contractor shall submit for approval only tests performed on cables which have been completely installed, terminated and visually inspected. All connectors are to be installed, conductors terminated, faceplates installed and mounted, cable routed, bundled, etc.
- C. The Contractor shall submit for approval, only test reports which indicate full compliance with minimum acceptable standards and specifications indicated here-in. Marginally acceptable test results, as indicated by some test equipment manufacturers as within a 15% Fault Anomaly Threshold, * or other notation will not be acceptable.
- D. The Contractor shall perform minimum verification testing of all cables on the reels before pulling and installation. The Contractor shall be responsible for all cable installed, and all cable must be fully acceptable and verified upon completion.

- E. Each voice/data communication outlet and each backbone cable shall pass a complete "active" operational test as performed by and acceptable to the Owner.
- F. Any outlet, cable or component not satisfactorily passing all of the "static" visual inspections, electronic micro-computer based automatic scanner testing, Owner performed "passive" testing, "active" operational tests or failing to meet quality installation standards as described in the specifications and standards herein, shall be repaired and/or replaced as directed by the Owner and Engineer at the Contractor's expense.
- G. The Contractor shall prepare complete electronic cable test results for all installed cables, for review and acceptance by the Owner and Engineer prior to final acceptance of the cabling system. The Contractor shall coordinate with the Owner and Engineer for a visual inspection and preliminary acceptance of the physical installation prior to performing certification testing, as any rework, changes, or alterations will necessitate retesting. Test reports on completed and acceptable installations only shall be submitted. All test reports shall be signed and dated by the Technician performing the tests and/or inspection. Electronic test results will include the name of the individual performing the tests on each cable.
- H. The Contractor shall recognize that the available programmable micro-computer based automatic scanner test equipment for copper media, and the fiber optic power meter test equipment described herein is limited in its ability to completely test all pertinent parameters of an acceptable cabling installation and as such, a "pass" test result will not be the determining criteria for acceptability of an installation which does not otherwise meet the standards and intent of this specification and the Engineering documents. Test results must exceed the minimum guaranteed margins by the manufacturer of the cable.
- I. The Contractor shall provide, in writing, a minimum of 48 hours (two working days) notice to the Owner and Engineer prior to commencing with cable testing. The Owner and Engineer shall at their discretion, observe any and/or all cable testing activities. Cable testing procedures shall be acceptable to the Owner and Engineer.
- J. The Contractor shall coordinate with the Owner, to perform at the Owner's discretion, concurrent Owner testing of randomly selected outlets and cables as to be determined by the Owner.
- K. The Contractor shall provide test results electronically in the Fluke Networks LinkWare Live or equal to the Owner and engineer within five (5) working days of performing the tests.
- L. The Contractor will provide a Manufacturer's certification that all electronic microcomputers used in testing this project have been factory calibrated within the last three (3) months prior to the date of first testing.
- M. The Contractor will provide a Manufacturer's certification that all electronic microcomputers used in testing this project have the current testing software and will provide the Owner a licensed copy of the current software required to view the test results for the owner's use.
- N. The Contractor will provide a Manufacturer's certification that all technicians operating testing equipment have been certified in the operation of the testing equipment.
 - 1. "Certified Test Technician" certificates shall be provided to Owner and Engineer a minimum of 72 hours (3 work days) prior to commencement of testing activities.

- O. All test equipment shall be owned and maintained by the Contractor. Rental and borrowing of test equipment is unacceptable.
- P. The Contractor shall provide a schedule for all proposed testing to the Owner and Engineer 72 hours (3 work days) prior to commencement of testing activities.
- Q. Transmission performance of structured cabling varies with length, connecting hardware, cords and total number of connections. The installer must take care to properly install the cabling components. To ensure that the installed structured cabling solution meets or exceeds the required performance it must be 'tested' or 'certified'.
- R. The requirements for each category of cabling (Cat5e, Cat6, or Cat6A) and optical fiber optics links are located in the ANSI/TIA-568 series standards.
- S. Test equipment must meet the requirements set forth in the ANSI/TIA-568 series Standard for Field Test Equipment. All Copper testers shall be Level III. All fiber testers shall meet the requirements in ANSI/TIA-568.
- T. Field Power Meters shall meet the following:
 - 1. Accuracy ± 0.2 dB
 - 2. Resolution 0.01 dB
 - 3. Precision ± 0.15 dB
- U. The Field light source shall meet the following:
- V. Accuracy ± 0.01 dB
- W. Wavelength 850 ± 30 nm
 - 1. 1300 ± 50 nm
 - 2. 1310 ± 30 nm
 - 3. 1550 ± 30 nm
- X. The calibration on all test equipment shall be current.
- Y. The software in all test equipment shall be current.

1.5 MANUFACTURERS

- A. FLUKE
- B. Ideal
- C. Softing

1.6 CABLE TESTING AND VERIFICATION CATEGORIES

- A. Cable Testing and Verification shall be of two (2) categories.
 - 1. A visual inspection of the completed cabling installation to be performed by the Contractor's RCDD.

2. Electronic microcomputer generated cabling performance verification testing. Electronic performance verification testing shall be of four (4) methods dependent upon the media under test.
 - a. Category-6 or 6A compliance verification testing of four (4) unshielded twisted pair (4UTP) horizontal workstation cabling.
 - b. Multi-twisted pair backbone trunk, riser, tie cable for “voice” distribution.
 - c. Coaxial CATV cables for “CATV” system distribution.
 - d. Fiber optic backbone and horizontal workstation cabling, typically of three (3) classifications.
 - e. 62.5/125um multi-mode fiber optic cable.
 - f. 50/125 um multi-mode fiber optic cable.
 - g. 8.7/125um single mode fiber optic cable.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CABLE TESTING PROCEDURES AND REQUIREMENTS

- A. Provide installation testing of equipment where required by manufacturer’s installation instructions.
- B. Provide complete end to end testing for all copper and fiber optic systems/channels based on latest applicable standards. Document all testing and submit with final as- built submittal package.
- C. For all controls and operating equipment, submit equipment/systems to at least three complete operational sequences, in which all equipment operations are tested, observed, and verified.
- D. Prior to substantial completion and project acceptance inspection, submit test reports to indicated scope of startup and operational tests, with results of testing for each specified operation.

3.2 COPPER CABLING SYSTEM TESTING

- A. General: Copper cabling shall be tested and certified after installation as follows and as required for cable manufacturer’s warranty. Twisted-pair copper cable channels shall be tested for continuity as specified below, presence of ac/dc voltage, and performance. All cabling shall be tested for conformance to horizontal cable specifications as outlined herein, and shall be tested per test set manufacturer’s instructions utilizing latest firmware and software. Testing shall include all electrical parameters as specified under Product. All cables and termination hardware shall be 100 percent tested by installation contractor for defects in installation and to verify cable performance under installed conditions. All conductors of each installed cable shall be verified useable by Contractor prior to system acceptance. All cables shall be tested per contract documents, manufacturer’s warranty provisions, and best industry practices. If any of these are in conflict, Contractor shall comply with most stringent requirements. All defects in cabling system installation shall be repaired or replaced to ensure 100 percent useable conductors in all cables installed, at no additional cost to Owner.

- B. Continuity: Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by test unit per manufacturers recommended procedures, and referenced to appropriate cable identification number and circuit or pair number. Any faults in wiring shall be corrected and cable re-tested prior to final acceptance.
- C. Length: Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to maximum distances set forth in ANSI/TIA-568-C standards and all other applicable standards specified in Appendix 1: Codes, Standards, and Informative References. Cable lengths shall be recorded, referencing cable identification number and circuit or pair number. For multi-pair cables, shortest pair length shall be recorded as length for cable.
- D. Factory testing: Every reel of cable shall be tested by cable manufacturer for all characteristics specified for cable type in this section. This testing shall be performed using a sweep test method and include frequencies specified for cable. A test report shall be available electronically, at no additional cost, for a minimum of five (5) years from the date of manufacture. The test report shall include the reel number, the date of the test, the Lot number, and test results for Return Loss (RL), Insertion Loss (Attenuation), Pair-to-Pair NEXT, and Power Sum NEXT Pair-to-Pair ELFEXT and Power Sum ELFEXT. The test report shall show the "Worst Case Margin" for the listed transmission characteristics.
- E. Test results: Test results shall be automatically evaluated by equipment, using most up- to-date criteria from TIA-568-C standards and all other applicable standards specified in Appendix 1: Codes, Standards, and Informative References, and result shown as pass/fail. Test results shall be printed directly from test unit or from a download file using an application from test equipment manufacturer. The printed test results shall include all tests performed, expected test result and actual test result achieved.
- F. Test reports: Test reports for all factory testing and field test reports for copper cabling installation shall be submitted to the Owner's Representative and manufacturer prior to commissioning voice and data system and final contract payment. Refer to Submittals in this Section.

3.3 MULTI-TWISTED PAIR TRUNK, RISER AND TIE CABLES (SHIELDED AND UNSHIELDED)

- A. All cables and all pairs shall be "Wire Map" tested for opens, shorts, continuity, pair-reversals (flips), and inspected for proper 25 pair color code sequence, 25 pair primary unit color code sequence, and 600 pair super binder group color code designation termination sequence. In addition, the first pair in each 25 pair binder group shall be tested for loop-resistance to the nearest 0.1 Ohms.

3.4 COAXIAL CABLES

- A. All coaxial cables shall be tested for "opens", "shorts", continuity, capacitance, impedance, loop resistance and length. Coaxial cables shall be tested utilizing a programmable microcomputer based automatic scanner/tester capable of generating complete printed test reports as noted above.

Written descriptions of the proposed calibration and testing procedures shall be submitted to the Engineer for prior approval, before beginning any testing. When the Contractor submits cable verification test reports generated by micro-computer based tester, the test report will be provided electronically to the Owner and Engineer

- B. Where applicable or otherwise noted on the Engineering Drawings or documents, the Contractor shall perform such additional testing of the coaxial cable system as is required and/or indicated. For a CATV system installation, the Contractor shall verify and record the incoming signal level. The Contractor shall test the frequency response of system and shall provide filters as required to provide a flat response from 50 MHz to 750 MHz. The maximum deviation shall be +5 dB. Contractor shall record and document (1) the location and value of all taps, splitters, directional couplers, attenuators, end of line resistors, amplifiers, filters, equalizers, etc. and (2) the loss/gain (+dB) at each location. Other coaxial cable systems shall be tested as directed.
 - 1. Unless noted otherwise on the Engineering drawings or documents, Time Warner Communications will furnish and install CATV amplifiers in the space provided, perform additional testing and balancing of the CATV system as required. Contractor shall verify.

3.5 OPTICAL FIBER CABLE TESTING

- A. General: Optical fiber cabling shall be tested and certified after installation as described below and as required for cable manufacturer's warranty. Fiber testing shall be performed on all fibers in completed end to end system. Testing shall consist of a bi-directional end to end test in accordance with applicable standards in 27 02 20.20, or a bi-directional end to end test performed by TIA-455-53A and all other applicable standards in 27 02 20.20. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode type glass and 1310 and 1550 nanometers for single-mode type glass. These tests shall also include continuity checking of each fiber. For spans greater than 90 meters, each tested span must test to a value less than or equal to value determined by calculating a link loss budget. For horizontal spans less than or equal to 90 meters, each tested span must be less than or equal to 2.0 decibels. The insertion loss for each mated optical fiber connector pair shall not exceed 0.40 decibels.
- B. Pre-installation testing: Test all optical fiber cable for all fibers prior to installation of cable.
- C. Performance testing: Where links are combined to complete a circuit between devices, Contractor shall test each link from end to end to ensure performance of system. Only a basic link test is required. Contractor can optionally install patch cords to complete circuit and then test entire channel. The test method shall be same used for test described above. The values for calculating loss shall be those defined in applicable TIA standards in Appendix 1: Codes, Standards, and Informative References.
- D. Attenuation testing: Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach test equipment to cable plant. The light source shall be left in place after calibration and power meter moved to far end to take measurements.
- E. Loss budget: All fiber cabling shall be tested at both wavelengths 850 nm and 1310 nm for multimode and 1300 nm and 1550 nm for single mode.
- F. The link attenuation shall be calculated using:
 - 1. The CommScope Fiber Performance Calculator for CommScope installations

2. The following calculation for other installations:
 - a. Link Attenuation Allowance (dB) = Cable Attenuation (dB) + Connector loss (dB) + Splice Insertion Loss (dB)
 - b. Where:
 - 1) Cable attenuation (dB) = Cable attenuation (dB/km) X Length (km)
 - 2) Connector loss (dB) = Number of Connector pairs X Allowable connector loss (dB) Splice Insertion Loss (dB) = Number of Splices X Allowable Splice loss (dB)
- G. Link loss: A mated connector to connector interface shall be considered a single connector. Loss numbers for installed link shall be calculated by taking sum of bi- directional measurements and dividing that sum by two. All links not meeting requirements of standard shall be brought into compliance by Contractor, at no additional cost to Owner.
- H. Documentation: Following final documentation shall be submitted to the owner's representative prior to commissioning data system and final contract payment according to Submittals in this section.
- I. Test results: Test results shall be automatically evaluated by equipment, using most up-to-date criteria from all applicable standards specified in 27 02 20.20 and result shown as pass/fail. Test results shall be printed directly from test unit or from a download file using an application from test equipment manufacturer. The printed test results shall include all tests performed, expected test result and actual test result achieved.
- J. End to End Loss Data: final documentation shall be submitted to the owner's representative.
- K. As Installed/ As Built Diagrams: Final documentation shall be submitted to the owner's representative.

3.6 TEST DOCUMENTATION

- A. Electronic Format
 1. Certification Test Reports shall be submitted in electronic format using the appropriate software supplied by the test equipment manufacturer. The data format should be that of the test report software (i.e. *.flw files for Fluke). The contractor shall provide any necessary software to view and evaluate the test data.
 2. The following list is provided as a reference:
 - a. Tester
 - b. Fluke
 - c. Ideal
 - d. One electronic copy of the Test Reports shall be provided.
- B. Paper Format
 1. Provide test documentation in 3-ring binders within 2 weeks after completion of project testing. Binders shall be clearly marked on outside front cover and spine with words Test Results, project name, and date of completion (month and year). Major heading tabs, Horizontal and Backbone, shall divide binder. Each major heading shall be further sectioned by test type. Within horizontal and backbone sections, divide by tabs scanner test results by category, optical fiber attenuation test results, and continuity test results. Present test data within each section in sequence listed in administration records.

2. Provide test equipment by name, manufacturer, model number and last calibration date at the end of document. Unless manufacturer specifies more frequent calibration cycle, annual calibration cycle shall be required on all test equipment used for this installation.
3. Test document shall detail test method used and specific settings of equipment during test. Scanner tests shall be printed on 8 1/2 by 11 inches. Hand written test results (attenuation results and continuity results) shall be documented on a suitable test form.
4. When repairs and re-tests are performed, note problem found and corrective action taken, and collocate in binder both failed and passed test data.

3.7 TIER 1 TESTING

- A. Tier 1 testing shall be performed on all horizontal and centralized work area outlet and Equipment Room interconnect optical fiber cabling strands.
- B. Tier 1 testing shall consist of bi-directional light loss testing of each strand at both corresponding wave lengths (Multi-Mode: 850-1300 um, Single-Mode: 1310-1550 um).
- C. Tier 1 testing shall include power meter light source db loss tests.
- D. Tier 1 testing shall be performed utilizing an optical light loss test set (OLTS) utilizing a stabilized optical light source and optical meter and utilizing high quality factory made test jumpers of the same optical specifications as the fiber under test.
 1. Multi-Mode test jumpers shall include five (5) turns wrapped around a specifically sized mandrel.
- E. Contractor shall utilize the “End-to-End Attenuation Test Procedure” as described in the BICSI TDMM, 11th edition, Chapter 11 and TIA/EIA-TSB-140, modified as noted herein.
 1. Clean each test port and connector with a swab or wipe before each test set-up insertion.
 2. Remove dust cap from test jumper connectors, clean each with a wipe, clean the coupler with a swab, retain dust caps in place until the connector is inserted into the coupler.
 3. Clean the dust caps and connectors immediately upon removing the connector from the coupler and install the cleaned dust caps on the connector and coupler.
 4. The slightest speck of dust or dirt will alter how the fibers couple together and cause high losses and failed results.
 5. Having allowed for the recommended “warm up” period, and upon starting the test procedure set-up, DO NOT:
 - a. Turn “OFF” the optical light source or power meter.
 - b. Disconnect or adjust the test jumper connections to the optical light source or the power meter.
 - c. Reset or otherwise change the reference power reading.

3.8 TIER 2 TESTING

- A. Tier 2 testing shall be performed on all OSP and Riser fiber backbone cabling strands.
- B. Tier 2 testing shall consist of complete Tier 1 testing plus Bi-Directional Optical Time Domain Reflectometer (OTDR) testing of each strand at both wave lengths (Multi-Mode: 850-1300 um, Single-Mode: 1310-1550 um).

- C. Bi-Directional OTDR testing shall be performed utilizing the specified or approved OTDR instrument with high quality factory made “launch” and “receiver” cords of the same optical specifications as the fiber under test as per the OTDR manufacturer’s directions.
 - 1. An approved “receiver” cord shall always be utilized on any strand being OTDR tested. The “receiver” cord shall be installed on the far end of the strand under test.
- D. Optical fiber links shall be fully tested end-to-end, with industrial segments cross-connected with high quality factory made patch cords, minimizing 3 meters in length, of the same optical specifications as the fiber under test (see Specification Section 27 1619 – Patch Cords, Workstation Cords and Cross-Connect Wire for Communications).
- E. Optical fiber backbone links installed as a “redundant loop” (i.e. Point A to B, B to C, C to D, D to A) shall be tested as a continuous loop (i.e. Point A to Point A) with high quality factory terminated and tested patch cords installed around the loop, as required to complete the loop.
- F. Optical fiber backbone links installed as an extension of an existing segment shall be tested end-to-end, as a total segment (i.e. existing plus new).
 - 1. The Contractor shall be responsible for the link segment installed plus 10M into the existing segment or as disturbed to facilitate the extension. It is recommended that the Contractor test and record performance of the existing segment prior to disturbing.
- G. Optical fiber backbone links installed as intended to be utilized as standalone segment shall be tested end-to-end as a total segment.
- H. The Engineer shall approve the test procedure and set proposed for use by the Contractor prior to commencing testing.

3.9 ADDITIONAL SYSTEM VERIFICATION

- A. The above described testing procedures are the minimum acceptable. Additional independent system verification testing may be required as described in the drawings and/or documentation. In addition, independent system verification testing may be required at the Contractor's expense, in the event of non-performance of specified testing procedures and submittals or contested materials and/or installation procedures. Independent testing shall be determined by and arranged by the Owner and Engineer at the Contractor's expense.

3.10 TEST REPORT PREPARATION AND SUBMITTAL

- A. Each voice/data communication outlet and each backbone cable shall pass a complete “active” operational test as performed by, and acceptable to the Owner.
- B. Any outlet, cable or component not satisfactorily passing all of the “static” visual inspections, electronic micro-computer based automatic scanner testing, Owner performed “passive” testing, “active” operational tests or failing to meet quality installation standards as described in the specifications and standards herein, shall be repaired and/or replaced as directed by the Owner and Engineer at the Contractor’s expense.

- C. The Contractor shall prepare complete cable test reports for all installed cables, for review and acceptance by the Owner and Engineer prior to final acceptance of the cabling system. The Contractor shall coordinate with the Owner and Engineer for a visual inspection and preliminary acceptance of the physical installation prior to performing certification testing, as any rework, changes, or alterations will necessitate retesting. Test reports on completed and acceptable installations only shall be submitted. All test reports shall be signed and dated by the Technician performing the tests and/or inspection.
- D. The Contractor shall submit for approval only tests performed on cables which have been completely installed, terminated and visually inspected. All connectors are to be installed, conductors terminated, faceplates installed and mounted, cable routed, bundled, etc.
- E. The Contractor shall submit for approval, only test reports which indicate full compliance with minimum acceptable standards and specifications indicated herein. Marginally acceptable test results, as indicated by some test equipment manufacturers as within a 15% Fault Anomaly Threshold, * or other notation will not be acceptable.
- F. After the horizontal cable tests have been performed, the Contractor shall install the permanent faceplate labels, modular jack dust covers and permanent preprinted patch panel labels.

3.11 INDEPENDENT SYSTEM VERIFICATION

- A. The above described testing procedures are the minimum acceptable. Additional independent system verification testing may be required as described in the drawings and/or documentation. In addition, independent system verification testing may be required at the Contractor's expense, in the event of non-performance of specified testing procedures and submittals or contested materials and/or installation procedures. Independent testing shall be determined by and arranged by the Engineer at the Contractor's expense.

SECTION 270802 - DOCUMENTATION AND CLOSE OUT FOR TECH & SECURITY SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Furnish complete project documentation and close-out functions for the communications project as shown on the Drawings, Specified or otherwise required.

PART 2 - PRODUCTS

2.1 FINAL INSPECTIONS

- A. As per General Conditions, Article 10, the Contractor shall:
 - 1. Prepare Contractors Punch List, complete work, make corrections, sign-off on the Contractor's Punch List and submit to the Owner and Engineer with Contractor's request for final inspection.
 - 2. Contractor shall complete and correct all work items noted, sign-off on the Owner and Engineer's Punch Lists and submit with the request for Certificate of Contract Completion.

2.2 PROJECT RECORD DOCUMENT SUBMITTALS

- A. The Contractor shall submit completed project documents as per General Conditions.
- B. Record Drawings
 - 1. The Contractor shall keep in the field and open to inspection, an accurate, current, progressive record of the actual installation of the data/communication cabling system. Upon completion of the work, the Contractor shall deliver marked up prints showing the actual routing of cable runs, outlet locations, outlet/cable identifications, cable tray sizes and routes, conduit sizes and routes, distribution frame layouts, punch down block locations, coax cable system splitter and tap locations with dB values and signal levels indicating system loading and balancing, etc.
 - 2. Where applicable or otherwise noted on the Engineering Drawings or documents, the Engineer will provide to the Contractor an Auto-Cad file of the appropriate available floor plans and/or drawings as required for the Contractor to update and/or provide the required record documentation.
 - 3. Cable Tray and Conduit Routing Submittal Drawings.
- C. Submittals for Inclusion in the Project Manual shall include an Excel Spreadsheet with the following:
 - 1. LCD List
 - a. Room No.
 - b. Description
 - c. Part Number
 - d. Serial Number

- e. Unit Cost
- 2. WAP List
 - a. Room No.
 - b. Description
 - c. Part Number
 - d. WAP Number
 - e. Cable ID
 - f. Serial Number
 - g. MAC Address
 - h. Unit Cost
- 3. BCM/SRG Keycodes - Or CS1000 License IDs
 - a. Description
 - b. License IDs
- 4. IP Address Scheme
 - a. Subnet
 - b. Default Gateway
 - c. VLAN Number
 - d. VLAN Name
 - e. Example of Schematic

2.3 CONTRACTOR QUALIFICATIONS

- A. Testing reports for copper and fiber optic cables as per specifications.
- B. Factory Master Reel Test Reports and Contractor's Pre-Installation Copper and Fiber Optic Test Report per specifications. Report is required to be submitted to Owner before horizontal cable installation begins.
- C. Record copy of Grounding Test Reports and Diagrams as per specification. Report is required to be submitted to Owner before horizontal cable installation begins.
- D. Fire stopping Shop Drawing Submittals as per specification.
- E. Product, Equipment and Material Shop Drawings as per specification.
- F. Warranties and Guarantees as per specifications.
- G. All other miscellaneous submittals as per specification, as required.

PART 3 - PROJECT MANUAL

- 3.1 Provide complete written Project Manuals, which shall include, but not be limited to the following:
 - A. First Page: Title of job, Owner, address, date of submittal and name of Contractor.
 - B. Second Page: Index of Contents
 - C. Third Page: Introduction to first section containing a cross-reference to the equipment schedule and cable schedule.
 - D. First Section: One copy each of accepted shop drawings, equipment catalog cuts and manufacturer's instructions for all components and materials utilized in the technology and security systems, including approved fire stopping shop drawings.
 - E. Second Section: One copy each of all Contractor Qualification Submittals, including references, certifications, registrations, workforce registrations, etc.
 - F. Third Section: One copy each of all completed, signed and accepted test reports, including Factory Master Reel Tests, Pre-installation tests, grounding, and cable installation verification testing.
 - 1. All voice and data station cable and data riser cable test results will be submitted in their original format as down loaded from the tester in software on one or more CDs or USB drive with a standard protective case.
 - 2. All fiber test results will be submitted on one or more CDs or USB drive with a standard protective case. OTDR test results shall be submitted in their original format and in PDF format on CDs or USB drive.
 - G. Fourth Section: One copy of all manufacturer's installation and operational manuals.

- H. Fifth Section: One copy of all Contractor's, manufacturer's, and vendor's warranties and guarantees.

3.2 PROJECT MANUAL ASSEMBLY AND SUBMITTAL

- A. Bind the written system instruction manual's information and materials into a PDF binder of 8½" x 11" size.
- B. Submit digital copies each to the Owner and Engineer for approval.
- C. After approval, submit digital copies to the Engineer for delivery to the Architect and Owner.
- D. Submit complete digital sets of record drawings to the Owner and Engineer (one each) for review.

END OF SECTION 270802

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All provisions of the Division 00 and Division 01, apply to all work in Division 27.

1.2 WORK INCLUDES

- A. Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.

1.3 SCOPE OF WORK

- A. The intent of this specification is to cover the materials and installation of a communications equipment room fitting system as outlined herein and as detailed on the drawings. Work shall consist of:
 - 1. Telecommunications Room termination and cable management including racks, cabinets, ladder rack, etc.
 - 2. Cabling pathways including raised floor cable tray, overhead fiber duct, overhead ladder rack, innerduct, etc.
 - 3. Cable management system within racks and cabinets
 - 4. System labeling confirming to ANSI/TIA-606-B standards
 - 5. Each Rack shall have an appropriately sized UPS to allow for 15 minute uptime based on equipment power ratings in the rack. Calculations to be determined by contractor when final equipment layout for submittals.
- B. Termination Equipment – Racks and Cabinets
- C. Cable Management – Ladder rack, rack mounted horizontal and vertical cable management
- D. Cabling pathways including raised floor cable tray, overhead fiber duct, overhead ladder rack, innerduct, etc.

1.4 SUMMARY

- A. The intent of this specification section is to cover the materials and installation of a communications equipment room fitting system as outlined herein and as detailed on the drawings. Work shall consist of:
 - 1. Telecommunications Room termination and cable management including racks, cabinets, ladder rack, etc.
 - 2. Cabling pathways including raised floor cable tray, overhead fiber duct, overhead ladder rack, innerduct, etc.

3. Cable management system within racks and cabinets.
4. System labeling conforming to ANSI/TIA-606-B standards.

- B. Termination Equipment – Racks and Cabinets
- C. Cable Management – Ladder rack, rack mounted horizontal and vertical cable management
- D. Cabling pathways including raised floor cable tray, overhead fiber duct, overhead ladder rack, innerduct, etc.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD or BICSI Installer, Level 2.
 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.
- B. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standards ANSI ANSI/TIA 568, 569, 606, & 607, 758, 862 and all applicable and current Technical Service Bulletins (TSB).
- C. All equipment and installation practices shall comply with the latest BICSI Telecommunications Distribution Methods Manual (TDMM) and BICSI Customer-Owned Outside Plant Design Manual (OSDM) Standards and applicable National Electric Code Sections.
- D. All equipment shall be UL or ETL listed.
- E. All equipment and installation practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- F. All installation practices shall comply with the local electrical code.
- G. ISO 9001:2000 – Quality Management Systems – Requirements.
- H. All equipment racks and cabinets shall comply with the latest EIA/ECA-310 Equipment Standards.
- I. All The Contractor (or sub-contractor) shall be a member of Building Industry Consulting Service International (BICSI) and have a Registered Communication Distribution Designer (RCDD) status.
- J. The Contractor (or sub-contractor) shall provide the services and equipment of a company listed by Underwriters Laboratories, Inc. in its directory as being capable of furnishing the system specified herein. Said company shall be authorized to, and shall, issue a certificate stating that the equipment and connected wiring and devices which form the specified system, together with installation and maintenance service, are in compliance with the requirements established by Underwriters Laboratories and ANSI/TIA Standards.

- K. Work shall be performed by a BICSI certified Telecommunications Contractor. Telecommunications Contractors (or sub-contractors) that wish to be considered for this project shall have an on-staff RCDD. Proof of this shall be presented in writing by the winning contractor to the Owner/Architect/engineer prior to contract signing. It shall not be acceptable for any portion of the work specified herein to be performed by a sub-contractor unless such sub-contractor has been pre-approved by the Owner/Architect in writing.
- L. BICSI Certification shall include the following:
 - 1. Copy of the BICSI RCDD certificate for the Contractor's (or sub-contractor) on-staff, full time project manager.
 - 2. Copy of the BICSI Apprentice, Installer or Technician certificate(s) for the Contractor's on-staff, full time installation personnel. Prior to commencement of work, the Contractor (or sub-contractor) shall submit the resume of personnel assigned to the project. Any approval given during bidding shall be based upon the information submitted. Change in approved personnel prior to completion of the project shall be brought to the attention of the Engineer for review.
- M. Copy of the current Voice/Data system Manufacturers Approval Certificate indicating that the contracting COMPANY is a certified installer of the proposed voice and data cabling equipment/Cabling System Solution. Individual technician certificates should be provided in addition to current COMPANY certificate.

1.6 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.
 - 2. Manufacturer Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.
 - 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 5. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
- C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

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

1.7 RELATED REQUIREMENTS:

- A. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
- B. Section 270528 "Pathways for Communications Systems for telecommunications pathway requirements within communications equipment rooms
- C. Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling for materials and installation requirements for penetrations in exterior walls and basement floors
- D. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
- E. Section 271500 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.
- F. Section 280013 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.
- G. All local, state and national codes
- H. The National Electric Code (NEC)
- I. The National Electrical Safety Code (NESC)
- J. Electronic Industries Alliance (EIA) / Telecommunications Industry Association (TIA) 526, 568, 569, 606, J-STD-607, 758 and all applicable and current Technical Service Bulletins (TSB).

1.8 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. LAN: Local area network.
- C. RCDD: Registered Communications Distribution Designer.

1.9 COORDINATION

- A. Coordinate work with other trades for placement of electrical connections.
- B. Coordinate UPS and Power Strip input connectors with electrical contractor.
- C. Coordinate with the Network Integrators such that UPS units are capable of remote monitoring.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
- C. Handling: Protect materials during handling and installation to prevent damage.

1.11 WARRANTY

- A. Warranty Period: One (1) year.
- B. The Contractor shall supply a full manufacturer's application assurance warranty for all new installations, to include approved termination hardware and cabling media from the proposed manufacturer's list of approved materials. Services to be provided by this contractor to the Owner during the warranty period shall include, without limitation, the following:
 - 1. Remedial Maintenance: Contractor shall provide service on Owner's site as necessary including, but not limited to, fault isolation, diagnosis, and repair.
 - 2. Maintenance Records: Contractor shall maintain at the jobsite a current record of the cabling system configuration, including maintenance history and all adds, moves, and changes.
- C. Replacement Parts: Contractor shall provide and install replacement parts, including new components,
- D. Field Change Orders: Contractor shall provide and install field change orders with Owner approval. All change order requests shall be processed by the Construction Manager or General Contractor.
- E. Post-System Warranty Maintenance Service
 - 1. The Owner shall reserve the right to elect or cancel at any time any maintenance service to be provided by the Contractor.
 - 2. Warranty of On-Site Response regardless of the cause of the problem, contractor shall ensure that parts, equipment, and materials are available to remedy the problems and its personnel are ready to begin work (such action being deemed a "response")
 - 3. Warranty of Security: Contractor shall warrant that its personnel, including all subcontractors, shall at all times comply with all Owner security regulations of which contractor has been informed by Owner. Contractor also warrants that it has obtained all necessary licenses and permits required by federal, state, and local government.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

- A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided and meet default manufacturer part number. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the “precise functional equivalent” shall result in the removal of the alternate equipment at the Contractor’s expense.
- B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be determined part of these specifications.

2.2 PERFORMANCE REQUIREMENTS

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

2.3 GENERAL REQUIREMENTS

- A. Provide all required 120V power distributed through rack as required by installed equipment from local UPS unit and to dedicated receptacle in room. (Standard of quality is Tripp Lite or Geist) Acceptable manufacturers must demonstrate product equivalency.
- B. Refer to drawings for cabinet’s quantities and locations.
- C. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
- D. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.
- E. Finish: Manufacturer's standard, baked-polyester powder coat.
- F. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
- G. Final rack configurations including rail width, useable depth, weight loading, etc. to be carefully coordinated with installed equipment prior to ordering. Refer to equipment section for additional rack requirements.
- H. Racks
 - 1. Racks shall be manufactured from aluminum and/or steel extrusion.

2. Each rack will have two L-shaped top angles, two L-shaped base angles and two C-shaped equipment-mounting channels. The rack will assemble with nut and bolt hardware. The base angles will be pre-punched for attachment to the floor.
3. Equipment mounting channels will be punched on the front and rear flange with the EIA-310 Universal Mounting hole pattern.
4. Aluminum Racks will be threaded with 12-24 roll-formed threads and will include 40 each combination pan head, pilot point mounting screws.
5. Steel Racks will have 3/8" square holes and will include 40 each #12-24 x
6. 1/2" mounting screws and 40 each #12-24 cage nuts.
7. The rack will include assembly and equipment-mounting hardware. The rack will be rated:
8. Two Post Racks: 1,000 lb. (453.6 kg) of equipment
9. Four Post Racks: 2,000 lb. (907.2 kg) of equipment
10. The rack will be UL Listed
11. When assembled with top and bottom angles, equipment-mounting channels will be spaced to allow attachment of 19" EIA rack-mount equipment.

I. Rack Cable Management

1. Vertical cable management shall have doors that are lightweight, sturdy, and be available in different sizes to allow flexibility in design.
2. The cable management system shall have a C-Channel bracket that allows for easy access to the cable trough.
3. The vertical cable management system shall allow tool-less installation of Cable Spool.
4. Doors shall come standard with on all cable management and be available in both single and double sided configurations.
5. The door shall have dual hinge design that can be opened to the right or left.
6. The door latching mechanism shall have an easy closing feature.
7. The door shall have one point removal and installation process for door.
8. Horizontal wire managers: The door shall have horizontal cover hinges up or down and be lockable into position with cylindrical finger ends for easy snap on installation
9. The door shall have a recessed handle to eliminate snag potential for clothes and arms.
10. The Horizontal cable management system shall have an open back on 2U and 3U horizontal troughs for easy pass-through of cables

2.4 FREE STANDING FOUR POST ALUMINUM RACKS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: 45U – 7FT Rack unless otherwise noted. Subject to compliance with requirements, provide comparable product by one of the following:
 1. Legrand/Ortronics, Inc.
 2. Tripp Lite
 3. APC.
 4. Middle Atlantic Products, Inc.
- C. 45U – 7FT Four Post Communications rack, 19 inches wide, 84 inches high. Black in color with 45 rack mounting units (1.75 inches per RU), self-supporting. Aluminum, rated 1500 lb., epoxy-polyester hybrid powder coat 1000 lb.

1. Rack shall have full-height, 6 inch wide front/rear vertical organizers. Where multiple racks are ganged together, there shall be one vertical manager between each two racks and one additional section at each end of the lineup.
2. Base shall have self-supporting and self-squaring base.
3. Bond each rack and all parts of the cable ladder as 1 ground system.
4. Horizontal cable management systems must be provided on all relay racks.
5. All racks must be grounded to the building technical grounding system.
6. Rear access shall be available for installation and maintenance.
7. Rack shall be bolted to the floor.
8. The tops of the racks shall be securely braced to rigid ladder tray and bracketed to the wall.
9. All hardware shall be provided for protection within seismic zones where applicable.
10. Contractors shall observe minimum clearance requirements as follows:
 - a. Racks shall be mounted to allow a minimum of 36 inches access space in both front and rear.
 - b. The sides of a rack or group of racks situated against a wall shall have a minimum of 6 inch clearance from rack to the adjacent wall, with 12 inches preferred where TR space allows. Clearance for the access “walk around” end shall be 24 inches minimum.
11. The rack shall be UL listed.
12. Each rack shall have two (2) L-shaped top angles, two (2) L-shaped base angles and two (2) C-shaped equipment-mounting channels.
13. The rack shall assemble with bolt hardware.
14. Equipment-mounting channels shall be threaded for easy assembly.
15. The base angles shall be pre-punched for attachment to the floor.
16. Equipment mounting channels shall be 3” deep and punched on the front and rear flange with the EIA-310-D universal hole pattern to provide 45 RU for equipment. Each mounting space shall be marked and numbered on the mounting channel.
17. When assembled with top and bottom angles, equipment-mounting channels shall be spaced to allow attachment of 19 inch EIA rack-mount equipment. Attachment points shall be threaded with 12-24 roll-formed threads. The rack shall include assembly and equipment-mounting hardware. Each rack shall include fifty (50) each combination pan head, pilot point mounting screws.
18. The assembled rack shall measure 7 feet (84 inches) high by 20.3 inches wide by 23 inches deep. The sides (webs) of the equipment-mounting channels shall be punched to allow attachment of vertical cable managers along the sides of the rack or for rack-to-rack baying.

2.5 VERTICAL CABLE MANAGEMENT FOR RACKS

- A. The vertical cable management kits are installed on the side of a 19-inch or 23-inch (483 or 584 mm) wide industry standard rack.
- B. The door(s) shall be designed to provide a concealed vertical space for organizing patch cables.
- C. Cable spools shall be used to organize longer patch cable lengths.
- D. Cable managers are to be matched to the cable rack. Cable managers are available in 6 inch (152 mm), 8 inch (203 mm), 10 inch (254 mm), and 12 inch (305 mm) widths and in 7 foot (2.1 m), 8 foot (2.4 m), and 9 foot (2.7 m) heights.

2.6 HORIZONTAL CABLE MANAGEMENT FOR RACKS

- A. The horizontal cable management kits are installed on a 19-inch (483 mm) wide industry standard rack above or below panels to organize patch cables.
- B. The kits shall be available in a single-sided and double-sided configuration, and in a 1U-, 2U-, and 3U-height.
- C. The units shall include covers that can be opened from the top, the bottom, or removed altogether.
- D. The cover hinges shall be designed to hold the cover open from the top or bottom to facilitate faster cabling.
- E. The 2U and 3U cable managers shall have a pass-through feature allowing access to and from the rear for additional cable routing.
- F. The depth of the units shall be
 - 1. Single-sided: 5-1/2 inches (140 mm) deep from front to back with the cover closed
 - 2. Double-sided: 11 inches (280 mm) deep from front to back with the covers closed.

2.7 OVERHEAD CABLE LADDER SYSTEM

- A. All cable ladders shall be custom cut to fit.
- B. Install cable ladder vertically behind each vertical organizer.
- C. Center the cable ladder on the vertical organizer so that when additional racks are added, the cable ladder can be used to serve both racks, and will not interfere with the components mounted in the rack.
- D. 12" wide cable ladder with channels.
- E. Corner clamp for connecting horizontal ladder on the top to the cable ladder that attaches to the wall.
- F. Wall saddle for attaching horizontal cable ladder section to the wall. Equipped with "J" bolts.
- G. Runway shall be tubular steel, ladder type with 1.50 inch stringer height with welded rungs. Stringer side rail shall conform to the minimum chemical and mechanical properties of ASTM A513 Grade 1008 steel.
- H. Cable runway shall be flat black powder coat.
- I. All fittings, supports, splices, etc. for the runway system shall be installed to provide a complete assembly—including fasteners, hardware and other items required to complete the installation as indicated on the drawings.
- J. Cable runway shall be capable of carrying a uniformly distributed load of 95 lbs/ft. on a 5-foot support span with a safety factor of 1.5 when supported as a simple span. Load and safety factors specified are applicable to both side rails and rung capabilities.

- K. Ladder Rack as manufactured by B-Line, Snake Tray, Hubbell, Great Lakes or approved equal.
- L. Attach all cable ladders to the rack with unistrut and unistruts "L" and "T" connectors.

2.8 INNERDUCT

- A. Exterior Innerduct—Flexible corrosion-resistant innerduct with corrugated interior and crush resistant construction. Innerduct to be available in a variety of multi-cell construction, colors and shall range in individual cell size from ½” to 2” I.D.
- B. Interior Innerduct—UL listed, plenum rated, flexible innerduct, corrugated with pull line. All interior fiber optic cables shall be installed in innerduct.

2.9 PATCH CORD ORGANIZERS:

- A. Patch cords organizers shall be steel and shall allow routing of patch cables from electronics to the patch panels.
- B. 2 rack unit organizer
- C. When multiple racks are provided in a row, the Contractor shall provide one (1) inter-bay organizer.
- D. Cable Wraps:
 - 1. Cable wraps shall be used on the cable ladder of the rack systems to bundle the cables as they pass along the cable ladder. Cables shall be bundled in groups of no more than 24 cables.
 - 2. Cable wraps should not be used above the drop ceiling or in cable tray except in limited circumstances. The pathway shall support the cables without the use of extra tie wraps.
 - 3. Cable wraps shall be Velcro type.

2.10 POWER STRIPS

- A. Power Strips: Comply with UL 1363.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Rack mounting.
 - 3. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
 - 4. LED indicator lights for power and protection status.
 - 5. LED indicator lights for reverse polarity and open outlet ground.
 - 6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
 - 7. Close-coupled, direct plug-in line cord.
 - 8. Rocker-type on-off switch, illuminated when in on position.
 - 9. Peak Single-Impulse Surge Current Rating: 33kA per phase.
 - 10. 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 330 V.
 - 11. Shall be rack mountable, and match the equipment rack/cabinet provided.

2.11 UPS—NEW TR IN ADDITION ONLY

A. MANUFACTURERS

1. Approved Manufacturers for Communications Rack Online UPS:
2. Tripp Lite
3. Liebert.
4. APC

B. Approved Manufacturers for Power Strips:

1. Tripp Lite
2. Geist
3. Wiremold

C. Provide true online battery back-up, power conditioning UPS, rack mounted in each TR to serve network electronics as indicated on the drawings. Unit shall utilize combination of battery and microprocessor regulation to provide protection from brownouts and over voltage. UPS to have the following features at a minimum:

D. 2200VA Capacity

E. Output operating range—120V (<3000VA) nominal

F. Communications—Unit shall provide an Ethernet based SNMP management interface, through the LAN to provide remote diagnostics and alarm conditions. Provide vendor management software with all applicable licenses.

G. Expandability—Unit shall provide for the connection of external battery packs in modules to extend the total unit run-time.

H. Complete battery independence- Battery independent restart ensures automatic UPS power-up without user interaction after lengthy power outages, even when batteries are completely drained\discharged.

I. All UPS will be equipped with network management over IP or SNMP capable.

J. 2200 VA UPS shall include the following: Standard of quality is Tripp Lite part number SU2200RTXLCD2U. Acceptable manufactures must demonstrate product equivalency.

1. Output Power Capacity - 18000 wattts/2200VA.
2. Nominal Output Voltage- 120V.
3. Output Connections- (6) NEMA 5-15/20R and (2) NEMA L5-20R.
4. Nominal Input Voltage- 120V.
5. Input connections - NEMA 5-20P.
6. Cord Length - 10'.
7. Rack Mounted - Max. 2U rack space.
8. Transfer Time- 2-4ms.
9. Battery Type- maintenance free sealed lead acid with electrolyte: leakproof.
10. Backup time- 28 minutes at half load (925 watts) 8 minutes at full load (1850 watts.)
11. Extended Run Capable options.
12. Communications/Interface Ports- unit shall communicate through the LAN (SNPM) to provide remote diagnostics and alarm conditions.
13. LED Status - On battery/Replace Battery/and overload indicators.

14. Audible Alarms.
 15. Surge energy Rating - 570 joules.
 16. Filtering - full time multi- pole noise filtering
- K. All UPS units shall be rack mountable with proper mounting hardware and support. Tower UPS systems are not permitted unless otherwise noted.
- L. UPS External battery Packs for 2200 or 3000 VA APC or approved equal for systems that specify extended run time such as the phone system.
- M. Power Strips
1. Raceway and all components shall be UL listed. The base and cover shall be ivory in color and shall be attached to the cable ladder of the rack system or wall field as per the drawings.
 2. Electrical outlet strip shall have (13) NEMA 5-15\20 outlets.
 3. Provide all attachment hardware required to securely attach the outlet strip to the back of the vertical cable ladder or wallfield. Refer to the detailed drawings for required locations.
 4. All power strips shall be equipped with surge protection.
 5. All power strips shall be come with adjustable mounting brackets for 2 or 4 post installation.
 6. Strips shall be 20A-120V with NEMA 5-20P on a 15-foot line cord.
 7. Install and test all outlets prior to project completion.
 8. Provide outlet strip with attached cord and 3-prong plug.
 9. All power strips shall be equipped with a long enough cord to reach the UPS units located at the bottom of the racks.
 10. All power strips will plug into UPS units unless otherwise specified. Custom length cords may be required.

2.12 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Telecommunications Main Bus Bar:
1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
 2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
 3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
- C. Comply with ANSI/TIA-607-B.

2.13 LABELING

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

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and housing when so directed by service provider.
- B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground, buried and/or aerial pathways.

3.2 TELECOMMUNICATIONS ROOMS

- A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes.
- B. The final layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room.
- C. Final configuration of the TR shall be submitted to the Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.
- D. Provide ladder rack in TR in configurations as required by final room layout.
- E. Coordinate layout of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.
- F. Coordinate the layout of TR with electrical plans and locations of electrical outlets.
- G. Layout of telecommunications equipment cabinets and racks shall provide a minimum of 36 inch aisle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.
- H. Within the various TR, coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as servers and UPS units may have special mounting requirements that need occasional coordination.

3.3 RACKS AND CABLE MANAGEMENT INSTALLATION

- A. Assemble racks and cable management per manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
- B. All racks must be attached to the floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through the raised floor tile and be secured in the structural floor below.

- C. Racks shall be grounded to the TGB using appropriate hardware provided by the contractor. The ground will meet local code requirements and will be approved by the Authority Having Jurisdiction (AHJ).
- D. In seismic areas, the rack should have additional bracing as required by building codes and the recommendations of a licensed structural engineer.
- E. Ladder rack may be attached to the top of the rack to deliver cables to the rack. The rack should not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer.
- F. The equipment load should be evenly distributed and uniform on the rack. Place large and heavy equipment towards the bottom of the rack. Secure all equipment to the rack with equipment mounting screws.
- G. Comply with NECA 1.
- H. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- I. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- J. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
 - 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
 - 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- K. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- L. Location of the communications racks and cabinets shall be finalized in the communications room or space shown on the drawings prior to installation.
- M. Locate all equipment to be installed and make certain that space is available for maintenance and service during the life of the system.
- N. Lay-out of the telecommunications equipment racks and cabinets shall provide a minimum of 36 inch aisle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.
- O. If any changes from the drawings are required, the Contractor shall submit a proposed layout of the communications room to the Engineer for approval prior to installation.

- P. Clean floor prior to installation of the communications racks or cabinets.
- Q. Coordinate with all other Contractors and ensure that the locations of all cable tray and conduits are correct and will feed the rack and or cabinet system adequately.
- R. All racks/cabinets shall be square to the walls and installed in a straight line. See the detailed drawings for exact placement.
 - 1. Use only 3/8 inch bolts and connectors when constructing the racks and associated cable ladder.
 - 2. Install vertical cable ladder to the back of each vertical organizer of each rack. When multiple racks are side by side, 1 section of vertical cable ladder can serve both racks.
 - 3. Install horizontal sections of cable ladder along the top of the rack. Attach the horizontal sections to the vertical sections as well as the horizontal section of the next rack.
 - 4. Contractor shall provide all ladder and materials for a complete cable ladder system
 - 5. Contact the Engineer prior to final placement of the racks.
 - 6. After approval of the placement of the racks, secure racks to the floor with anchors. Racks shall be secure after installation.
 - 7. Use 6 inch vertical organizers as spacers for racks. Attach racks to both sides of the vertical organizer, where multiple racks are required.
 - 8. Install unistrut "L" brackets to the bottom of the vertical cable ladder to secure the cable ladder to the floor.
 - 9. Each rack or cabinet shall have an engraved phenolic label. The label shall be self-adhesive, black with white letters. The label shall be affixed to the front and top of the rack and or cabinet so it is visible while standing in front of the racks. Label shall correspond with the designated rack label as shown on the detailed the drawings.
 - 10. Install woven ground braids between racks and cable ladder for eventual connection to the Telecommunications Ground Bar (TGB).
 - 11. Remove paint from rack where ground braid is attached to the rack or cable ladder. Use star washers for all ground connections.
- S. The communications cabinet shall be located near the wall to allow connection of the power and communications cables. See the detailed drawings for exact placement.
 - 1. The cabinet shall be located so that the front and back doors will open and are not directly facing a wall.
 - 2. The contractor shall locate the cabinets to provide sufficient space for technicians and the owner to install and maintain the equipment in the racks.
 - 3. Contact the Engineer prior to final placement of the cabinets.
 - 4. Remove paint from cabinet where ground braid is attached to the cabinet or cable ladder. Use star washers for all ground connections.
 - 5. Where multiple cabinets are to be located beside one another, do not install side panels where the cabinets are joined.

3.4 UPS

- A. Contractor is to be familiar with other specification sections where system run time is specified in the event of a power outage. It is the contractor's responsibility to configure and provide the required extended battery packs to the UPS units to meet all specified system run times.

- B. Location of the UPS units and Power strips shall be finalized in the communications room or space shown on the drawings prior to installation.
- C. Locate all equipment to be installed, and make certain that space is available for maintenance and service during the life of the system.
- D. If any changes from the drawings are required, the Contractor shall submit a proposed layout of the communications room/racks to the Engineer for approval prior to installation.
- E. Placement of UPS units shall be in the Main Equipment Room and Telecommunications closets
 - 1. All UPS units shall be rack Mounted unless otherwise noted.
 - 2. Mount UPS units on the bottom of the communications racks or cabinets.
 - 3. Mount UPS units using all Manufactures recommended and required hardware.
 - 4. Provide support between the floor and the UPS unit. Wood or Plastic blocks cut to the width of the space between the UPS and the floor shall be installed.
 - 5. Provide all programming for SNMP setup of all UPS units to Owners LAN. Provide all cards and cords for connection to the LAN.
- F. Power strips shall be installed so that they do not interfere with the cable routing, or the installation of components into the rack.
 - 1. Modular plug for the outlet strip shall be installed at the bottom of the outlet strip.
 - 2. All power strips shall plug into UPS units. UPS units shall be plugged into 1 of 2 duplex receptacles installed at the bottom of the rack. Refer to the detailed drawings for receptacle locations.
 - 3. Coil any extra cord from the outlet strip and tie wrap it to the bottom of the vertical cable ladder.
 - 4. Securely attach the outlet strips to the back edge of the vertical cable ladder or Wallfield as per detailed drawings.
 - 5. Electrical outlets are installed by others. Communications Contractor shall be responsible for connecting the power strips to the UPS unit(s) and the UPS unit(s) to the power receptacles.
- G. **FACTORY-ASSISTED STARTUP** If a factory assisted UPS start-up is requested, factory trained service personnel will perform the following inspections, test procedures, and on-site training.
 - 1. Visual Inspection:
 - a. Inspect equipment for signs of damage.
 - b. Verify installation per manufacturer s instructions.
 - c. Inspect battery modules.
- H. Mechanical Inspection:
 - 1. Check all UPS and external service bypass panel internal power wiring connections.
 - 2. Check all UPS and external service bypass panel terminal screws, nuts, and/or spade lugs for tightness.
- I. Electrical Inspection:
 - 1. Verify correct input and bypass voltage.

2. Verify correct UPS control wiring and terminations.
3. Verify voltage of all battery modules.
4. Verify that neutral and ground conductors are properly landed.
5. Inspect external service bypass panel for proper terminations.

J. Site Testing:

1. Ensure proper system start-up.
2. Verify proper firmware control functions.
3. Verify proper firmware bypass operation.
4. Verify proper bypass switch operation (where applicable).
5. Verify proper inverter operation and regulation circuits.
6. Simulate utility power failure.
7. Verify proper charger operation.
8. Document, sign, and date all test results.

K. On-Site Operational Training: During the factory assisted start-up, operational training for site personnel includes key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

L. FIELD QUALITY CONTROL

1. Manufacturer Field Service:
 - a. Worldwide Service: The UPS manufacturer has a worldwide service organization available, consisting of factory trained field service personnel to perform startup, preventive maintenance, and service of the UPS system and power equipment. The service organization offers service support 24 hours a day, 7 days a week, 365 days a year.
 - b. Replacement Parts: Parts are available through the worldwide service organization 24 hours a day, 7 days a week, 365 days a year. The worldwide service organization is capable of shipping parts within four working hours or on the next available flight, so that the parts may be delivered to the customer site within 24 hours.

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 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

- A. Standard of quality is STI. Acceptable manufactures must demonstrate product equivalency.
- B. Comply with requirements in Section 078413 "Penetration Firestopping."
- C. Comply with TIA-569-B; Annex A, "Firestopping."
- D. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.7 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-B.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.8 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements in Section 260553 "Identification for Electrical Systems."
- B. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for Class 2 level of administration including optional identification requirements of this standard.
- C. If Label Numbering Scheme already exists, this contractor shall be responsible for maintaining and extending that numbering scheme as directed by the Owner.
- D. All labeling and recording preprinted or computer-printed type.
- E. The Contractor shall be responsible for labeling all supplied communications equipment, in accordance with the guidelines as described herein.
- F. Equipment racks/cabinets shall be labeled to indicate closet designation and sequential number within each closet.
- G. On renovation projects where shall be approved by the Owner and the Engineer prior to application.

3.9 AS-BUILT DOCUMENTATION

- A. Copies of all approved shop drawings with the Engineer's stamp.
- B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operation, maintenance, and troubleshooting and product repair/replacement information.
- C. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of Owner's manuals must contain the proper software viewers for each document type.

1. Racks
2. Cabinets
3. Ladder Rack
4. Power Strips
5. Cable Tray

- D. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored markings based upon actual field conditions.
- E. AutoCAD architectural floor plans at a scale of 0.25" = 1.0" on 30x42, 24x36 size sheets showing the telecommunications equipment layout in each TR and MER. This layout shall include the racks, cable tray, conduit sleeves, 120V power, etc. Each piece of equipment where labeled in the field shall have the corresponding label on these plans. These drawings shall be as-built conditions.

3.10 WARRANTY

- A. All equipment as specified herein shall have a minimum of a one year warranty after notice of final completion.
- B. The Installing Contractor shall provide the initial warranty service of one (1) year.
- C. The extended warranty shall be provided by the manufacturer.
- D. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

END OF SECTION 271100

(This page intentionally left blank)

SECTION 271323 - COMMUNICATIONS FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 SUMMARY

- A. This section provides a project overview and general project and Contractor requirements for backbone cabling and the associated connectors, faceplates, and termination equipment.
- B. In the detailed specifications and on the contract drawings, the phrases "or equivalent," "approved equivalent," "approved equal," "or equal" and "engineer approved equivalent" shall be used interchangeably and shall mean the same thing.
- C. All equals, equivalents, or alternates shall be approved by the Engineer prior to ordering or installation. Without approval, deviation from the products listed in the specifications and on the drawings shall be presumed to be nonconforming and shall be removed and replaced at the direction of the Engineer and at the Contractor's expense.

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. EMI: Electromagnetic interference.
- D. IDC: Insulation displacement connector.
- E. LAN: Local area network.
- F. RCDD: Registered Communications Distribution Designer.
- G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

- A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects,

mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.
- C. The extent of work shall be as is shown on the drawing and detailed in these specifications.
- D. Coordinate work under provisions in Division 1 of these specifications.
- E. All fiber optic cables shall be coordinated with the installation of the telecommunications raceways and risers.
- F. Coordinate location of the spare coiled fiber cables with Owner prior to installation.

1.5 QUALITY ASSURANCE

- A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA-568.1-D, when tested according to test procedures of this standard.
- B. All work shall be installed in compliance with the latest edition of the ANSI/TIA-568, 569, 570, 606, 607, 862 Standards, BICSI Telecommunication Distributions Methods Manual (TDMM), and BICSI Customer-Owned Outside Plant Design Manual.
- C. All equipment shall be UL listed.
- D. All equipment and installation practices shall comply with the latest ANSI/NFPA-70 NEC.
- E. All equipment installation practices shall comply with the Local Electrical Code.
- F. All equipment shall comply with the latest ANSI/TIA-607-D Commercial Building Grounding and Bonding Requirements for Telecommunications Standards.
- G. All inter-building cabling shall comply with the latest ANSI/TIA-758-B Customer-Owned Outside Plant Telecommunications Cabling Standard as applicable.
- H. All inter-building cabling shall comply with the latest ANSI/ICEA s-98-688 Broadband Twisted-Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors Standard as applicable.
- I. All inter-building cabling shall comply with the latest ANSI/ICEA S-99-689 Broadband Twisted-Pair Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors Standards as applicable.
- J. IEEE 802.3-1990: (also known as ANSI/IEEE Standard 802.3-1990) or ISO 8802-3- 1990 (E), Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
- K. ANSI/TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.

- L. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- M. 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.
- N. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-E.
- O. Grounding: Comply with ANSI/TIA-607-D.

1.6 CONTRACTOR QUALIFICATIONS

- A. The Contractor (or sub-contractor) shall provide the services and equipment of a company listed by Underwriters Laboratories, Inc. in its directory as being capable of furnishing the system specified herein. Said company shall be authorized to, and shall, issue a certificate stating that the equipment and connected wiring and devices which form the specified system, together with installation and maintenance service, are in compliance with the requirements established by UL (Underwriters Laboratories) and ANSI/TIA Standards.
- B. Work shall be performed by a BICSI certified Telecommunications Contractor that is properly certified in the cabling system being installed. Contractor's requesting pre-approval from the Engineer to perform the work as specified in this section shall meet the following requirements:**
- C. The Contractor must have an on-staff, full time RCDD. The personnel assigned to project manager for this project must be a current RCDD in good standing.
- D. The personnel assigned to project foreman at the project site must be a minimum BICSI Level II certified installer.
- E. The Contractor must have at least one BICSI Level I certified installer in the daily work crew.
- F. The Contractor must hold a current certification from the manufacturer of the proposed cabling system solution. This certification must be valid for both installation and testing and shall enable the Contractor to offer the full manufacturer's product and applications warranties as specified herein.
- G. Requests for consideration shall be sent to the Construction Manager/Architect/Engineer (by mail or fax) and shall include the following:
 - 1. Copy of the BICSI RCDD certificate for the Contractor's on-staff, full time project manager.
 - 2. Copy of the BICSI Level I, II and III certificate(s) for the Contractor's on-staff, full time installation personnel. Prior to commencement of work, the Contractor shall submit the resume of personnel assigned to the project. Any approval given during bidding shall be

based upon the information submitted. Change in approved personnel prior to completion of the project shall be brought to the attention of the Engineer for review.

3. Copy of the current Voice/Data System Manufacturers Approval Certificate indicating that the Contractor COMPANY is a certified installer of the proposed voice and data Cabling System Solution. Individual technician certificates should be provided in addition to current COMPANY certificate.

- H. It will not be the responsibility of the Engineer to recognize or respond to incomplete or incorrect requests.
- I. It shall not be acceptable for any portion of the work specified herein to be performed by a sub-contractor unless such sub-contractor has been pre-approved by the Engineer in writing. Refer to following requirements:
- J. The Engineer will respond in writing to applicants who meet the requirements of this specification or to the project's construction manager. This response will serve as formal notice that the Contractor is approved for the listed project.
- K. Contractors who have not received approval from the Engineer prior to issue of formal contracts will not be approved to perform the work outlined in this specification section regardless of their qualifications.

1.7 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 1. Submit shop drawings including product data sheets and wiring diagrams per requirements in the General Conditions including the following:
 - a. A complete list of materials with model and part numbers and reference to the specification paragraph number.
 - b. A complete set of detailed manufacturers specifications describing and illustrating all standard and special components and materials.
 - c. A complete set of drawings of special items.
 - d. Illustrations and scale drawing of the system rack and special cabinets.
 - e. Drawings shall include designations, dimension, operating controls, instruments, etc.
 2. Submittals that do not contain all this required information **WILL BE REJECTED**
 3. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 4. Cabling administration drawings and printouts.
 5. Wiring diagrams to show typical wiring schematics including the following:
 - a. Patch panels.
 - b. Patch cords.
 6. Patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
 7. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.

- b. Clearances for access above and to side of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
- C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- 1. Copy of current BICSI and manufacturers certifications. Certifications that are past the expire date will not be accepted.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.8 CLOSEOUT SUBMITTALS

- A. Prior to final system commission by the Engineer/Owner/Architect, the contractor shall provide the following information for review and inclusion in the O&M manuals:
- 1. Microsoft Visio or AutoCAD floor plans at a scale of 1/8"=1'-0" on 30x42/24x36 size sheets showing the location and label of each workstation outlet, TR and MER. Labeling shall match the labeling installed in the field.
 - 2. Microsoft Visio or AutoCAD floor plans at a scale of 1/4"=1'-0" on 30x42, 24x36 size sheets showing the telecommunications equipment layout in each TR and the MER closet. This layout shall include the racks, backboards, cable tray, conduit sleeves, 120V power, etc. Each piece of equipment where labeled in the field shall have the corresponding label on these plans.
 - 3. Microsoft Visio or AutoCAD drawings showing the elevations of each telecommunications rack. The details shall indicate each piece of telecommunications equipment in each rack including equipment labels such as a patch panel, wire management panel, blank panel, space, etc. Each port of each patch panel shall be fully labeled to match the labeling installed in the field.
- B. The contractor shall also submit a copy of his valid state contractor's license and show proof that he is a factory authorized distributor of the submitted equipment and in general meets all requirements of these specifications including on-staff RCDD and BICSI Certification of project Foreman.
- C. ADOBE PDF Files of all documentation and drawings for the owners use.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.

1. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
2. Test each pair of UTP cable for open and short circuits.

1.10 PROJECT CONDITIONS

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

1.11 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Digital HVAC control system and building management systems
- C. Integrated audio/video, and video (e.g., MATV, CATV, and CCTV)
- D. Paging, public address, intercom, background music, and other audio
- E. Electronic/digital signage
- F. Internal cellular and paging
- G. Access control, electronic surveillance, intrusion detection, detection and alarm, and personal protection
- H. Coordinate the service entrance arrangement with the service providers.
- I. Coordinate with the electrical contractor for pathways and spaces.

PART 2 - PRODUCTS

2.1 STRUCTURED CABLING SYSTEM

- A. The entire voice/data backbone cabling solution shall be a listed ANSI/TIA cabling system solution from a single Manufacturer/Source or approved exclusive partnership between cable and connectivity manufacturers (ie Legrand / Superior Essex)
- B. Indoor backbone cabling shall be plenum rated.
- C. Outdoor and underground backbone cabling shall be OSP rated.

2.2 MANUFACTURER

- A. Legrand/Superior Essex
- B. Leviton/Berk-Tek
- C. Panduit/Belden
- D. Siemon

2.3 PATHWAYS

- A. Refer to Section 270528 for further details.
- B. General Requirements: Comply with ANSI/TIA-569-E.
- C. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - 1. Support brackets with cable tie slots for fastening cable ties to brackets.
 - 2. Lacing bars, spools, J-hooks, and D-rings.
 - 3. Straps and other devices.
- D. Cable Trays:
 - 1. Refer to Section 270536 for further details.
 - 2. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inches (0.012 mm) thick or hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inches (0.055 mm) thick.
 - a. Basket Cable Trays: 18 inches wide by 4 inches high. Wire mesh spacing shall not exceed 2 by 4 inches.
 - b. Ladder Cable Trays: Nominally 18 inches (455 mm) wide, and a rung spacing of 12 inches (305 mm).
- E. Conduit and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.]
 - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.4 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.
- B. All backboards shall be painted with white fire retardant paint.

2.5 OPTICAL FIBER CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Acceptable manufactures must demonstrate product equivalency.
1. Berk-Tek; a Nexans company.
 2. CommScope, Inc.
 3. Corning Cable Systems.
 4. Superior Essex Inc.
 5. Siemon
- B. All fiber strands shall be surrounded by synthetic yarn for added strength and crush resistance.
- C. All fiber shall be UL listed OFNP.
- D. The outer jacket of the cable shall be surface printed with the manufacturer's identification and required UL markings.
- E. All fibers shall be subjected to a minimum fireproof stress of 0.7 GPa (100 kpsi).
- F. The minimum bend radius of the cable under full rated tensile load shall be no larger than 15 times the outside diameter of the cable and no more than 10 times the outside diameter of the cable with no load on the cable.
- G. Optical and mechanical performance shall not be degraded and the cable shall not be damaged in any way by immersion in ground water.
- H. The fiber optic cable shall meet or exceed the requirements of this specification when measured in accordance with the methods of the individual requirements or the following methods as defined in EIA-STD-RS-455.
1. Fiber dimensions.
 2. Attenuation.
 3. Bandwidth.
 4. Numerical aperture.
 5. Fiber proof test.
 6. Cable bending.
 7. Tensile load
 8. Impact resistance.
 9. Crush resistance.
 10. Attenuation vs. temperature.
- I. Manufacturer shall provide ISO 9001 certification.
- J. The cable shall withstand an impact force 1500 times per ANSI/TIA/EIA-RS-455 (FOTP- 25A).
- K. The cable shall withstand compression load of 2200 N I cm per ANSI/TIA/ EIA-RS-455 (FOTP-41A).

- L. Fiber shall be plenum-rated based on the areas in which the fibers will be installed. Contractor shall be responsible for identifying if fiber cable shall be riser or plenum rated, and installing the correct fiber.
- M. Distribution (DX) type fiber is for interior connections.
 - 1. The cables shall consist of tight buffered optical fibers surrounded by a synthetic yarn strength member and a color-coded flame retardant elastomeric polymer jacket. The strength member shall be composed of individually and precisely tensioned elements such that tensile loads are equally shared by each element.
- N. See the Detailed drawings for fiber quantities and locations.

2.6 OUTDOOR SINGLEMODE FIBER OPTIC CABLE REQUIREMENTS:

- A. Provide a singlemode fiber optic cable between the MER of the network center and each associated building's MER.
- B. The singlemode fiber cable shall be 8.3/1.0 micron.
- C. The singlemode fiber shall be gel-filled or indoor/outdoor rated, tight-buffered cable installed in underground duct banks or aerially between buildings.
- D. If the fiber cable shares the duct bank with other cables, install an inner-duct.
- E. The singlemode fiber shall be a minimum of 12 strands between buildings.
- F. The singlemode fibers shall be terminated with fusion-spliced, factory-polished LC pigtails capable of 10 Gbps operation.
- G. Angle-Polished Connectors (APC) shall be utilized on all singlemode fibers used to support AM Video (CATV, etc.) applications.
 - 1. Singlemode fibers must meet the following minimum requirements:
 - a. Core/Cladding Diameter
 - b. 8.3/1.0 um
 - c. Maximum Attenuation
 - 1) 1310nm 1.0 dB/km
 - 2) 1550nm 0.75 dB/km
 - d. Support of IEEE 802.3z 5000m
 - e. Maximum dispersion (1300 nm) <3.2 ps/nm-km
 - f. Maximum dispersion (1500 nm) <18 ps/nm-km
 - g. Tension Rating 600 lbs.
 - h. Outdoor shall be dual OFNP/OSP rated.
 - 2. Provide a maintenance loop at the termination point. Consult the cable manufacturer for the recommended loop radius.
 - 3. Each cable shall be labeled on both ends and at all accessible points. Coordinate labeling scheme with A/E.
 - 4. Refer to drawings for quantities and locations.

2.7 INDOOR SINGLEMODE FIBER OPTIC CABLE SYSTEM

- A. Provide a singlemode fiber optic cable between the MER and each associated TR.
- B. The singlemode fiber cable shall be 8.3/1.0-micron fiber.
- C. The singlemode fiber shall be a minimum of 12 strands per TR to MER.
- D. The singlemode fibers shall be terminated with fusion-spliced, factory-polished LC pigtails capable of 10 Gbps operation.
- E. Angle-Polished Connectors (APC) shall be utilized on all singlemode fibers used to support AM Video (CATV, etc.) applications.
- F. Singlemode fiber must meet the following minimum requirements:
- G. Singlemode fiber with di-electric strength members 2.9mm, heavy duty, with individual jackets for easy connectorization, Fan-Out cable plenum rated with overall jacket.
- H. Singlemode cable shall meet the following requirements:
 - 1. Core/Cladding Diameter 8.7/1.0 um
 - 2. Maximum Attenuation
 - a. 1310nm 1.0 dB/km
 - b. 1550nm 0.75 dB/km
 - 3. Support IEEE 802.3z 5000m
 - 4. Maximum Dispersion
 - a. 1310nm <3.2 ps/nm-km
 - b. 1550nm <18 ps/nm-km
- I. Provide a 3 meter maintenance loop at the termination point. Consult the cable manufacturer for the recommended loop radius.
- J. Cable shall be labeled on both ends and at all accessible points where the cable can be administered. Coordinate labeling scheme with A/E.
 - 1. Refer to the drawings for quantities and locations.
 - 2. All fiber to be installed in plenum inner-duct.
 - 3. Comply with ICEA S-83-596 for mechanical properties.
 - 4. Comply with ANSI/TIA-568-C.3 for performance specifications.
 - 5. Comply with TIA/EIA-492AAAA-B for detailed specifications.
- K. Jacket:
 - 1. Jacket Color: Aqua for 50/125-micrometer cable.
 - 2. Jacket Color: Yellow for singlemode fiber.
 - 3. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
 - 4. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.8 OPTICAL FIBER CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Acceptable manufactures must demonstrate product equivalency.
1. Berk-Tek; a Nexans company.
 2. Corning Cable Systems.
 3. Legrand
 4. Leviton.
 5. Hubbell
 6. Siemon
- B. FIBER PATCH PANELS
1. Fiber patch panels shall be mounted in equipment racks, and shall be 24/48/72/144 port as required.
 2. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner. Provide each patch panel fully loaded. Each connected port to be labeled as coordinated with Owner. Refer to drawings for locations of rack mounted patch panels.
 3. Provide quantity of fiber patch panels to accommodate complete termination of all installed fiber backbone strands.
 4. All fiber strands to be terminated on fusion spliced, factory polished pigtailed. Fusion splice shall be core-alignment type.
 5. Provide APC type couplers for singlemode cables.
 6. Rack mount fiber patch panels shall be modular in design.
 - a. Mounting brackets shall be provided for 6 pack, 9 pack, 12 pack and 15 pack adapters high-density
 - b. Adapter packs shall sit horizontally in the panel.
 7. Patch Panel shall mount into standard 19 inch relay racks.
 8. Patch panel shall include:
 - a. Quick release hatches on front cover.
 - b. Tinted removable Plexiglas cover.
 - c. Black powder coat finish.
 - d. Adaptor Panels shall be yellow in color for Singlemode fibers.
 - e. Adaptor Panels shall be duplex LC type.
- C. FIBER CONNECTORS
1. 12 strand pigtailed
 2. Terminate singlemode fibers with factory-terminated angle polished APC singlemode pigtailed. Match fiber cable type provided.
- D. FIBER SPLICE TRAYS
1. Provide fiber fusion splice trays for connecting the factory terminated APC pigtailed to the associated singlemode fibers.
 2. Rack Mount Fiber Splice Enclosures and Splice Trays.
 - a. Enclosures shall be either 1 RU or 2 RU.
 - b. Enclosures shall accommodate the required amount of splice trays to fusion splice all fibers as per the drawings.
 - c. 12 fiber fusion tray or 24 fiber fusion tray
 3. Wall Mount Fiber Optic patch panel Interconnect Center.

- a. Enclosures shall include:
 - 1) Fiber Splice trays.
 - 2) Black powder coat finish.
 - 3) Lockable Doors.
 - 4) Enclosures shall be able to support 1-4 adaptor plates. Provide enclosure capable of housing the required amount of fibers as per the drawings.

- E. Patch Cords: Factory-made, dual-fiber cables in 1-3m lengths with reverse polarity uni boots
 - 1. This contract shall be responsible for providing all required patch cables to make a complete and fully functioning network. The following patch cables requirements are considered part of these specifications:
 - 2. Data Backbone - Provide three (3) 2-meter 2 strand fiber jumper cables at each termination point for each fiber backbone cable. Coordinate jumper type and length with Owner.

- F. Cable Connecting Hardware:
 - 1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with ANSI/TIA-568.3-D.
 - 2. Insertion loss not more than 0.75 dB. Coordinate with Owner.
 - 3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.9 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with ANSI/TIA-607-D.

2.10 IDENTIFICATION PRODUCTS

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

2.11 SOURCE QUALITY CONTROL

- A. Factory test cables on reels according to ANSI/TIA-568.1-D.
- B. Cable will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Refer to drawings for quantity and arrangement of backbone cabling system.
- B. Make all backbone terminations at TR termination equipment at each end utilizing a tool appropriate for the equipment as recommended by the equipment manufacture.
- C. Coordinate all cable and termination equipment color requirements with Owner/Engineer. Color coding shall be consistent for all like equipment.
- D. Data backbone cables shall be handled and installed with extreme care. Hook and loop shall loosely hold cables; do not overtighten. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less than 10 times the outer diameter of the cable. The cable manufacturer's recommended bending radius and maximum pulling tensions shall be strictly adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.

3.2 INSTALLATION

- A. The Contractor shall be familiar with the location(s) where the work will be done. No additional compensation will be made for items the Contractor claims he was not aware of during bidding.
- B. Work Area:
 - 1. All work areas shall be cleaned at the end of each day. All debris shall be cleaned and removed from the site and disposed of in the approved container for the site.
 - 2. All equipment shall be moved out of common areas and stored in the Contractor's lay down area, or in other approved storage locations on site.
 - 3. Any work that is low hanging, or may otherwise impede the general use of the space, and cannot be removed, shall be flagged and cordoned off by the Contractor.
- C. All equipment and parts shall be installed in a neat and workmanlike manner. Standards compliant installation practices shall be used throughout the project.
- D. All cables routed above the drop ceiling or in the ceiling area shall be installed square to the building.
- E. All cut edges of conduits, boxes, raceway, etc., shall be trimmed and filed so that no burrs or rough edges will damage cable as it is installed.
- F. All surface raceways, including conduits in exposed areas shall be painted to match the existing colors of the surrounding area.
- G. If in the course of the work, the Contractor damages, marks, or misplaces any ceiling tiles, the Contractor shall repair, and/or replace the ceiling tile to the original condition.

1. The Engineer shall decide if ceiling tiles have been damaged. Based on the Contractors proposed fixes, the Engineer shall decide the best course of action to repair any damage done by the Contractor to the ceiling tiles.
- H. It shall be the responsibility of the Contractor to repair any damage done to the structure or finishes in the building by the Contractor. The building shall be returned to its original condition prior to final sign off of the project.
- I. Where specifically permitted for cabling to be run in J-hook / cable management system above accessible ceiling, wiring shall be run as high as possible above piping and ductwork, so as to not interfere with mechanical trades, access to mechanical and electrical devices, and to allow freedom to remove ceiling panels. Cables shall not run next to electrical conduits or within 5” of lighting fixtures utilizing electronic ballasts. Cables shall be run in continuous lengths, without splices. Cabling lying on top of the ceiling grid will not be acceptable. J-hooks / cable management system shall be sized to provide 100% growth of supported cables.
- J. Where cables are installed open wired through the use of J-Hooks/cable management systems, they shall be installed such that there is minimum sag of 4 inches for every 4 foot of horizontal run.
- K. Where backbone cables are installed in conduit, the conduit system shall conform to the following:
 1. No section of conduit shall be longer than 100 feet between pulling points.
 2. No more than two 90 deg. Bends in a section of conduit between pulling points.
 3. Each section of conduit shall be labeled for length, destination closet and origination closet.
 4. Refer to ANSI/TIA 569-E for specific conduit and pull box requirements.
- L. Backboard mounted wiring connecting blocks shall be mounted such that the top of block is no more than 72 inches from the floor and the bottom of lowest block is no lower than 30 inches from the floor.
- M. Each TR shall be provided with a Telecommunications Ground Bar (TGB). In Addition, the MER shall be provided with the Main Telecommunications Ground Bar (TMGB). The TMGB shall be bonded to the building Electrical System Ground and shall be bonded to one additional building electrical system ground (such as building steel). Provide a Telecommunications Bonding Backbone (TBB) from the TMGB to each TGB. The TBB shall be routed with the backbone cabling. Ground all backbone cable sheaths, shield drain wires from all voice/data horizontal cable, equipment racks and equipment to the local TGB / TMGB. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607-D.
- N. Backbone cable shall be identified and labeled on the blocks and patch panels. Both ends of data and telephone system cabling shall be tagged and identified utilizing a Brady or or similar cable marking system as approved by the Owner / Engineer. Hand written labels WILL NOT BE ACCEPTED.
- O. Patch cables from data patch panels to network electronic equipment shall be provided by this Contractor.
- P. Examine all pathways prior to installation of fiber cable.

- Q. Identify location of racks, and position of fiber patch panels prior to fiber installation.

3.3 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.4 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.5 INSTALLATION OF PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA-569-E.
- B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.
- C. Comply with ANSI/TIA-569-E for pull-box sizing and length of conduit and number of bends between pull points.
- D. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- E. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- F. Pathway Installation in Communications Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - 2. Install cable trays to route cables if conduits cannot be located in these positions.
 - 3. Secure conduits to backboard when entering room from overhead.
 - 4. Extend conduits 3 inches above finished floor.

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.6 INSTALLATION OF CABLES

- A. Comply with NECA 1.

- B. General Requirements for Cabling:

1. Comply with ANSI/TIA-568.1-D.
2. Comply with BICSI ITSIM, Ch. 6, and "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, and "Pulling Cable." Monitor cable pull tensions.

- C. Optical Fiber Cable Installation:

1. Comply with ANSI/TIA-568.3-D.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
3. Inspect fiber cable prior to installation for damage during shipping. The Contractor shall be responsible for all damaged or nonfunctional fiber cables. If any strands of a fiber cable are not working, the Engineer has the right to order the complete replacement of the entire fiber cable.
4. Contractor shall designate the location of the spare coil of fiber at each end of the run prior to installation.
5. Installation of fiber cable shall be by a trained installer.
6. All fiber, if not installed inside cable tray, shall be attached to the building structure with conduit clamps or supports a minimum of every 5 feet.
7. Fiber shall be continuous from end to end, no splices are allowed unless specifically noted.
8. At each termination point of the fiber, the Contractor shall provide a service coil consisting of 30 feet of fiber cable. This coil shall be stored on the wall in a stowage ring.

9. Contractor shall adhere to all manufacturers' recommended pull tensions during installation.
 10. As part of the as-built drawings, provide the actual footage of each fiber cable installed. Mark this on the drawings.
 11. Any fiber strands that do not pass a sufficient signal light signal will be identified as noncompliant, and the Engineer has the right to order the complete replacement of the fiber cable by the Contractor.
 12. Where fiber cable passes vertically through a building, the fiber cable shall be supported against the wall a minimum of every 4 feet.
 13. Do not exceed recommended bend radius of fiber cable during or after installation.
- D. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- E. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
 2. Install cabling after the flooring system has been installed in raised floor areas.
 3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.
- F. Group connecting hardware for cables into separate logical fields.
- G. Fiber patch panels shall be located at the top of the relay rack or cabinet at which they are installed.
1. Provide patch panels as described on the contract drawings or additional panels as required to terminate all fiber strands of all fiber cables. Blank Adaptor Panels shall be used to fill any unused openings.
 2. Install fiber panels in the top of the rack, and install them in the rack closest to the wall.
 3. A splice shelf is required for splicing of singlemode fibers, install the shelf directly below the associated patch panel.
 4. Route fiber cable into side of the panel.
 5. The sheath of the fiber cable shall extend to the side of the panel. Individual fibers or subgroups shall not be seen outside of the panel, except for the single mode bundles.
 6. Fibers shall be installed in the adapter packs in color code order. For vertical mounted 6 pack adapters, top to bottom then left to right. In panels where the couplers are horizontally mounted, left to right for each 6 pack, then top to bottom. Contact the Engineer with any questions.
 7. All individual fiber strands shall be neatly installed in the back of the panel after termination. Provide a minimum of 4 feet of spare fiber in the back of each panel. This spare shall be coiled in a Figure 8.
 8. All fibers shall be neat and orderly.
 9. Label the fiber cable just outside of the fiber panel with a yellow fiber optic cable label.
 10. Secure the fiber to the entrance of the patch panel with tie wraps.
 11. After installation and termination of the fiber cable, install labels on the patch panel showing what strand each connector is connected to, and where the overall fiber cable is terminated at the other end.

12. Attach a self-adhesive clear plastic sleeve to the inside of the Plexiglas cover of the panel. Slide in a laser printed label showing all information about the fiber cable.
13. The figure below demonstrates the layout of the fiber panel label. Each label shall be customized for each individual panel. The figure below is for the 72 port panel.
14. Contact the Engineer with questions on the correct labeling prior to installation.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and ANSI/TIA-569-E recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.7 TELECOMMUNICATIONS ROOMS

- A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes.
- B. The final layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room.
- C. Final configuration of the TR shall be submitted to the Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

- D. Provide ladder rack in TR in configurations as required by final room layout.
- E. Coordinate layout of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.
- F. Coordinate the layout of TR with electrical plans and locations of electrical outlets.
- G. Layout of telecommunications equipment cabinets and racks shall provide a minimum of 36 inch aisle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.
- H. Within the various TR, coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as servers and UPS units may have special mounting requirements that need occasional coordination.

3.8 FIRESTOPPING

- A. Standard of quality is STI, Acceptable manufactures must demonstrate product equivalency.
- B. Comply with requirements in Section 078413 "Penetration Firestopping."
- C. Comply with ANSI/TIA-569-E; Annex A, "Firestopping."
- D. Comply with BICSI TDMM, "Firestopping Systems" Article.
- E. Firestopping is required at all riser conduits, and all pass-thru. All firestopped locations should comply with a corresponding UL system to verify the accuracy of the installation. UL systems should be a part of the submittal process.
- F. Each cable tray penetration of a wall shall be firestopped after cable installation. Use pillow type firestop to allow additional cables to be installed in the future.
- G. Where riser conduits pass through floors, the area between the concrete and the conduit shall be firestopped. This shall be completed with a putty or liquid firestop product. Fill in the space with mineral wool, and then install the firestop on top. All firestop shall be of sufficient thickness to secure the rating required by code.
- H. After final cable installation, install a putty firestop around all cables where they enter and exit conduit pass-thru's and conduit risers.
- I. All firestop shall be installed to provide the fire rating as described by local fire code.
- J. It shall be the responsibility of the Contractor to verify that all conduits, walls, and raceways required to be firestopped have been firestopped.

3.9 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

- B. Comply with ANSI/TIA-607-D
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.10 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with ANSI/TIA-606-C. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with ANSI/TIA-606-C for Class 2 level of administration including optional identification requirements of this standard.
- D. Comply with requirements in Section 271500 "Communications Horizontal Cabling" for cable and asset management software.
- E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, and entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- G. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

- a. Individually number wiring conductors connected to terminal strips and identifies each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA 606-C, for the following:
1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. The Contractor shall be responsible for testing all installed structured cables.
- C. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted. All final test reports shall utilize that field installed labels at each outlet for the test of the corresponding outlet. Test reports which contain temporary generic or incorrect labels will not be accepted.
- D. Tests and Inspections:
 1. Visually inspect 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.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- E. Fiber Optic Testing Manufactures:
 1. JDSU
 2. Fluke.
- F. Fiber Optic Tester:
 1. Fiber optic cable shall be tested with a light power meter.
 - a. Multi-mode at 850nm and 1300nm, and single mode at 1310nm and 1550nm shall be tested by the OTDR.
 - b. Power meter testing shall have a range of +20 dBm.
 - c. Testing at both wavelengths shall appear on the readout at one time for single mode.
 - d. All connector types shall be available for testing.
 - e. Resolution of testing shall be to 1 foot.
 2. All fibers shall be tested prior to any splice (other than pigtailed) being closed and secured.

3. Contractor shall have a minimum of 3 years of experience installing and testing fiber optic cabling systems.
 4. Unless otherwise specified, single mode fiber cable must meet the transmission performance parameters as specified in ANSI/TIA/EIA-568.3-D.
 5. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years of experience in producing field test equipment. Manufacturers must be ISO 9001 certified.
 6. Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA/EIA-526-7 Method A, "Measurement of Optical Power Loss of Installed Single Mode Fiber Cable Plant, Insertion Loss Using an Optical Power Meter.
 7. Traces and records shall be provided to the Engineer and Owner in hard (paper) and soft (disk) copy.
- G. Testing shall be completed after fiber is installed inside the fiber patch panel and the fiber panel has been put together.
- H. All tests of the terminated, installed fiber cable shall be done with a light meter.
1. The light meter test shall be done to show the loss of signal along each section of the fiber cable.
 2. Calibrate the light meters through 2 patch cords connected via a coupler before testing installed fiber cable.
 3. Light meter results for single mode shall be provided at the 1310 and 1550 nm wavelength.
 4. Testing shall be of the optical link. An optical fiber link is defined as the passive cabling network between 2 optical cross connects (patch panels or outlets). This includes cable, connectors, and splices but does not include active components. The link test contains the representative connector loss at the patch panel associated with the mating of patch cords but does not include the performance of the connector at the equipment interface.
 5. Test reports shall include the following information for each cabling element tested:
 - a. Actual measured and maximum allowable attenuation (loss) at the specified wavelengths per Part 2, Section 3, (ANSI/TIA/EIA-568-8.3) and the margin. An individual test that fails the link criteria shall be marked as FAIL.
 - b. Reference method.
 - c. Number of mated connectors and number of splices (if any).
 - d. Actual length and maximum allowable length per Part 2, Section 3
 - e. (ANSI/TIA-568.3-D). Any individual test that fails the link length criteria shall be marked as FAIL.
 - f. Group refractive index (GRI) for the type of fiber tested, if length was optically measured.
 - g. Tester manufacturer, model, serial number, and software version.
 - h. Circuit ID number and project/job name.
 - i. Link criteria (autotest) used.
 - j. Overall pass/fail indication.
 - k. Date and time of test.
 6. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568.1-D. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- I. 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.

- J. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- K. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- L. Prepare test and inspection reports.

3.12 AS-BUILT DOCUMENTATION

- A. Copies of all approved shop drawings with the Engineer's stamp.
- B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operation, maintenance, and troubleshooting and product repair/replacement information.
- C. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of Owner's manuals must contain the proper software viewers for each document type.
- D. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored markings based upon actual field conditions.
 - 1. AutoCAD architectural floor plans at a scale of 0.25" = 1.0" on 30x42, 24x36 size sheets showing the showing the routing of all backbone cables between communications equipment rooms. Labeling shall match the labeling installed in the field. These drawings shall be as-built conditions.
 - 2. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configurations, device locations and cable types.
 - 3. Rack and wall elevations for all backbone cable termination systems. The details shall indicate each piece of telecommunications equipment in each rack including equipment labels such as patch panel, wire management panel, blank panel, space, etc. Each port of each patch panel shall be fully labeled to match the labeling installed in the field.
- E. Cable Test Results—provide bound documents of all cable test results in printed format and in software version on a CD. Software version must include any required reader software where file formats are proprietary or non-standard text files. Cable test results shall be organized by type (data, voice) and by closet. Information must be included in O&M Manuals.
 - 1. Fiber Test Results—the raw information which is generated from these test methods will be compiled, organized and presented as an indication of the installed fiber optic network's compliance to specifications and overall quality. These test results shall be included in the O&M manuals.
 - 2. Single-mode fiber test results—provide an end-to end attenuation test at 1310nm and 1550nm for all singlemode fiber optic cable links after installation and terminations. The dB loss test shall be performed in accordance with EIA/TIA-526-7; "Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant". Provide a hard copy of

the test results to the Owner. Each optical fiber cable and jack shall be electronically verified based upon the following criteria:

- a. Continuity Test
 - b. Insertion Loss Test
 - c. Return Loss Test
 - d. Optical Time Domain Reflectometer (OTDR)
 - e. Bandwidth Certification or Link Confidence Testing (LCT)
3. Create a detailed record sheet for each backbone cable. Record shall indicate connection rack/backboard, patch panel/cross-connect, and jack/port, at both ends for each cable within each backbone cable assembly. Provide with O&M Manuals.
 4. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials as described herein. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.
- F. Create a detailed record sheet for each backbone cable. Record shall indicate connection rack/backboard, patch panel/cross-connect and jack/port, at both ends for each cable within each backbone cable assembly. Provide with O&M Manuals.

3.13 WARRANTY

- A. The entire technology wiring system as specified herein shall be guaranteed against defects in workmanship and materials for a period of TWENTY (20) years warranty. Period shall commence after system has been commissioned by the Owner, Engineer and Owner/Architect. The Installing Contractor shall provide the warranty service. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.
- B. The entire fiber backbone cabling system warranty shall be a listed cabling system solution from a single manufacturer/source. The system shall carry an industry standard, performance based warranty, by the manufacturer, for a period of at least 20 years on the horizontal cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of one year from date of substantial completion.

3.14 CERTIFICATION

- A. The contractor shall be responsible for filing all required paperwork on behalf of the Owner to acquire the system performance warranty and certification as outlined in the Structured Cabling System Solution.
- B. Project final completion will be pending delivery of manufacturer's warranty certificate.

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All provisions of the Division 00 and Division 01, apply to all work in Division 27

1.2 SUMMARY

- A. Section Includes:

1. UTP cabling.
2. Audio/Video cabling.
3. Cable connecting hardware, patch panels, and cross-connects.
4. Telecommunications outlet/connectors.
5. Cabling system identification products.
6. Cable management system.

- B. Related Requirements:

1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Section 270525 "Fire Stopping"
3. Section 270526 "Grounding and Bonding"
4. Section 270528 "Pathways"
5. Section 270529 "Hangers and Supports"
6. Section 270526 "Cable Trays"
7. Section 270544 "Sleeves"
8. Section 270533 "Identification"
9. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 SCOPE OF WORK

- A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings. Work shall consist of

1. Work area outlets including faceplates, jacks (voice, data, CATV, A/V), and labels. Boxes and conduit are being provided by Div 26 contractor.
2. Voice and data copper station cabling from workarea outlets to telecommunications rooms including termination testing and labeling.
3. Voice and data work area equipment cords.
4. Voice and data horizontal cross-connect jumpers and patch cables including labeling.

- B. System Description

1. Voice and Data station cabling (copper) system shall consist of:
 - a. Workstation outlet jacks.
 - b. Voice and data station cabling as specified herein from each workstation outlet to the termination equipment located in the Local Telecom Closet (TR-0X) or the Main Telecom Room (ER).
 - c. Station Cable Termination Equipment in each TR.
 - d. Final connections of the station cabling at the workstation outlet jack and the termination equipment in each TR.
 - e. Cross connects / patch cable to connect work area outlets to backbone / network electronics.
 - f. Testing and labeling.

1.4 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- D. EMI: Electromagnetic interference.
- E. IDC: Insulation displacement connector.
- F. LAN: Local area network.
- G. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.
- H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
- I. RCDD: Registered Communications Distribution Designer.
- J. UTP: Unshielded twisted pair.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.6 QUALITY ASSURANCE

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

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
- B. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standards ANSI EIA/TIA 568, 569, 606, & 607, 862.
- C. All equipment and installation practices shall comply with the latest BICSI Telecommunications Distribution Methods Manual (TDMM) and BICSI Customer-Owned Outside Plant Design Manual (OSDM) Standards and applicable National Electric Code Sections.
- D. All equipment shall comply with the latest ANSI/TIA 607-B Commercial Building Grounding and Bonding Requirements for Telecommunications Standard.
- E. All equipment shall be UL listed.
- F. All equipment and installation practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- G. All installation practices shall comply with the local electrical code.
- H. All The Contractor (or sub-contractor) shall be a member of Building Industry Consulting Service International (BICSI) and have a Registered Communication Distribution Designer (RCDD) status.
- I. The Contractor (or sub-contractor) shall provide the services and equipment of a company listed by Underwriters Laboratories, Inc. in its directory as being capable of furnishing the system specified herein. Said company shall be authorized to, and shall, issue a certificate stating that the equipment and connected wiring and devices which form the specified system, together with installation and maintenance service, are in compliance with the requirements established by Underwriters Laboratories and EIA/TIA Standards.
- J. Work shall be performed by a BICSI certified Telecommunications Contractor. Telecommunications Contractors (or sub-contractors) that wish to be considered for this project shall have an on-staff RCDD. Proof of this shall be presented in writing by the winning contractor to the Owner/Architect/engineer prior to contract signing. It shall not be acceptable for any portion of the work specified herein to be performed by a sub-contractor unless such sub-contractor has been pre-approved by the Owner/Architect in writing.
- K. BICSI Certification shall include the following:
1. Copy of the BICSI RCDD certificate for the Contractor's (or sub-contractor) on-staff, full time project manager.
 2. Copy of the BICSI Apprentice, Installer or Technician certificate(s) for the Contractor's on-staff, full time installation personnel. Prior to commencement of work, the Contractor (or sub-contractor) shall submit the resume of personnel assigned to the project. Any approval given during bidding shall be based upon the information submitted. Change in approved personnel prior to completion of the project shall be brought to the attention of the Engineer for review.

3. Copy of the current Voice/Data system Manufacturers Approval Certificate indicating that the contractor COMPANY is a certified installer of the proposed voice and data cabling equipment/Cabling System Solution. Individual technician certificates should be provided in addition to current COMPANY certification.
- L. It shall not be acceptable for any portion of the work specified herein to be performed by a Subcontractor unless such sub-contractor has been pre-approved by the Engineer in writing. Refer to the following requirements:
 1. The Engineer will respond in writing to applicants who meet the requirements of this specification or to the project's construction manager. This response will serve as formal notice that the Contractor is approved for the listed project.
 2. Contractors who have not received approval from the Engineer prior to issue of formal contracts will not be approved to perform the work outlined in this specification section regardless of their qualifications.
- M. Copy of the Voice/Data system Manufacturers Approval Certificate indicating that the contractor is a certified installer of the proposed voice and data cabling equipment/Cabling System Solution.

1.7 WIRING METHODS

- A. The entire voice/video and data horizontal station cabling solution shall be a listed ANSI/EIA/TIA, Link configuration for voice and Link/Channel configuration for data, cabling system solution from a single Manufacturer/Source as required by the Manufacturer/Source.
- B. All cables shall be run in conduit from outlet to above accessible ceiling.
- C. Horizontal (station) cable shall be plenum rated. Backbone cabling shall be plenum rated.
- D. J-hooks/cable management system where specifically allowed shall be installed on 5 Foot centers and supported from structure as required by the manufacturer.
- E. Refer to drawings for quantity and arrangement of voice/data/technology outlets including Connectors and cabling.
- F. All connecting equipment shall be from the same manufacturer.

1.8 SHOP DRAWINGS AND SUBMITTALS

- A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Blue-line drawings shall be prepared and submitted electronically. Equipment lists, data sheets, etc. Shall be properly bound into a PDF.
- B. Submit to the following for approval:
 1. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item.
 2. Manufacturer's data sheets on all equipment items.
 3. System block diagram(s)
 4. Equipment rack layouts showing all rack mounted equipment items.

5. Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.
- C. Final Documentation: All final documentation shall be submitted and approved before final acceptance by the Owner will be granted. Within 45 days after completion of the work, deliver to the Owner, electronic set of the following:
1. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers and quantities of each item.
 2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts and other designations and coding.
 3. Complete equipment rack layouts showing all rack mounted equipment items.
 4. Operations instructions for each major item of equipment furnished.
 5. Manufacturer's warranty for each major item of equipment furnished.
 6. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.
- D. Samples: For workstation outlets, Connectors, Connector assemblies, in specified finish one for each size and outlet configuration.

1.9 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Patch-Panel Units: One of each type.
 2. Connecting Blocks: One of each type.
 3. Device Plates: One of each type.
 4. Multiuser Telecommunications Outlet Assemblies: One of each type.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
1. Test each pair of UTP cable for open and short circuits.

1.11 WARRANTY

- A. The entire technology wiring system as specified herein shall be guaranteed against defects in workmanship and materials for a minimum period of TWENTY (20) year warranty. Period shall commence after system has been commissioned by the Owner, Engineer and Owner/Architect. The Installing Contractor shall provide the warranty service. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 - 1. TIA/EIA-568-C.2 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
 - 4. Splitters shall not be installed as part of the optical fiber cabling.
- B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.
- D. Horizontal cabling systems shall be Link configuration for voice and Link configuration for data.
- E. Horizontal cable shall be plenum rated.
- F. Voice/Data station cabling shall be terminated utilizing EIA/TIA 568 standards.
- G. Cables installed in underground conduits shall be wet label rated. Where wet label cables are required to feed floor boxes, the contractor shall transition cable back to plenum rated cable be providing "consolidation point" above ceiling consisting of Category Rated 110 block and plenum enclosure and make transition from wet label cable to indoor plenum rated cable. Transition shall not affect system warranty.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-C.2 when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with ANSI/TIA-607-B.

2.3 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.
- B. All backboards shall be painted with fire retardant white paint.

2.4 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Standard of quality is Superior Essex CAT 6 and CAT 6A (wireless only) Datagain. Acceptable manufactures must demonstrate product equivalency.
 - 1. Superior Essex Inc.
 - 2. Berk-Tek; a Nexans company.
 - 3. Belden
- B. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic Connectoret.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-C.2 for performance specifications.
 - 3. Comply with ANSI/TIA-568-C.2 Category 6 or 6A (for wireless only).
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
- C. Category 6 or 6A (for wireless only, 4 pair, shielded or non-conductive isolation wrap on cable (non-continuous shield), rated for 350 MHz for CAT 6 and 650 MHz for CAT 6A. Cable shall be sequentially marked at 2 foot intervals. Acceptable manufactures must demonstrate product equivalency.
- D. Each cable shall be a dedicated home run from the workstation outlet jack to the data termination equipment in the local TR. Terminate cable at the workstation and at the TR termination equipment as specified herein and as indicated on the drawings.
- E. Cable shall be labeled at both ends to indicate patch panel and port served. Coordinate labeling scheme with Owner and submit to Engineer for review.
- F. Cable Color:
 - 1. Data—Blue
 - 2. Voice—Blue
 - 3. Wireless--Green

2.5 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements. Standard of quality is Legrand / Ortronics CAT 6 and CAT 6A (for wireless). Acceptable manufactures must demonstrate product equivalency.

- a. Legrand/Ortronics
 - b. Leviton
 - c. Panduit
 - d. Siemon
2. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
 3. Connecting Blocks: 110-style IDC for Category 6 and 6A (for wireless only.) Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and Connectors where indicated.
 4. Number of Terminals per Field: One for each conductor in assigned cables.
- B. Connectors and Connector Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

2.6 WORK AREA CONNECTORS

- A. Data: Color shall be Gray (Standard of quality is Legrand/Ortronics Keystone CAT 6 and 6A, Acceptable manufactures must demonstrate product equivalency).
1. Shall be CAT 6 and 6A (for wireless only) rated, 8 position, 8 wire flush mounted modular Connector (RJ-45), T568/B coded.
 2. Each Connector shall be an individually constructed unit and shall snap mount in an industry standard keystone opening (.760 inches x .580 inches).
 3. Connector housings shall be high impact 94 V-0 rated thermoplastic.
 4. Connector housings shall fully encase and protect printed circuit boards and IDC fields.
 5. Modular Connector contacts shall accept a minimum of 1000 mating cycles with 5.0 milliohm (maximum) increase over initial with the use of an FCC compliant plug.
 6. Modular Connector contact wires shall be formed flat for increased surface contact with mated plugs.
 7. Modular Connector contacts shall be constructed of beryllium copper for maximum spring force and resilience.
 8. Contact plating shall be a minimum of 50 micro inches of hard gold in the contact area over 50 micro inches of nickel.
 9. Connector termination shall follow the industry standard 110 IDC.
 10. Connectors shall have a designation indicating CAT 6 or 6A.
 11. Connectors shall utilize a paired punch down sequence. Cable pair twist shall be maintained up to the I DC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
 12. Connectors shall terminate 22-26 AWG stranded or solid conductors.
 13. Connectors shall terminate insulated conductors with outside diameters up to .050 inches.
 14. Connectors shall be compatible with single conductor, 110 impact termination tools.
 15. Connectors shall include translucent wire retention stuffer cap that holds terminated wires in place and allows the conductors to be visually inspected in the IDC housing.
 16. Connectors shall be compatible with EIAITIA 606A color code labeling.
 17. Connectors shall accept snap on icons for identification or designation of applications.
 18. All CAT 6 or 6A modular Connectors shall meet or exceed the following transmission characteristics:
 - a. Connectors shall be designed for 100 Ohm UTP cable termination.

- b. Connectors shall be UL verified for TIA/EIA Category 6Aa electrical performance.
 - c. Connectors shall be UL listed 1863 and CSA certified.
 - d. Connectors shall be manufactured by an ISO 9002 registered manufacturer.
 19. Connectors shall exhibit a worst pair channel NEXT loss of at least the following:
 - a. 100MHz 54dB
 20. Connectors shall exhibit a worst pair channel PSANEXT value which meets or exceeds the following:
 - a. 100MHz 67dB
 21. Connectors shall exhibit worst-pair channel insertion loss of not more than the following:
 - a. 100MHz 0.2dB
 22. Connectors shall exhibit worst pair channel FLEXT loss of at least the following:
 - a. 100MHz 43.1dB
 23. Connectors shall exhibit worst pair channel PSAFLEXT loss of at least the following:
 - a. 100MHz 67dB
 24. Connectors shall exhibit a channel return loss of at least the following:
 - a. 100MHz 28dB
 25. The data cable shall be terminated directly to the modular Connector with insulation displacement connectors.
 26. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty.
 27. The data cable shall be terminated directly to the modular Connector with insulation displacement connectors.
 28. The cable shall have a minimum 15 ft. slack, and coiled in the ceiling for placement of WAPS.
 29. The cable shall be marked on ceiling grid with a blue REMOVABLE dot for identification and location purposes.
- B. 3.5mm Stereo Connector Standard of quality is Legrand/Ortronics keystone, part # OR-KS35ST, Acceptable manufactures must demonstrate product equivalency
1. 3.5mm Stereo or miniature connector used for 3 conductor audio applications. Also referred to as a 1/8" stereo connector, using a tip ring sleeve configuration for signal transmission.
 2. QuickPort connector used for stereo audio signals
 3. Compatible with male plugs for headsets
 4. Screw terminal connection for quicker field installation
 5. UL1863
 6. UL 94V-0 rated
 7. Snap-in connector bodies are high-impact, fire-retardant plastic rated UL94V-0
 8. Compatible with 22-24 AWG Shielded Audio Cable
 9. Used for unbalanced audio (or line level stereo) connections
 10. Match color to housing or wallplates.
- C. USB Connector Standard of quality is Legrand/Ortronics keystone, part number OR-KSUSBAA. Acceptable manufactures must demonstrate product equivalency
1. Rugged thermoplastic construction for secure fit
 2. Flush mounted modules for an aesthetic appearance
 3. All modules snap in for easy installation
 4. Width U S: 0.559 Depth U S: 1.35 Height U S: 0.632
 5. Category Performance Application: USB 3.0

6. Number Of Ports: 1-port
 7. Color shall be Gray
- D. HDMI Connector Standard of quality is Legrand/Ortronics keystone, part number OR-KSHDMI. Acceptable manufactures must demonstrate product equivalency
1. Connectors shall be designed for use in high-definition applications to provides interface between compatible devices.
 2. Used for high definition audio and video
 3. Snaps easily into QuickPort housing or wallplate
 4. Female to female connectors for easy installation
 5. Feedthrough connector accepts HDMI cables
 6. with Type A plugs
 7. CL2-rated cable recommended for in-wall wiring
 8. UL 94-V0 flammability standard
 9. Dimensions: 0.626" W x 0.772" H x 1.024" D
 10. Materials: ABS Plastic
 11. Color shall be Gray
- E. USB 3.0 Balun Extender Kit Standard of quality is Legrand/Quiktron, Acceptable manufactures must demonstrate product equivalency
1. Composed of two separate units.
 - a. Local Extender
 - b. Remote Extender
 2. Conventional USB cables are used to connect the Local Extender unit to the host computer and to connect the remote USB device to the Remote Extender unit.
 3. Category 6A or higher UTP cabling is used to connect the Local Extender and Remote Extender units over a distance of up to 50 meters (165ft).
 4. The USB Extender Kit is powered from USB and delivers enough power at the remote unit to drive most USB devices.
 5. Compatible with standard devices
 6. The USB Extender supports USB 2.0 peripheral devices at speeds up to 480 Mb/s over a distance of 50 meters (165 ft.).
 7. The USB 2.0 shall be a single port, Class A devices which connects host computers and peripherals with standard Category 5 or higher UTP cable.
 8. To be installed wherever a USB Connector is called out on the drawings.
 - a. Standard of quality is Legrand / Quiktron part #s 53880, 53879, 53878, 53877. Alternatives must demonstrate product equivalency
- F. HDMI Extender Kit Over CAT 6A (isolation wrap 6A) Standard of quality is Legrand/Quiktron, Acceptable manufactures must demonstrate product equivalency
1. Video Bandwidth: 2.5Gbps
 2. Support the following distances and resolutions using CAT 6A cabling:
 - a. 40m @ 3840 x 2160 pixels (2160p 8 bit per channel)
 - b. 60m @ 1920 x 1080 pixels (1080p 8 bit per channel)
 3. Input TMDS Signal: 1.2V (Peak-to-Peak)
 4. Input DDC Signal: 5V (Peak-to-Peak)
 5. Power Adapter
 - a. Power Input: 100-240VAC ~47/63Hz, 0.48A Max.

- b. Power Output: 5VDC, 2.5A, 12.5W Max
- c. *Power adapter must be connected to the DC input on the remote unit.
6. Physical Characteristics:
 - a. Video Input Connector (base): Type A HDMI Female—19 pin
 - b. Video Output Connector: Type A HDMI Female—19 pin
 - c. Connector Plating: Gold
 - d. Housing Material: Metal
7. Supports HDCP
8. Wall Mountable
9. Includes:
 - a. Transmitter Unit
 - b. Receiver Unit
 - c. Mounting Brackets
 - d. Power Adapter
10. Manufacturers
 - a. Legrand / Quiktron
 - b. Hubbell
 - c. Extron
11. One per HDMI Connector

G. HDMI Splitter 1 x 2

1. HDMI with Deep Color, x.v. color, high speed refresh rates and lossless multi-channel surround sound.
2. Supports 480i, 480p, 720p, 1080i, 1080p and 4k resolutions
3. HDCP-compliant for full playback of high definition content
4. Maximum bandwidth: 2.25 Gbps
5. Supports up to 12 bit color
6. One HDMI source
7. One or two HDMI-compatible monitors/receivers
8. One or two HDMI M/M cables
9. 120 VAC power adapter

2.7 COVER PLATES

A. Standard plastic Flush Mount Plates Standard of quality is Legrand/Ortronics w/ keystone openings, Part number OR-KSFPX where X = number of openings.

1. Shall be UL listed and CSA certified.
2. Plates shall be constructed of high impact thermoplastic.
3. Plates shall be modular, front-loading and colored to match the video/data wall plates.
4. All plate colors shall be coordinated with the architect to match furnishings and fixtures.
5. Wall mounted phones shall use 630 style faceplates.
6. Cover Plates shall accept the approved voice/ data and video Connectors including voice/data (RJ-11, RJ-45), Video (VGA, HDMI, Display Port), Audio (type RCA, 1/8th “mini) and fiber (type ST, SC, LC and MT-RJ).
7. Faceplates shall cover single or dual ganged boxes.
8. Faceplates and Connectors shall be by a single manufacturer.
9. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty.

10. EVERY Connector shall be labeled to corresponding patch panel and port.
 11. Coordinate labeling scheme with A/E.
 12. Labels shall be computer generated on an adhesive media and attached to the workstation outlet.
 13. Labels applied with pens or markers will not be acceptable.
 14. Provide blank inserts for all unused ports.
 15. Faceplates for specialized drops shall be as shown on the drawings.
 16. Refer to drawings for arrangement of various workstation outlets including Connector types and quantities within each outlet type. All voice/data/video/audio and fiber Connectors indicated in the faceplate shall be deemed included in this specification unless specifically noted otherwise.
- B. Wall mount phone plates shall be stainless steel. Standard of quality is Legrand/Ortronics part number OR-403STJ1WP
1. Each plate shall be equipped with a CAT 6A, 8 port modular Connector.
 2. Each plate shall be equipped with stainless steel studs for mounting a wall mount telephone to the plate.
 3. Single gang wall mount phone plate shall be Hubbell or equal.
- C. Surface Mount Interface Plates: Standard of quality is Legrand/Ortronics keystone
1. At locations where the CAT 6A cables or coax cables are to be terminated on furniture/existing walls, the contractor shall provide surface mount plates.
 2. The plates shall be mounted to the modesty panel on individual tables or on the base of office furniture.
 3. Surface-mount plates shall be office white in color and shall accommodate between one and four cables in each surface mount box.
 4. Surface-mount boxes shall be mounted securely to the furniture with screws.
- D. In addition to flush faceplates and surface housings, some installations call for integrated furniture outlets, GFI style outlets, and standard 106 style frames. Standard of quality is Legrand/Ortronics keystone
1. The Contractors shall identify which type of outlet or frame is required at each location throughout the system.
 2. Match the particular outlet with the faceplate required.
 3. GFI, more commonly referred to as style line outlets, are rectangular and fit in a rectangular plate used for GFI receptacles.
 4. Each type of modular furniture has certain requirements for its voice and data modules. The Contractor shall coordinate with the furniture installer and provide the correct faceplate and outlets to match the color and style of the furniture.
 5. The 106 style frame fits in a common duplex electrical receptacle faceplate. The frame holds 2 or 4 modular Connectors.
 6. For all connections that do not have a faceplate with a location for a laser printed paper label, the Contractor shall provide an engraved lamacoid label detailing the location number of each cable.

2.8 PATCH PANELS

- A. CAT 6A patch panels for mounting in a 19 inch rack shall either be 48 port or 24 port or equals. Standard of quality is Legrand/Ortronics (Part # OR-SP6U24; OR-SP6U48 for 24 and 48 port panels respectively)
1. Panels shall be made of black anodized aluminum, in 24 and 48 port configurations unless otherwise specified.
 2. Panels shall accommodate 24 ports for each rack mount space or “u” (1 U = 1.75 inch).
 3. Panels shall be manufactured with a rolled edge at the top and bottom for stiffness.
 4. Panels shall have modular Connectors employing staggered array contacts with a flat "hairpin" design made of beryllium copper with a minimum 50 micro inch gold plating on contact surfaces over 50-100 micro inch of nickel compliant with FCC Part 68.
 5. Panels shall be wired in accordance with the T568B wiring schemes.
 6. Panels shall be equipped with 110 style termination made of fire retardant UL 94VO rated thermoplastic and tin lead solder plated IDC.
 7. Panels shall include optional rear cable support bar for strain relief which shall clip to the panel.
 8. Panels shall have self-adhesive, clear label holders and white designation labels provided with the panel for each 8 port adapter. Contractor shall provide laser printed paper inserts that detail the cable number associated with each outlet on the patch panel.
 9. Panels shall provide wiring identification and color code and maintain a paired punch down sequence that does not require the overlapping of cable pairs.
 10. Panels shall terminate 22-26AWG solid conductors, maximum insulated conductor outside diameter 0.050 inch.
 11. Transmission Characteristics:
 - a. Panels shall be ANSI/TIA/EIA-568-B and ISO/IEC 11801 compliant.
 - b. Panels shall be UL verified for TIA/EIA Category 6A performance.
 - c. Panels shall be UL listed 1863 and CSA certified.
 - d. Panels shall be made by an ISO 9002 certified manufacturer.
- B. Twisted pair loadable angled patch panels (accepting CAT 6A black keystone jacks, part # OR-KT2J6A-00), rack mounted, CAT 6A rated, 110 termination, RJ-45, multi-port (24 or 48). Standard of quality is Legrand/Ortronics (Part # OR-SPAKSU24; OR-SPAKSU48 for 24 and 48 port angled 6A panels respectively) Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Provide quantity of patch panels as required by quantity of data station cable. Mount panels in equipment racks/cabinets. Each panel shall be fully loaded. Provide labeling for each connected port as coordinated with Owner.
- C. Patch Panel: Modular panels housing multiple-numbered Connector units with IDC-type connectors at each Connector for permanent termination of pair groups of installed cables.
- D. Number of Connectors per Field: One for each four-pair UTP cable indicated
- E. All patch panels shall be in accordance with ANSI/TIA/EIA 568B.2 (or latest) and shall be equipped with eight positions, modular Connectors with insulation displacement connectors, rear cable management bars/standoffs and front label designation strips.
- F. Provide quantity of patch panels as required by quantity of data station cable. Mount panels in data racks in each TR/MER.

- G. Each panel shall be fully loaded.
- H. Provide 24 or 48 port, CAT 6A (minimum) rated patch panels for termination of all horizontal cabling (6A Patch Panels for WAPs). When the MER or TR serves more than one floor, sequentially group the cables by floor on separate patch panels.
- I. Provide color-coded, CAT 6A (minimum) rated patch cords for all connections (6A cords for WAPs) plus 10% spare.
- J. Color-coding to be coordinated with Owner/Architect prior to ordering.
- K. Lengths to be coordinated with Owner/Architect prior to ordering.

2.9 CONSOLIDATION POINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Standard of quality is Legrand/Ortronics or Legrand/Wiremold depending on application. Acceptable alternatives must demonstrate product equivalency.
 - 1. Legrand
 - 2. Leviton
 - 3. Panduit
 - 4. Siemon
- B. Description: Consolidation points shall comply with requirements for cable connecting hardware.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
 - 2. Number of Connectors per Field:
 - a. One for each four-pair UTP cable indicated.
 - 3. Mounting: Recessed in ceiling, Wall, Desk, or Furniture.
 - 4. NRTL listed as complying with UL 50 and UL 1863.
 - 5. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.10 PATCH CABLES

- A. Standard of quality is Legrand/Quiktron
- B. This contract shall be responsible for providing all required patch cables to make a complete and fully functioning network. The following patch cables requirements are considered part of these specifications.
- C. Data Station (copper) at Workstation – Provide a nominal 15ft patch cable with every workstation jack to match the EIA/TIA channel configuration of the cabling system. Coordinate the patch cable length and color with the Owner by establishing specific color types and various cable lengths throughout the installation. The Owner may request various lengths at various outlets depending upon the field conditions and the locations of the equipment which utilizes any given jack.

2.11 AUDIO/VIDEO CABLE

- A. Standard of quality is Legrand/Quiktron for A/V cables, cords and assemblies
- B. For applications involving conference rooms, collaborative work spaces, etc, that require HDMI, USB, Display Port, VGA, and other digital and/or analog A/V connections, the cabling infrastructure shall utilize the following Legrand solutions:
 - C. HDMI 2.0
 - 1. HDMI-to-HDMI direct (native signal) connections shall be High Speed rated and designed and tested to handle video resolutions of 1080p and beyond, including advanced display technologies such as 4K, UltraHD, 3D, and Deep Color
 - 2. HDMI-to-HDMI direct (native signal) connections shall not exceed 20 meters in length and may be CMP, CL3 or CL2 rated as appropriate to the application
 - 3. Legrand HDMI media conversion solutions such as RapidRun Optical, HDMI-over-Coax, HDBaseT and HDMI-over-UTP solutions may be deployed for connections under 20 meters in total length when form factor is appropriate to the installation requirements
 - 4. HDMI-to-HDMI connections greater than 20 meters in length shall be Legrand RapidRun Optical or Legrand HDMI extender solutions to include HDMI over Cat
 - 5. HDMI 2.0 Cable (Under 35 FT)
 - 6. 4K@50/60, (2160p), which is four times the clarity of 1080p/60 video resolution
 - 7. Up to 32 audio channels for a multi-dimensional immersive audio experience
 - 8. Up to 1536kHz audio sample frequency for the highest audio fidelity
 - 9. Simultaneous delivery of dual video streams to multiple users on the same screen
 - 10. Simultaneous delivery of multi-stream audio to multiple users (up to four)
 - 11. Support for the wide angle theatrical 21:9 video aspect ratio
 - 12. Dynamic synchronization of video and audio streams
 - 13. CEC extensions provide expanded command and control of consumer electronics devices through a single control point
 - 14. Pins 1 through 9 carry the three TMDS data channels (Transition Minimized Differential Signaling – the technology that allows DVI and HDMI to send high-speed digital data), three pins per channel. TMDS data includes both video and audio information, and each channel has three separate lines for + values, - values, and a ground or data shield.
 - 15. Pins 10 through 12 carry data for the TMDS clock channel, which helps keep the signals in synchronization. As with the TMDS data channels, there are separate lines for + values, - values, and a data shield.
 - 16. Pin 13 carries the CEC (Consumer Electronics Control) channel, used for sending command and control data between connected devices.
 - 17. Pin 14 is reserved for future use.
 - 18. Pins 15 and 16 are dedicated to the DDC (Display Data Channel), used for communicating EDID (Extended Display Identification Channel) information between devices.
 - 19. Pin 17 is a data shield for the CEC and DDC channels.
 - 20. Pin 18 carries a low-voltage (+5V) power supply.
 - 21. Pin 19 is the Hot Plug Detect, dedicated to monitoring power up/down and plug/unplug events.
 - D. USB 3.0
 - 1. USB cable connections shall be Legrand USB 3.0 rated for all applications except those specifically requiring 3.0 or faster speed transfer ability and shall not exceed 5 meters in unbroken length

2. USB connections greater than 5 meters in total length shall be one of the following, based on necessary form factor
 - a. USB connections greater than 5 meters but less than 12 meters in length shall be Legrand USB Active Cable solutions, or
 - b. USB connections greater than 5 meters but less than 100 meters in length shall be Legrand Legrand USB 3.0 over Cat 5 Superbooster solutions

E. Stereo Video / Audio Cables

1. Line level—Standard 22 gauge, tinned copper, 4 conductor cable with 100% overall shield, black FEP Connectoret. Plenum rated.

F. Control Cable

1. RS232—High performance, low capacitance serial control cable, 2-twisted pair #24 AWG tinned copper with overall outer aluminum polyester foil shield and a tinned copper drain wire.
2. IR Control—2 conductor #22 AWG
3. Relay Control—2 conductor #22 AWG

G. Refer to drawings for locations.

2.12 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with ANSI/TIA-607-B.

2.13 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606 and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.14 CABLE MANAGEMENT SYSTEM

- A. Manufacturers: Standard of quality is Legrand/Ortronics. Alternative products must demonstrate product equivalency. Subject to compliance with requirements, provide products by one of the following:
 1. Legrand/Ortronics
 2. Leviton
 3. Panduit.
- B. Description: Computer-based cable management system, with integrated database and graphic capabilities.

- C. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.
- D. Information shall be presented in database view, schematic plans, or technical drawings].
 - 1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.
- E. System shall interface with the following testing and recording devices:
 - 1. Direct upload tests from circuit testing instrument into the personal computer.
 - 2. Direct download circuit labeling into labeling printer.

2.15 SOURCE QUALITY CONTROL

- A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-C.2.
- B. Factory test UTP cables according to ANSI/TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
 - 3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:
 - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
 - 2. Install lacing bars and distribution spools.
 - 3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF CABLES

- A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.2.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for UTP at least 49 feet (15 m) from communications equipment room.
6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with ANSI/TIA-568-C.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.
- F. Group connecting hardware for cables into separate logical fields.
- G. Separation from EMI Sources:
1. Comply with BICSI TDMM and ANSI/TIA-568-C for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.3 FIRESTOPPING

- A. Standard of quality is STI EZ Path 44s. Acceptable manufactures must demonstrate product equivalency.
- B. Comply with requirements in Section 078413 "Penetration Firestopping."
- C. Comply with ANSI/TIA-568-C, Annex A, "Firestopping."
- D. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI/TIA-607-B.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 INSTALLATION OF CONNECTORS AND COVERPLATES

- A. Examine all pathways prior to installation of any connectors or faceplates.
- B. The Engineer or the Owner has the right to make adjustments to the location of any outlet to a new location within 7 wall-feet of the original location. If the change is made prior to final cable termination and prior to any raceway being installed, then the changes shall be a no cost change to the contract.
- C. Identify all locations where standard connectors or faceplates may not work with existing furniture or raceway. Contractor is responsible for making any required arrangements to accommodate the existing field condition. Make arrangements to install and terminate all cables in accordance with TIA/EIA 568 standards.
- D. Coordinate the installation of connectors and faceplates with other trades who may be using the same cable pathway or backbox.
- E. CAT 6A data/voice Connectors shall be installed at the user end of each CAT 6A cable installed in the system.
 - 1. Connectors shall be installed to provide minimal signal impairment by preserving wire pair twists as close as possible to the point of mechanical termination.
 - 2. Connectors shall be installed according to manufacturer's instructions and properly mounted in plates, frames, housings, or other appropriate mounting devices.
 - 3. Connectors shall be installed such that cables terminated to the Connectors maintain minimum bend radius of at least 4 times the cable diameter into the workstation outlet. Cables shall be terminated on Connectors such that there is no tension on the conductors in the termination contacts.
 - 4. Connectors and/or connectors shall be terminated to the appropriate cable and inserted in the correct orientation into the faceplate prior to the mounting of the faceplate.
 - 5. Connectors shall be inserted into the faceplate left to right, then top to bottom. 2 gang plates shall be labeled left to right, then top to bottom for each gang.
 - 6. Cable slack shall be stored behind the faceplate in such a way that allows the minimum bend radius of the cables to be maintained.
 - 7. Care shall be taken when mounting the faceplate to avoid crimping or kinking the cables.

8. Faceplates shall be securely mounted to a surface mounted housing, a recessed box, or box eliminator bracket.
 9. Each faceplate shall be labeled with laser printed paper inserted behind the clear plastic label strips.
 10. The label shall show the location identifier of the faceplate and the letter designation for each cable. The label shall be as large a font as possible and easily readable.
 11. Each faceplate comes with a label strip at the top and the bottom.
- F. Wall mount phone plates shall be mounted to a backbox or a drywall ring securely installed to the wall.
1. Terminate the cable to the 8 position Connector on the wall mount faceplate.
 2. Ensure that the faceplate is at the correct height for all ADA requirements.
 3. Provide an adhesive label on the faceplate identifying the cable with its location identifier number.
- G. When utilizing 106 style or GFI brackets, the Contractor shall provide self-adhesive, engraved lamacoid labels for each bracket, and a separate lamacoid label detailing which cable is at each position.
1. 106 plates and GFI plates will primarily be located in floorboxes. The contractor shall coordinate the faceplates required with the actual floorboxes installed by the electrical contractor.
 2. Provide the quantity of GFI and 106 style plates required.
 3. When terminating cables, ensure that the smallest amount of Connectoret is removed from the final termination point of the cables.
 4. Pair twists shall be maintained up to the IDC Connector for all the cables.
 5. When terminating cables on modular Connectors, use only single point, 110 style punch down tools. Multiple pair punchdown tools are not permitted for terminating individual 4 pair cables.
 6. Terminate all coax cables with F-connectors, unless otherwise noted. Use the correct crimp tool and die for all connectors.
 7. No strands or parts of the shield on the coax cable shall be visible after termination with the connector.

3.6 INSTALLATION OF PATCH PANELS

- A. CAT 6A cable termination equipment shall be installed according to TIA/EIA 568-B standards, including all updates and addenda.
1. Cables shall route down each side of a rack for termination. Split each panel into 2 sides. The first 12 positions on a panel are on the left, and positions 13 through 24 are on the right. Route the cables for panel positions 1 through 12 down the left cable ladder and route the cables for positions 13 through 24 down the right cable ladder.
 2. Each patch panel shall utilize a rear organizer for holding the cables as they route to the punchdown field.
 3. Each panel shall be separated by a horizontal patch cord organizer.
 4. Cables shall be bundled in groups of 4 as they route through the rear cable organizer.
 5. When terminating cables, ensure that the smallest amount of Connectoret is removed from the final termination point of the cables.

6. Panels shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the patch panel shall be no greater than a 1/2 inch (13 mm).
7. Panels shall be installed according to manufacturer's instructions and properly mounted to a rack, cabinet, bracket, or other appropriate mounting device.
8. Panels shall be installed such that cables terminated to the panel can maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts. Cables shall be terminated on the panels such that there is no tension on the conductors in the termination contacts.
9. When terminating cables on the back of patch panels or on modular Connectors, use only single point 110- style punchdown tool. Multiple pair punchdown tools are not permitted for terminating individual 4-pair cables.
10. Provide service loop of the cables on the vertical cable ladder. The loop shall extend no less than 1 foot below the termination point on the patch panel. Route the cables at least 2 feet below the patch panel, and then back up to the panel. This will provide room for future moves and additions to the rack.
11. Designation strips shall be installed between the 2 rows of outlets on the panel. The Contractor shall provide paper inserts for the labels of each outlet. Each outlet shall be labeled for the cable that is terminated there. Labels shall be on paper and shall be laser printed. Handwritten labels are not permitted.
12. The label for each outlet on the panel shall be the same as the wraparound label on each end of the cable as well as the user faceplate label.
13. Each label shall line up directly below or above the outlet on the panel. Misaligned labels will not be permitted.

3.7 IDENTIFICATION

- A. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, Connectors, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A.
- D. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, and entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

F. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar Connectors and plugs are used for both voice and data communication cabling, use a different color for Connectors and plugs of each service.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable Connectoret color but still complies with requirements in TIA/EIA-606-A.

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

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Visually inspect UTP and optical fiber cable Connectoret 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 TIA/EIA-568-C.2.
2. Visually confirm Category 6A, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone 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.
 - a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-C.2. 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.
5. UTP Performance Tests:

- a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-C.2 and ANSI/TIA-568-C.2:
 - 1) Wire map.
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay.
 - 10) Delay skew.
 6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
 - B. Document data for each measurement. 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.
 - C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
- ### 3.9 AS-BUILT DOCUMENTATION
- A. Copies of all approved shop drawings with the Engineer's stamp.
 - B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operation, maintenance, and troubleshooting and product repair/replacement information.
 - C. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of Owner's manuals must contain the proper software viewers for each document type.
 - D. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored markings based upon actual field conditions.

1. AutoCAD architectural floor plans at a scale of 0.25" = 1.0" on 30x42, 24x36 size sheets showing the showing the routing of all backbone cables between communications equipment rooms. Labeling shall match the labeling installed in the field. These drawings shall be as-built conditions.
 2. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configurations, device locations and cable types.
 3. Rack and wall elevations for all backbone cable termination systems. The details shall indicate each piece of telecommunications equipment in each rack including equipment labels such as patch panel, wire management panel, blank panel, space, etc. Each port of each patch panel shall be fully labeled to match the labeling installed in the field.
- E. Cable Test Results—provide bound documents of all cable test results in printed format and in software version on a CD. Software version must include any required reader software where file formats are proprietary or non-standard text files. Cable test results shall be organized by type (data, voice) and by closet. Information must be included in O&M Manuals.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

3.11 WARRANTY

- A. The entire technology wiring system as specified herein shall be guaranteed against defects in workmanship and materials for a period of TWENTY (20) years warranty. Period shall commence after system has been commissioned by the Owner, Engineer and Owner/Architect. The Installing Contractor shall provide the warranty service. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.
- B. The entire horizontal cabling system warranty shall be a listed cabling system solution from a single manufacturer/source. The system shall carry an industry standard, performance based warranty, by the manufacturer, for a period of at least 20 years on the horizontal cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of one year from date of substantial completion.
- C. The warranty shall not be affected by the use of POE on any or all of the links.
- D. The warranty shall not be affected by selected links required to have transition points from OSP to indoor where serving underground conduits to floor boxes. It shall be the Contractors responsibility to provide manufacturer's approved transition points to maintain system warranty on any affected runs.

3.12 CERTIFICATION

- A. The contractor shall be responsible for filing all required paperwork on behalf of the Owner to acquire the system performance warranty and certification as outlined in the Structured Cabling System Solution.
- B. Project final completion will be pending delivery of manufacturer's warranty certificate.

END OF SECTION 271513

SECTION 272100 - DATA COMMUNICATIONS NETWORK EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All provisions of the Division 00 and Division 01, apply to all work in Division 27 and Division 28.

1.2 SCOPE OF WORK

- A. All Bidders shall have an established SPIN number from the federal government in order to participate in any E-Rate funding opportunities for the project. This can be obtained through USAC <http://www.usac.org/sl/service-providers/step01/default.aspx>
- B. Provide a main rack mounted file server including OS software. Mount server in server cabinet provided under section 27 11 00. Coordinate server and cabinet.
- C. Provide a main chassis based switch with 1000BASE FX, and 1000BASE TX uplink ports and copper GB station ports in the MER. Fiber 10GB ports to provide full duplex non-blocking Gigabit uplink for a total of **20GB per stack** over fiber optic cable to stacked switches in each remote wiring closet. Copper station ports to provide 1000BaseT and 802.3at PoE+ auto sensing ports to local outlets and devices fed from main wiring closet.
- D. Provide a stacked with layer 2 switch management capable in each wiring closet to activate each wired data jack terminated in each wiring closet (including the outlets served directly from the main wiring closet). Provide 20GB uplinks from each switch stack to the main core switch.
- E. Provide PoE+ enabled ports in each wiring closet switch to activate wired data jacks terminated in wiring closet (including the outlets served directly from the main wiring closet).
- F. UTP patch cables to connect network electronics to station cable patch panels in each wiring closet are furnished under specification Section 27 15 13. This contract shall be responsible for installing and labeling all patch cables from patch panels to network electronics.
- G. This contract shall be responsible for providing, installing and labeling all required fiber jumpers and copper patch cables to connect network electronics to the fiber backbones and to the core switch.
- H. Online UPS units to support network electronics as described herein and as shown on the contract documents.
- I. Network management software with licenses for all equipment installed under this project.
- J. Programing of each switch to coordinate with the Owner's LAN and WLAN Network Operating System configuration and requirements including establishing parameters and operations associated with QoS, CoS, VLANs, WLAN, etc.

- K. The systems/equipment installed shall be of the latest revision and of the latest technology. The data systems shall serve the building, as well as, satellite buildings located throughout the owner for the foreseeable future and shall be able to grow as the owner grows.
- L. Provide and install all labor, tools, materials and accessories for a complete Data Network LAN comprised of switch components as listed.
- M. The contractor shall furnish and install switches.
 - 1. Install in appropriate rack.
 - 2. Connect to UPS
 - 3. Patch to associated patch panel
 - 4. Label (coordinate labeling with Owner/Architect)
- N. The Contractor shall demonstrate to the Owner and Engineer that the system is complete and complies with all operational requirements set forth in the plans and specs. The contractor shall provide all miscellaneous items and accessories required to make the system operational whether or not such items are specifically mentions in the plans and specifications.
- O. The contractor shall review all plans and specifications for any detail that may impact the installation of the system. Any discrepancies discovered shall be brought to the attention or the engineer prior to installation.
- P. The data network and all its components shall be installed so that access is provided to all components for general maintenance and repair.
- Q. The new data network equipment shall connect to various wide area connections and interface types. The Contractor shall make all necessary arrangements with the Local Service Provider(s) to provide all connections to the WAN well in advance to project close out. Wan connections shall be routed through the MC.
 - 1. The contractor shall provide and configure all the equipment required for connecting the data network to the wide area network.
 - 2. The Contractor shall ensure the data network is compatible with any routers, gateways and firewall provided by others/Owner.
- R. The data network electronics may be used to support voice traffic. Configure the system to meet all requirements of a voice system.
- S. The contractor shall work with the Owner to develop a patching scheme for all devices attached to the data network.
 - 1. The contractor shall be responsible for patching all devices from the patch panel(s) to the network equipment and any patching between the network electronics.
 - 2. Contractor shall coordinate with the Installation Company providing patch cables under 27 15 13 and the Owner color schemes and lengths of patch cables.
- T. In these specifications the words "data network," "data system," network electronics" and "electronics" shall be interchangeable and shall refer to the data network system and electronics and all its components.

1.3 SYSTEM DESCRIPTION

A. Section Includes

1. Network Core Switch
2. Edge Switches
3. KVM Switch
4. Radius Server

B. The "Contractor" as referred to in these specifications, shall be the bidder whose bid is eventually chosen as the winner.

C. The "Engineer" as referred to in these specifications, shall be BCL and its representative on this project.

D. The "Owner" as referred to in these specifications, shall be and its representative on this project.

E. In the detailed specifications and on the contract drawings, the phrases "or equivalent," "approved equivalent," "approved equal," "or equal" and "engineer approved equivalent" shall be used interchangeably and shall mean the same thing.

F. All equals, equivalents, or alternates shall be approved by the Engineer prior to ordering or installation. Without approval, deviation from the products listed in the specifications and on the drawings shall be presumed to be nonconforming and shall be removed and replaced at the direction of the Engineer and at the Contractor's expense.

G. The network electronics shall provide full-duplex, auto-sensing 1000BaseTX UTP Ethernet ports for wired data jacks. The edge switches shall provide full layer 2 switching.

H. POE+ switches shall provide IEEE 802.3at compliant POE+ on all provided ports simultaneously.

I. The network electronics shall provide software management capabilities such as Virtual LANs (VLANs), multilevel access security, and group management protocol. Software management shall be web-based and utilize a standard web browser. VLAN trunks shall be capable of being created from any port on any switch using IEEE 802.1Q standards based tagging. The main switch chassis shall provide full layer 2 and full layer 3 switching and routing.

J. The network electronics shall provide features associated with Quality of Service (QoS) and Class of Service (CoS) as well as port-based prioritization. The QoS shall be based upon IEEE 802.1.

1.4 QUALITY ASSURANCE

A. All equipment shall be UL listed.

B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.

C. All equipment Installation Practices shall comply with the Local Electric Code.

D. All equipment shall comply with the latest ANSI-J-STD-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for telecommunications Standard.

- E. All equipment and Installation Practices shall comply with the latest BICSI Telecommunications Distribution Methods Manual (TDMM). Current Revision 13.
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards and all Technical Service Bulletins (TSB)..
- G. All work applicable shall conform to the following standards:
 - 1. IEEE802.3-2012: (also known as ANSI/IEEEStd 802.3-1990) or ISO8802-3: 1990 (E), Carrier Sense Multiple Access with Collision Detection (CSMA/CD)Access Method and Physical Layer Specifications.
 - 2. NERC1300: Cyber Security Standards from the North American Electrical Reliability Council
- H. The system shall be in compliance with all FCC Rules and Regulations.
- I. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installations. All switch components shall be of a single manufacturer.

1.5 CONTACTOR QUALIFICATIONS

- A. The network electronics system shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the contractor to utilize a sub-contractor for any portion of the work, unless the sub-contractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.
- B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.
- C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.
- D. The Contractor shall have has a minimum of 1 year experience with the specified network electronics. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.6 Shop Drawings and Submittals

- A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Blue-line drawings shall be prepared and submitted on 30" x 42" paper. Equipment lists, data sheets, etc. Shall be 8-1/2" x 11" size properly bound into a single or multiple volumes.
- B. Submit to the following for approval:
 - 1. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item.

2. Manufacturer's data sheets on all equipment items.
 3. System block diagram(s)
 4. Equipment rack layouts showing all rack mounted equipment items.
 5. Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.
- 1.7 Final Documentation: All final documentation shall be submitted and approved before final acceptance by the Owner will be granted. Within 45 days after completion of the work, deliver to the Owner, four (4) sets of the following:
- A. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers and quantities of each item.
 - B. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts and other designations and codings.
 - C. Complete equipment rack layouts showing all rack mounted equipment items.
 - D. Operations instructions for each major item of equipment furnished.
 - E. Manufacturer's warranty for each major item of equipment furnished.
 - F. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.
- 1.8 COORDINATION
- A. Coordinate the location of the data network electronics and racks with the Electrical Contractor for placement of electrical connections.
 - B. Coordinate the configuration of the data network electronics for compatibility with WAN connections, addressing and routing.
 - C. Coordinate UPS and Power Strip locations with other trades for placement of electrical connections.
 - D. Coordinate all UPS and Power Strip input connectors with electrical contractor.
 - E. Coordinate with the Network Integrators such that the UPS units are communicating with the network utilizing their SNMP cards or IP based web monitoring.
- 1.9 STORAGE OF MATERIALS
- A. All materials shall be secured when not in use by the Contractor.

- B. It shall be the Contractor's responsibility to secure all equipment including all material to be installed as part of the contract. No changes shall be made to the contract due to loss or theft of equipment and materials not officially accepted by the Owner.

1.10 SYSTEM WARRANTY

- A. The Local Area Network Electronics software shall be warranted by the contractor for a period of three (3) years from date of substantial completion.
- B. Provide advanced replacement for all Network Electronics for the three (3) year period.

1.11 RELATED WORK BY OTHERS

- A. All conduit with pull strings, all electrical pull boxes, and all outlet boxes shall be furnished and installed under the electrical section of Division 26. Coordinate as necessary for proper installation. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.
- B. All power conductors and conduits associated with power circuits to all equipment locations shall be furnished and installed under the electrical section of Divisions 26. The power to the equipment racks shall be terminated inside the racks to Contractor - supplied isolated ground plugstrips or quad convenience outlets. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.
- C. An insulated #6 AWG stranded copper ground wire from each equipment rack to the building main service ground.

PART 2 - PRODUCTS

2.1 Product Equivalency

- A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.
- B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 SYSTEM REQUIREMENTS

- A. The contractor shall be required to fully review the existing infrastructure prior to cutover to the new system.

- B. The Contractor shall verify that space is available in existing racks/cabinets for all new network electronics equipment.
- C. All network equipment shall mount in standard 19" relay racks or cabinets.
- D. The overall intent of the data network is to provide a high-speed Ethernet based system for connecting all the users to their applications, files and the Internet while providing management of all aspects of the user connectivity via a network management system (NMS).
- E. All electronics provided for the system shall be from the same manufacturer and shall be fully supported by the management system provided by the contractor.
- F. In each communications room the equipment shall be directly connected to a ground bar ground in the building. Follow manufacturer's recommendations for grounding.

2.3 MANUFACTURERS—DATA NETWORK

- A. Approved Vendors for Data Network Equipment:
 - 1. Aruba Networks
 - 2. Cisco
 - 3. Extreme

2.4 NETWORK CHASSIS SWITCH

- A. The switch chassis shall be a modular unit providing support 1000BaseTX, 1000BaseSX, 10GB SFP+ ports in quantities and scalability as indicated on plans.
- B. Chassis Requirements:
 - 1. Dual power supply including power for integrated PoE+ service modules. Dual power supply shall be primary and standby, min 4200W.
 - 2. Dual Management Module
 - 3. Adequate space for all line cards and future port capacity as indicated on drawings.
 - 4. Rack mountable
 - 5. Switch shall be chassis based with redundant power supplies.
- C. Management Module Requirements
 - 1. Dual switching fabric. Dual switching fabric shall be redundant. Switching fabric shall be minimum full wire speed for all connected cards.
 - 2. Management module shall provide full layer 2 and full layer 3 switching and routing services. Layer 2 features including VLAN trunks, rapid spanning tree, 802.1Q link aggregation, IGMP multicast, and QoS/CoS. Layer 3 features including static IP routing, IP multicast, IGMP, IP routing protocols, IPv6.
 - 3. Port based QoS encompassing classification, scheduling and marking (QoS, ToS): including per port configuration and strict priority queuing.
 - 4. Multicasting management including hardware based, PIM and IGMP server
 - 5. Flash memory to enable future software and hardware upgrades without taking the switch offline.

6. Remote management via web-based graphical user interface, Telnet, SNMP.
7. Telnet, Ethernet based SNMP and web based GUI remote management interface.
8. Backplane connection providing full wire speed on all ports on all cards.
9. All switchports must support 802.1X and MAC address bypass (MAB).

D. Line Card Requirements

1. Line cards shall provide true wire speed switching between ports and through the backplane.
2. Modular ports shall utilize small form factor connectors (SFP+) supporting 10GB

E. The switch chassis shall provide sufficient ports for full-duplex, 20GB Ethernet connections to each wiring closet layer 2 edge switch stack over the installed fiber optic cable backbone patch cables as indicated on drawings and specified herein.

F. Refer to drawings for switch configurations.

G. The Core Switch shall be capable of connecting to all electronics throughout the facility as well as all existing servers, Internet connections and WAN connections. Refer to the drawings for details on the existing and future servers and connections.

H. The Core Switch shall be configured per specifications and shall be sized to 20% growth

I. Switch modules shall be provided for the Core Switch that will provide the correct quantity of connections as shown on the drawings and as described in the specifications.

2.5 EDGE SWITCH—TR

A. All switch ports shall be 1000BaseTX

B. The switch stacks shall provide sufficient ports for full-duplex, 20GB SFP connections to MER main chassis switch over the installed fiber optic cable backbone patch cables as indicated on drawings and as specified herein.

C. POE+ switches shall provide IEEE 802.3at compliant POE+ on all provided ports simultaneously.

D. Dual power supply including power to integrated POE+ service modules. Dual power supply shall be primary and standby.

E. Single switching fabric. Switching fabric shall be minimum full wire speed for all connected switches in the stack.

F. Management module shall provide full layer 2 and full layer 3 switching and routing services. Layer 2 features including VLAN trunks, rapid spanning tree, 802.1Q link aggregation, IGMP multicast, and QoS/CoS. Layer 3 features including static IP routing, IP multicast, IGMP, IP routing protocols, IPv6. Hardware based IPv6.

G. Port based QOS encompassing classification, scheduling and marking (QoS, ToS): including per configuration and strict priority queuing.

H. Multicast management including hardware based, PIM and IGMP server.

- I. Flash memory to enable future software and hardware upgrades without taking the switch offline.
- J. Remote management via web-based graphical user interface, Telnet, SNMP.
- K. Telnet, Ethernet based SNMP and web based GUI remote management interface.
- L. Backplane connection min. 20GB per stack
- M. All switchports must support 802.1X and MAC address bypass (MAB).

2.6 NETWORK MANAGEMENT MODULE

- A. Provide network management software module and all required support software/servers to provide owner wide, network enabled, secure remote management of all switches, routers, etc. provided under this contract. License shall allow for a minimum of 2 concurrent seats.

2.7 FILE SERVER

- A. Processor—Two (2) 2.4 GHz/10-core/25MB/90W Processors
- B. Adequate space for all line cords and future port capacity as indicated on the drawings
- C. Cache Memory—25MB L3 Cache
- D. I/O slots—1PCIe, 1 Storage
- E. Memory—64GB of DDR 4—2400 MT/s/RDIMM
- F. Network Controller—Broadcom 5719 QP 1Gb Network Interface Card
- G. Additional Network Controller—Qlogic 57810 DP 10GB DA/SFP+ Converged Network Adapter
- H. Storage Controller—PERC 6/I RAID. Should be set up for RAID 6
- I. Internal Storage—8TB RAID Level 6 of internal storage (SAS) hot swappable
- J. Network Interface—Provide dual 10GB Fiber connections with fail over and load balancing
- K. Power Supply—Dual, Hot-plug, Redundant Power Supply (1+1), 1100W
- L. Fans—Hot plug, redundant fans (individually removable)
- M. Video—Provide embedded video card
- N. Integrated Lights Out Management
 - 1. Dedicated 10/100/1000 Base-TX LAN port for LAN console and embedded web console access
 - 2. One RS 232 serial port for local console
 - 3. Password protected console ports

4. Console mirroring between all local, modem, LAN and web consoles
 5. Remote power up and power down control
 6. Configurable remote access control
 7. Event notification to system console-Provides connectivity, information, and support for UX tools (such as STM and EMS) to notify by email, pager, and/or response centers
 8. Interface to system monitoring and diagnostic hardware via an internal IC bus
 9. Secure Sockets Layer security on web console
 10. Integrity Lights Out (iLO3) Advanced Pack provides additional remote management capabilities, including LDAP directory services, Virtual Media (CD, DVD, and ISO image) for UX and Windows, and Integrated Remote Console (Virtual Keyboard, Video, and Mouse) for Windows
 11. The integrated chip provides basic graphic capabilities. One VGA port is supported, with optional connection from front or rear of the system
- O. Form Factor—2U Rack
- P. Mounting—Provide 4-post mounting hardware with sliding rails and cable management
- Q. Rack mount server in server Cabinet provide under this section
- R. Install VMware 6.5—license and software can be provided by the client
- S. Server to be VMware Certified
- T. Server to be loaded with Aruba ClearPass Policy Manager and appropriate licensing or equivalent:
1. Full support for 802.1x authentication
 2. Server shall support unlimited clients, VoIP equipment and WLAN equipment
 3. Server shall support SQL, LDAP and proxy operation
 4. Server shall utilize web based admin and reporting
- U. 22” LCD Wide Display Monitor
- V. Warranty Server Warranty includes 3-year Parts, 3-year Labor, 3-year Onsite support with next business day response
- W. VMware/ESXI should be installed on an embedded flash media
- X. Approved Manufacturers: HPE, Dell, IBM
- 2.8 RACK MOUNT LCD W/8 PORT KVM SWITCH
- A. Server Cabinets—Provide a 1x8 multi-port KVM switch with secure IP remote connectivity to connect servers and other equipment to monitor/keyboard/mouse. Connect to the following:
1. New file server
 2. VoD servers

- B. CCTV/CATV Cabinets—Provide a 1x8 multi-port KVM switch with secure IP remote connectivity to connect servers and other equipment to monitor/keyboard/mouse. Connect to the following:
 - 1. CCTV NVR
 - 2. Digital Enterprise Management System
- C. Provide all required Serial, PS2, USB, VGA, and HDMI cabling as required to fully connect each computer/server/NVR on each port. Provide full cabling/connector bundles for each unused port and turn over to Owner.
- D. 1U rack mount design.
- E. Shall allow attached servers or devices to continue network functions in the event the KVM switch loses power or functionality.
- F. Manufacturers: Avocent, Rose, Raritan, Minicom, or approved equal.

2.9 MONITOR/MOUSE/KEYBOARD

- A. Provide a combination 15” color display with native resolution of 1024x768, 103-key keyboard, built-in trackball or touchpad, (support for AT/XT, PS2, USB and UNIX) in a rack mounted pull-out drawer. Unit shall be rack mountable in a single rack space.
- B. Mount in each server cabinet and connect to KVM.
- C. Manufactures: Rose, APC, or Raritan or approved equal.

2.10 PATCH CABLES

- A. The Contractor shall be responsible for providing and installing all required fiber and copper patch cables at each switch uplink port and main core switch uplink ports to make a complete and fully functioning network. The following patch cable requirements are considered part of these specifications:
 - 1. Fiber Jumper—provide fiber jumper cables at each edge switch requiring fiber uplink and duplex fiber jumpers at each fiber port in the chassis switch to fully connect the network. Coordinate jumper type and color with equipment and jumper length to provide a neat, orderly and workman like appearance after system patching is complete.
 - 2. Copper patch cable—provide patch cables at each edge switch requiring copper uplink ports and copper patch cables at each copper 1000BASE TX port in the chassis switch to fully connect the network. Patch cables to match the EIA/TIA channel configuration of the cabling system. Coordinate patch cable length and color to provide a neat, orderly and workman like appearance after system patching is complete.
- B. The Contractor shall be responsible for coordinating with the 27 15 13 Contractor regarding patch cables being supplied by the 27 15 13 Contractor for patch panel-to-switch patching. Final quantities and lengths of patch cables shall be arranged to provide the cleanest best managed patching solution. This Contractor is responsible for taking delivery of the patch cables, installing the patch cables and labeling each end for patch panel port and switch port identification.

- C. Ensure adequate strain relief for any fiber or copper patch cable supplied.
- D. The contractor shall work with the Owner to develop a patching scheme for all devices attached to the data network. The contractor shall be responsible for patching all devices from the patch panel(s) to the network equipment and any patching between the network electronics. The contractor shall provide (2)-two Cat-6 patch cord for every copper port provided under this contract. Contractor shall provide a fiber patch cord for every fiber port provided under this contract.

2.11 UPS

A. MANUFACTURERS

- B. Approved Manufacturers for Communications Rack Online UPS: Standard of quality is Tripp Lite. Tripp Lite UPSs shall also be ordered with Tripp Lite's SNMPWEBCARD. Acceptable manufactures must demonstrate product equivalency.

- 1. Tripp Lite
- 2. Liebert.
- 3. APC

- C. Approved Manufacturers for Power Strips: Standard of quality is Tripp Lite. Acceptable manufactures must demonstrate product equivalency.

- 1. Tripp Lite
- 2. Geist
- 3. Wiremold

- D. Provide true online battery back-up, power conditioning UPS, rack mounted in each TR to serve network electronics as indicated on the drawings. Unit shall utilize combination of battery and microprocessor regulation to provide protection from brownouts and over voltage. UPS to have the following features at a minimum:

- 1. 5000/3000/2200/2000/1500 VA capacity as indicated on drawings
- 2. Output operating range—280V (5000VA)/120V (<3000VA) nominal
- 3. Communications—Unit shall provide an Ethernet based SNMP management interface, through the LAN to provide remote diagnostics and alarm conditions. Provide vendor management software with all applicable licenses.
- 4. Expandability—Unit shall provide for the connection if external battery packs in modules to extend the total unit run-time.
- 5. Complete battery independence- Battery independent restart ensures automatic UPS power-up without user interaction after lengthy power outages, even when batteries are completely drained\discharged.
- 6. All UPS will be equipped with network management over IP or SNMP capable.

- E. 1500 VA UPS shall include the following: Standard of quality is Tripp Lite part number SU1500RTXLCD2U. Acceptable manufactures must demonstrate product equivalency.

- 1. Output Power Capacity- 1350W/1500VA.
- 2. Nominal Output Voltage- 120V.

3. Output Connections - (6) NEMA 5-15R
 4. Nominal Input Voltage- 120V.
 5. Input connections- NEMA 5-15P.
 6. Cord Length - 12'.
 7. Rack Mounted - Max. 1U rack space.
 8. Transfer Time- 2-4ms.
 9. Battery Type- maintenance free sealed lead acid with electrolyte: leakproof.
 10. Communications/Interface Ports- unit shall communicate through the LAN to provide remote diagnostics and alarm conditions.
 11. LED Status- On battery/Replace Battery/and overload indicators.
 12. Audible Alarms.
 13. Filtering -full time multi- pole noise filtering
- F. 2200 VA UPS shall include the following: Standard of quality is Tripp Lite part number SU2200RTXLCD2U. Acceptable manufactures must demonstrate product equivalency.
1. Output Power Capacity - 18000 wattts/2200VA.
 2. Nominal Output Voltage- 120V.
 3. Output Connections- (6) NEMA 5-15/20R and (2) NEMA L5-20R.
 4. Nominal Input Voltage- 120V.
 5. Input connections - NEMA 5-20P.
 6. Cord Length - 10'.
 7. Rack Mounted - Max. 2U rack space.
 8. Transfer Time- 2-4ms.
 9. Battery Type- maintenance free sealed lead acid with electrolyte: leakproof.
 10. Backup time- 28 minutes at half load (925 watts) 8 minutes at full load (1850 watts.)
 11. Extended Run Capable options.
 12. Communications/Interface Ports- unit shall communicate through the LAN (SNPM) to provide remote diagnostics and alarm conditions.
 13. LED Status - On battery/Replace Battery/and overload indicators.
 14. Audible Alarms.
 15. Surge energy Rating - 570 joules.
 16. Filtering - full time multi- pole noise filtering
- G. 3000 VA UPS shall include the following: Standard of quality is Tripp Lite part number SU3000RTXLCD3U. Acceptable manufactures must demonstrate product equivalency.
1. Output Power Capacity- 2700 wattts/3000VA.
 2. Nominal Output Voltage- 120V.
 3. Output Connections- (9) NEMA 5-15R and (2) NEMA 5-20R.
 4. Nominal Input Voltage- 120V.
 5. Input connections- NEMA L30P.
 6. Cord Length - 10'.
 7. Rack Mounted - Max. 2U rack space.
 8. Transfer Time - 2-4ms.
 9. Battery Type - maintenance free sealed lead acid with electrolyte: leakproof.
 10. Backup time- 11 minutes at half load (1350 watts) 4 minutes at full load (2700 watts.)
 11. Extended Run Capable options.
 12. Communications/Interface Ports - unit shall communicate through the LAN (SNMP) to provide remote diagnostics and alarm conditions.
 13. LED Status- On battery/Replace Battery/and overload indicators.

14. Audible Alarms.
 15. Surge energy Rating - 570 joules.
 16. Filtering - full time multi- pole noise filtering
- H. 5000 VA UPS shall include the following: Standard of quality is Tripp Lite part number SU5000RT4U. Acceptable manufactures must demonstrate product equivalency.
1. Output Power Capacity--4000 Watts/5000 VA
 2. Max Configurable Power--4000 Watts/ 5000 VA
 3. Nominal Output Voltage--120V, 208V
 4. Efficiency at Full Load--90.0%
 5. Output Voltage Distortion--Less than 2%
 6. Output Frequency--(sync to mains) 50/60 Hz +/- 3 Hz user adjustable +/- 0.1
 7. Other Output Voltages--240
 8. Crest Factor--3 : 1
 9. Topology--Double Conversion Online
 10. Waveform Type--Sine wave
 11. Output Connections--(8) NEMA 5-15/20R (2) NEMA L6-30R (2) NEMA L6-20R
 12. Bypass--Internal Bypass (Automatic and Manual)
 13. Nominal Input Voltage--208V
 14. Input Frequency--50/60 Hz +/- 5 Hz (auto sensing)
 15. Input Connections--NEMA L14-30P
 16. Cord Length 10'
 17. Input voltage range for main operations--100 - 140VAC (L1-N:L2-N)
 18. Input voltage adjustable range for mains operation--85 - 136V
 19. Other Input Voltages--240
 20. Interface Port(s)--RJ-45 10/100 Base-T
 21. Control panel LED status display with load and battery bar-graphs and On Line : On Battery : Replace Battery : Overload and Bypass Indicators
 22. Alarm when on battery : distinctive low battery alarm : overload continuous tone alarm
 23. Emergency Power Off (EPO)
 24. Surge energy rating 365 Joules
 25. Filtering Full time multi-pole noise filtering : 0.3% IEEE surge let-through : zero clamping response time : meets UL 1449
- I. All UPS units shall be rack mountable with proper mounting hardware and support. Tower UPS systems are not permitted unless otherwise noted.
- J. UPS External battery Packs for 2200 or 3000 VA APC or approved equal for systems that specify extended run time such as the phone system.
- K. Power Strips Standard of quality is Tripp Lite part number PDU1220. Acceptable manufactures must demonstrate product equivalency.
1. Raceway and all components shall be UL listed. The base and cover shall be ivory in color, and shall be attached to the cable ladder of the rack system or wall field as per the drawings.
 2. Electrical outlet strip shall have (13) NEMA 5-15\20 outlets.
 3. Provide all attachment hardware required to securely attach the outlet strip to the back of the vertical cable ladder or wallfield. Refer to the detailed drawings for required locations.
 4. All power strips shall be equipped with surge protection.

5. All power strips shall be come with adjustable mounting brackets for 2 or 4 post installation.
6. Strips shall be 20A-120V with NEMA 5-20P on a 15 foot line cord.
7. Install and test all outlets prior to project completion.
8. Provide outlet strip with attached cord and 3-prong plug.
9. All power strips shall be equipped with a long enough cord to reach the UPS units located at the bottom of the racks.
10. All power strips will plug into UPS units unless otherwise specified. Custom length cords may be required.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of system components.
- B. Some network electronics such as layer 2 switches, UPS units, etc., will be required to be mounted in relay racks and server cabinets provided under Section 27 11 00. Careful coordination with 27 11 00 contract will be required. This coordination shall include providing all required dimensional, weight and mounting data to the 27 11 00 Contractor to ensure a fully coordinated installation.
- C. It is the Contractor's responsibility to program the devices in this section according to the Owner's Network requirements. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming.
- D. Provide any miscellaneous equipment such as identification tags, cable tie, wiring harnesses, patch cables (both copper and fiber), stacking cables etc. necessary for a complete TURNKEY system.
- E. Provide all required jumper and patch cables and coordination with the Owner to connect to the Owner's File Server(s).
- F. Install and setup all UPS equipment. Review power down procedure with the Owner.

3.2 EXAMINATION

- A. The Contractor shall be knowledgeable of the requirements and limitations at the site prior to submission of the Bid Response.

3.3 PREPARATION

- A. Each location where equipment of the data network will be placed shall be identified and reviewed prior to installation of the components.

- B. All work shall be done by trained professionals with a history of work on the equipment being installed.
- C. The Contractor shall provide all hardware, software, cable, connecting blocks, electronics, configuration, and labor required for a complete and operating system.

3.4 SYSTEM CONFIGURATION

- A. The Contractor shall configure and install the data network as per the detailed specifications and the configuration meetings with the Owner.
 - 1. Meetings shall be scheduled with the Owner to discuss the configurations of all electronics and the capabilities of the system. The System shall be configured for all Ethernet IP systems installed such as: Video on Demand, VoIP, wireless network, IP cameras and Video Surveillance Control, Access Control, Etc. Contractor shall configure VLANS as well as OS set up with priority being given to voice and video.
 - 2. The owner shall be made aware of all the capabilities of the data network electronics and all possible configurations and shall be able to decide all aspects of the programming and configuration.
 - 3. The Contractor shall generate a report on the requirements of the owner and shall program and configure all the data electronics to meet the owner's needs. All costs associated with the meetings and programming are to be included in the bid.
 - 4. From the meetings the owner and contractor shall generate a plan for all configuration issues of the data network including but not limited to:
 - a. IP Numbering Scheme
 - b. VLAN Settings - possible VLANs for: Administration, HVAC, Management, Personnel, Video, Voice, Wireless, etc.
 - c. Quality of Service (QoS) Settings
 - d. Network Prioritization
 - e. New Data Connections.
 - f. Wireless Connectivity for Patrons and Administrators.
 - g. Wireless Security
 - h. Video Surveillance and Access Control
- B. The owner shall be able to be involved in all aspects of the configuration.
- C. The network electronics shall be configured with complex authentication credentials (passwords.)
- D. The network electronics shall NOT be configured with default usernames, default passwords or default SNMP community strings.
- E. Configured SNMP community strings shall be protected via an access control list such that only the NMS and Owner selected IP addresses can perform SNMP queries.
- F. The network electronics shall be configured to synchronize internal clocks to a designated internal NTP server.

3.5 USER CONNECTIVITY

- A. The Contractor shall meet with the owner as soon as the project has begun to discuss connectivity of the new data electronics to, but not limited to: Local/Remote users, WAN, WLAN, VLAN, LAN, Printers, etc.
- B. The contractor shall provide a minimum of the detailed quantity of 10/100/1000 Ethernet ports shown on the drawings.
- C. The Owner may provide additional locations where additional 10/100/1000 Ethernet connections shall be made and the contractor shall locate those cables and make plans to connect them to the new data electronics.
- D. When the new electronics are installed, the contractor shall provide all new patch cables for all data connectivity in the rack/cabinet and to the user's device.
 - 1. Patch cables shall be of same category has horizontal cables, fiber cables, etc. and shall be factory made and be matched to the length required between the user patch panel and the data electronics.
 - 2. When installing the new electronics the contractor shall ensure that all patch cables and ports are connected to a user PC or printer.

3.6 ELECTRONICS PLACEMENT

- A. The Contractor shall be responsible for the placement of the data electronics and all its components in the assigned Communications Rooms.
- B. Contractor shall consult with the owner about electronics placement prior to cutover.
- C. All equipment shall be secured in communication racks using the maximum number of screws as there are holes provided by vendor equipment.

3.7 TESTING

- A. The Contractor shall be responsible for energizing and testing each port. This test shall include “Rack-to-Jack” and from main switch and from main switch to switch “stacks”. The contractor shall be responsible for ensuring that the network is in proper working condition.
- B. The Contractor shall be responsible for testing and verifying that all software and management level functions of the system as required by the Owner’s Network system are programmed and operating properly. This includes but is not limited to:
 - 1. Set-up and segregation of VLANs as required by the Owner on a per port and per switch basis.
 - 2. Switch clustering and addressing through a single IP address.
 - 3. Operation of remote monitoring events such as alarm, history, statistics, events, etc.
 - 4. Set-up of multi-level security including MAC addressed-based and terminal access control to prevent unauthorized users from altering the configurations.

5. Set-up and administration of prioritization, quality of service, IP clustering, video multi-casting, VoIP, etc.

3.8 LABELING

- A. All labeling and recording shall be approved by the Owner and the Engineer prior to application.
- B. Provide a printed, computer generated record of each connected port in each switch. Label shall indicate data jack label, port and switch label and closet label.
- C. All supplied devices shall have a label affixed in a visible location on the front and rear of the equipment.
 1. The label shall identify the switch name and IP address.
- D. All labels shall be machine printed.
- E. All copper and fiber patch cables interconnecting switches shall have a self-laminating label affixed on each end of the patch cable.
 1. The label shall identify the switch and port at the opposite end of the cable.
- F. All copper and fiber patch cables interconnecting switches to servers shall have a self-laminating label affixed on each end of the patch cable.
 1. The label shall identify the switch and port at the server end of the cable and the server name at the switch end of the patch cable.
- G. All copper and fiber patch cables interconnecting switches to routers, firewalls and gateways shall have a self-laminating label affixed on each end of the patch cable.
 1. The label shall identify the switch and port at the router end of the cable and the router name at the switch end of the patch cable.

3.9 WORK AREA

- A. The Contractor shall provide a clean and orderly area to work in during system installation.
 1. The work areas shall be cleaned daily. All packing trash and other assorted junk items shall be removed at the end of each workday.
 2. Dust shall be kept to a minimum during the installation. All dust shall be removed prior to the cutover, and then again just prior to project closeout.
 3. The Owner and Engineer shall have access to the work area at any time during normal working hours.
 4. The Owner and Engineer have the right to stop work and seek answers to questions and concerns that may come up during the installation of the new data network.

3.10 UPS

- A. Contractor is to be familiar with other specification sections where system run time is specified in the event of a power outage. It is the contractor's responsibility to configure and provide the required extended battery packs to the UPS units to meet all specified system run times.
- B. Location of the UPS units and Power strips shall be finalized in the communications room or space shown on the drawings prior to installation.
- C. Locate all equipment to be installed, and make certain that space is available for maintenance and service during the life of the system.
- D. If any changes from the drawings are required, the Contractor shall submit a proposed layout of the communications room/racks to the Engineer for approval prior to installation.
- E. Placement of UPS units shall be in the Main Equipment Room and Telecommunications closets
 - 1. All UPS units shall be rack Mounted unless otherwise noted.
 - 2. Mount UPS units on the bottom of the communications racks or cabinets.
 - 3. Mount UPS units using all Manufactures recommended and required hardware.
 - 4. Provide support between the floor and the UPS unit. Wood or Plastic blocks cut to the width of the space between the UPS and the floor shall be installed.
 - 5. Provide all programming for SNMP setup of all UPS units to Owners LAN. Provide all cards and cords for connection to the LAN.
- F. Power strips shall be installed so that they do not interfere with the cable routing, or the installation of components into the rack.
 - 1. Modular plug for the outlet strip shall be installed at the bottom of the outlet strip.
 - 2. All power strips shall plug into UPS units. UPS units shall be plugged into 1 of 2 duplex receptacles installed at the bottom of the rack. Refer to the detailed drawings for receptacle locations.
 - 3. Coil any extra cord from the outlet strip and tie wrap it to the bottom of the vertical cable ladder.
 - 4. Securely attach the outlet strips to the back edge of the vertical cable ladder or Wallfield as per detailed drawings.
 - 5. Electrical outlets are installed by others. Communications Contractor shall be responsible for connecting the power strips to the UPS unit(s) and the UPS unit(s) to the power receptacles.

3.11 TRAINING

- A. Provide the Owner with a minimum of 40 hours of training designed to make all users familiar with the operation of the system. Appropriate hands on training as well as manuals and detailed troubleshooting guides should be given to Owner personnel.
- B. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

- C. Training shall include multiple four-hour sessions encompassing all instructions required for system operation. Provide operators manuals and user guides with training. Provide follow up training after initial training.
- D. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.
- E. Demonstrate adjustment, operation and maintenance of the system including each component and control.

3.12 AS-BUILT DOCUMENTATION

- A. The Contractor shall furnish the Owner two (2) CDs with complete as-built manuals and drawings in an indexed PDF file format. Drawings shall be a minimum of 11”x17” engineering format. These manuals shall contain:
 - 1. System Operating Instructions
 - 2. System Functional Block Diagram(s)
 - 3. System Schematic Diagram(s)
 - 4. System Wiring Diagrams
 - 5. As-Built Drawings of Entire System including Equipment Rack Elevations
 - 6. Component Technical Operation Manuals
 - 7. Component Service Manuals
 - 8. Software Operating Manuals
 - 9. Port and Switch Labeling
 - 10. Final Endurance Test Report
- B. Maintenance Manual: The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
- C. The contractor shall provide a new owner network map indicating all new buildings included in this scope of work. Network map shall include equipment information, IP addresses, VLAN information, etc. Network map shall be prepared utilizing a computer drafting program such as AutoCAD or Visio, and shall be presented in electronic format.

3.13 WARRANTY

- A. If any defects are found within the three (3) year full warranty period, the defective system component shall be replaced at no extra cost to the Owner for part or labor. Provide a statement of this warranty with the O&M Manuals.
- B. During the warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. Resolve any previous outstanding problems.
- C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

- D. The Contractor shall be responsible to provide service during normal working hours on a normal business day within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system components operation, or the loss of the main switch or other dead-end equipment which renders the entire system beyond 50% inactive or un-usable. Provide an on-site authorized factory technician within 24 hours if required.
- E. If equipment cannot be repaired within 24 hours of service visit, Contractor shall supply “loaner” equipment to the Owner at no charge.

3.14 CERTIFICATION

- A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

(This page intentionally left blank)

SECTION 272133 - DATA COMMUNICATIONS WIRELESS ACCESS POINTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. All provisions of the Division 00 and Division 01, apply to all work in Division 27.

1.2 SCOPE OF WORK

- A. This specification section is intended to provide a complete system Wireless Local Area Network Electronics (WLAN) system as indicated herein and as shown on the contract documents.
- B. Provide an IEEE 802.11 Wi-Fi 6 standard and WiFi compliant system of wireless access points (AP), antennas (interior and exterior), Plenum rated AP housings, cabling, RF Management platforms, RF site survey, Mobil Device Management (MDM), Application management, programming, and testing as required to provide a complete and comprehensive WLAN within the specified areas.
- C. The WLAN shall provide support for 4:1 ratio with adequate client support as well as total system throughput:
 - 1. 7Mbps per attached user minimum with the ability to control throughput on a per user level
 - 2. Provide minimum of -65dB signal level at all locations in building for 802.11ax coverage.
 - 3. Provide capacity coverage of 30-90 devices per radio
 - 4. Provide capacity coverage for 30 people per room
- D. Programming of each AP to coordinate with the Owner's LAN Network Operating System and mobile wireless client device configuration and requirements including establishing parameters and operations associated with security, QoS, CoS, VLANs, etc.
- E. Provide and install all labor, tools material and accessories for a complete Data Network WAN comprised of components as listed in Part 2.
- F. This contractor is responsible for supplying the proper configuration to OWNER with quantities and model numbers for a complete working system.
- G. Perform an RF Survey Utilizing a WiFi Survey software tool to verify coverage. Contractor shall provide a written survey report to the Owner technical staff prior to installation. Contractor shall provide an electronic copy of the Project file with the written report.
- H. Owner may opt to have third party site survey verification of the wireless coverage provided by Contractor.
- I. The Contractor shall demonstrate to the Owner and Engineer that the system is complete and complies with all operational requirements set forth in the plans and specs. The contractor shall

provide all miscellaneous items and accessories required to make the system operational whether or not such items are specifically mentions in the plans and specifications.

- J. The contractor shall review all plans and specifications for any detail that may impact the installation of the system. Any discrepancies discovered shall be brought to the attention of the engineer prior to installation.

1.3 SYSTEM DESCRIPTION

- A. The WLAN system shall be an 802.11ax standard and WiFi standard compliant and shall conform to the following minimum requirements:
 - 1. WPA2-AES compliant, WPA3 upgradable with 192-bit encryption
 - 2. Fully WiFi6 and WiFi5 Compliant, including full MU-MIMO, downlink and uplink OFDMA.
 - 3. BLE 5
 - 4. Advanced Cellular Coexistence
 - 5. VoWiFi compliant
 - 6. Comply with all appropriate FCC regulations. This shall be deemed to include the equipment as well as the installation.
 - 7. Provide ubiquitous coverage throughout the facility regardless of frequency band.
 - 8. Utilize POE+ IEEE 802.3at standards for access points.
- B. Provide a system of RF management with features such as Intrusion Detection, seamless Layer 3 roaming, load balancing, self-healing, etc. The WLAN system shall provide real-time awareness and location of all authorized access points and shall provide means and methods to isolate and remove rogue access points automatically.
- C. The WLAN system shall provide intelligent management with such features as support for VLANs and 802.11e QoS features to ensure highest priority to the most sensitive data (such as VoIP and video conferencing).
- D. Patch cables to connect the WLAN AP to the LAN electronics are provided under section 27 21 00. This contract shall be responsible for connection of cable to AP and coordination of exact AP locations with 27 15 13 contractor.
- E. The wireless network and all its components shall be installed so that access is provided to all components for general maintenance and repair.
- F. The wireless network equipment shall connect to various types of new or existing equipment.
 - 1. The contractor shall provide and configure all the equipment required for connecting the wireless network to the local area network.
 - 2. The Contractor shall ensure the wireless network is compatible with any routers, gateways, firewall etc. provided by others.
- G. The contractor shall be responsible for working with the owner, owner's representative or other contractors for the final layout and configuration of the wireless network. This shall include but not be limited to all aspects of Security, VLANS, traffic shaping, IP addressing, integration with servers, DHCP address assignments, traffic prioritization, routing and all other aspects of the configuration of the data electronics.

1.4 QUALITY ASSURANCE

- A. The Contractor shall maintain a fully equipped factory certified service organization which under normal business operations will provide full maintenance and service of the installed system within 24 hours.
- B. The equipment supplier shall have been an authorized distributor of the equipment provided for a minimum of 1 year. The equipment supplier shall provide factory trained technicians for programming, installation support and training of Owner personnel.
- C. All components of the system shall be newly manufactured products. Remanufactured, refurbished or show floor equipment is not permissible.
- D. The system shall be installed with the latest revision of all hardware, firmware and software supported by the manufacturer; as of the date of the solution implementation.
- E. All equipment shall be UL listed.
- F. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- G. All equipment Installation Practices shall comply with the Local Electric Code.
- H. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- I. All equipment and Installation Practices shall comply with the latest BICSI Telecommunications Distribution Methods Manual (TDMM).
- J. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards.
- K. All equipment shall provide protection and containment of unwanted wireless signals and prevent people access to unwanted networks and content, in accordance with CIPA requirements.
- L. FCC/Industry of Canada
- M. CE Marked
- N. R&TTE Directive 1995/5/EC
- O. Low Voltage Directive 72/23/EEC
- P. EN 300 328
- Q. EN 301 489
- R. EN 301 893

- S. UL/IEC/EN 60950
- T. EN 60601-1-1, EN60601-1-2
- U. CB Scheme Safety, cTUVus
- V. UL2043 plenum rating
- W. Wi-Fi Alliance certified 802.11a/b/g/n/ac

1.5 CONTRACTOR QUALIFICATIONS

- A. The Network Electronics system shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the contractor to utilize a sub-contractor for any portion of the work, unless the subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.
- B. The contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.
- C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.
- D. The Contractor shall have had a minimum of 1 year experience with the specified Network Electronics. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The contractor shall provide references and contract information for the project sites in which the qualifying installations occurred.

1.6 SHOP DRAWINGS AND SUBMITTALS

- A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Blue-line drawings shall be prepared and submitted on 30" x 42" paper. Equipment lists, data sheets, etc. Shall be 8-1/2" x 11" size properly bound into a single or multiple volumes.
- B. Submit to the following for approval:
 - 1. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item.
 - 2. Manufacturer's data sheets on all equipment items.
 - 3. System block diagram(s)
 - 4. Equipment rack layouts showing all rack mounted equipment items.
 - 5. Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.

- 1.7 Final Documentation: All final documentation shall be submitted and approved before final acceptance by the Owner will be granted. Within 45 days after completion of the work, deliver to the Owner, four (4) sets of the following:
- A. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers and quantities of each item.
 - B. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts and other designations and codings.
 - C. Complete equipment rack layouts showing all rack mounted equipment items.
 - D. Operations instructions for each major item of equipment furnished.
 - E. Manufacturer's warranty for each major item of equipment furnished.
 - F. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.
- 1.8 COORDINATION
- A. Coordinate the location of the data network electronics and racks with the Electrical Contractor for placement of electrical connections.
 - B. Coordinate the configuration of the data network electronics for compatibility with WAN connections, addressing and routing.
 - C. Coordinate UPS and Power Strip locations with other trades for placement of electrical connections.
 - D. Coordinate all UPS and Power Strip input connectors with electrical contractor.
 - E. Coordinate with the Network Integrators such that the UPS units are communicating with the network utilizing their SNMP cards or IP based web monitoring.
- 1.9 STORAGE OF MATERIALS
- A. All materials shall be secured when not in use by the Contractor.
 - B. It shall be the Contractor's responsibility to secure all equipment including all material to be installed as part of the contract. No changes shall be made to the contract due to loss or theft of equipment and materials not officially accepted by the Owner.

1.10 SYSTEM WARRANTY

- A. The Wireless Area Network Electronics software shall be warranted by the contractor for a period of three (3) years from date of substantial completion.
- B. Provide advanced replacement for all Network Electronics for the three (3) year period.
- C. Provide proof of warranty from manufacturer.

1.11 RELATED WORK BY OTHERS

- A. All conduit with pull strings, all electrical pull boxes, and all outlet boxes shall be furnished and installed under the electrical section of Division 26. Coordinate as necessary for proper installation. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.
- B. All power conductors and conduits associated with power circuits to all equipment locations shall be furnished and installed under the electrical section of Divisions 26. The power to the equipment racks shall be terminated inside the racks to Contractor - supplied isolated ground plugstrips or quad convenience outlets. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.
- C. An insulated #6 AWG stranded copper ground wire from each equipment rack to the building main service ground.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

- A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the “precise functional equivalent” shall result in the removal of the alternate equipment at the Contractor’s expense.
- B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 MANUFACTURERS

- A. Approved Vendors for Wireless Network Equipment:
 - 1. Aruba
 - 2. Ruckus

3. Extreme

2.3 WIRELESS NETWORK--GENERAL

- A. Provide all necessary licenses required for a fully operational system.
- B. Provide Centrally Powered, 802.11ax Wi-Fi AP with 2.5Gbps NBASE-T uplink Wireless Access Points and associated Wireless Network Controller(s) or cloud-based controller, to support wireless Network Devices and Phones throughout the building and the associated campus.
- C. Shall have the ability to manage the AP directly
- D. Dual radios shall support 2.4GHz: 575Mbps (11ax) and 5GHz: 4.8 Gbps (11ax)
- E. Coordinate 802.1X, VLAN and Security Settings/Requirements with the Owner.
- F. Provide ubiquitous wireless coverage for the entire building and associated perimeter area based on capacity (assumption of 2 devices per individual).
- G. Provide minimum of:
 - 1. 3:1 ratio of devices per person
 - 2. -65 dB signal level throughout building for ubiquitous 802.11ax coverage.
 - 3. 7 Mbps throughput per user with the ability to control throughput on a per user level
 - 4. 30-90 devices per AP/radio
- H. Supply sufficient Access Points to provide for expected throughput and load sharing.
- I. The users shall “see” at least 3 Access points to provide for load sharing and balancing.
- J. Wireless Survey
 - 1. Prior to installation of cabling for Access Points, the contractor shall perform an on-site Validation Survey. This survey shall be utilized to obtain actual site conditions including RF environment and RF properties of the construction. Prepare an AP placement plan utilizing the Validation Survey information and using the AP controllers “planning” tools. Provide a report to the Owner and Technology Consultant for review and approval.
 - 2. After complete install of all AP’s, perform a final survey to verify coverage. Move any AP’s required to guarantee that coverage and performance requirements are met. Provide final report to the Owner and Technology Consultant for review and approval.
- K. Coordinate with local Law Enforcement and Safety Forces regarding their requirements for remote and wireless access into building Security and Energy Management Systems.
- L. Law Enforcement and Safety Forces shall be responsible for providing their own remote access equipment.

2.4 WIRELESS CONTROLLER or WIRELESS SOFTWARE FOR CLOUD MANAGED

- A. Scalability and performance

1. 1024 access points
 2. 24,000 clients
 3. 4096 VLANs
- B. RF management
1. Proactively identifies and mitigates signal interference for better performance
 2. Provides both real-time and historical information about RF interference affecting network performance across controllers, through system wide integration
- C. Multimode with indoor, outdoor mesh access points
1. Controller with support for centralized, distributed, and mesh deployments to be used at different places in the network
 2. Centralized control, management, and client troubleshooting
 3. Seamless client access in the event of a WAN link failure (local data switching)
 4. Access point upgrade optimizes the WAN link utilization for downloading access point images
 5. Technology that supports corporate wireless service for mobile and remote workers with secure wired tunnels to indoor access points
- D. Security
1. Client data should be securely encrypted and tunneled from APs to Controller
 2. Management frame protection detects malicious users and alerts network administrators
 3. Rogue access point detection and detection of denial-of-service attacks
- E. Voice Support
1. Supports Unified Communications for improved collaboration through messaging, presence, and conferencing
 2. Supports all Unified IP Phones for cost-effective, real-time voice services
- F. Fault tolerance and high availability
1. Sub-second access point and client failover for uninterrupted application availability
 2. Multi 1 Gigabit or NBASE-T Ethernet connectivity
 3. Solid-state device-based storage – no moving parts
 4. Hot-swappable redundant AC or DC power supply and solid-state storage with no incremental system downtime
- G. Service provider Wi-Fi
1. Wi-Fi Alliance Passpoint (Hotspot 2.0) certified, facilitating hotspot operation for mobile data offloads
 2. Network-based mobility management
- H. Enterprise Wireless Mesh
1. Enterprise Wireless Mesh is ideal for locations where extending a wired connection may prove difficult or aesthetically unappealing: parking lots, playgrounds, stadiums, campus environments

- I. Mobility, security, and management for IPv6 and dual-stack clients
 - 1. Highly secure, reliable wireless connectivity and consistent end-user experience
 - 2. Increased network availability through proactive blocking of known threats

- J. Licensing
 - 1. Provide right-to-use (with End-User License Agreement [EULA] acceptance) license enablement for faster time to deployment, with flexibility to add additional access points as business needs grow.
 - 2. Additional access point capacity licenses can be added over time.
 - 3. Right-to-use licensing (with EULA acceptance) for faster and easier license enablement.

- K. Wireless
 - 1. IEEE 802.11a, 802.11b, 802.11g, 802.11d, WMM/802.11e, 802.11h, 802.11n, 802.11k, 802.11r, 802.11u, 802.11w, 802.11ax Wave1 and Wave2, 802.11ax

- L. Data request for comments (RFC)
 - 1. RFC 768 UDP
 - 2. RFC 791 IP
 - 3. RFC 2460 IPv6
 - 4. RFC 792 ICMP
 - 5. RFC 793 TCP
 - 6. RFC 826 ARP
 - 7. RFC 1122 Requirements for Internet Hosts
 - 8. RFC 1519 CIDR
 - 9. RFC 1542 BOOTP
 - 10. RFC 2131 DHCP

- M. Security standards
 - 1. Wi-Fi Protected Access 2 and 3 (WPA2, WPA3)
 - 2. IEEE 802.11i (WPA2, RSN)
 - 3. RFC 1321 MD5 Message-Digest Algorithm
 - 4. RFC 1851 ESP Triple DES Transform
 - 5. RFC 2104 HMAC: Keyed Hashing for Message Authentication
 - 6. RFC 2246 TLS Protocol Version 1.0
 - 7. RFC 2401 Security Architecture for the Internet Protocol
 - 8. RFC 2403 HMAC-MD5-96 within ESP and AH
 - 9. RFC 2404 HMAC-SHA-1-96 within ESP and AH
 - 10. RFC 2405 ESP DES-CBC Cipher Algorithm with Explicit IV
 - 11. RFC 2407 Interpretation for ISAKMP
 - 12. RFC 2408 ISAKMP
 - 13. RFC 2409 IKE
 - 14. RFC 2451 ESP CBC-Mode Cipher Algorithms
 - 15. RFC 3280 Internet X.509 PKI Certificate and CRL Profile
 - 16. RFC 4347 Datagram Transport Layer Security
 - 17. RFC 4346 TLS Protocol Version 1.1

N. Encryption

1. Wired Equivalent Privacy (WEP) and Temporal Key Integrity Protocol-Message Integrity Check (TKIP-MIC): RC4 40, 104 and 128 bits (both static and shared keys)
2. Advanced Encryption Standard (AES): Cipher Block Chaining (CBC), Counter with CBC-MAC (CCM), Counter with Cipher Block Chaining Message Authentication Code Protocol (CCMP)
3. Data Encryption Standard (DES): DES-CBC, 3DES
4. Secure Sockets Layer (SSL) and Transport Layer Security (TLS): RC4 128-bit and RSA 1024- and 2048-bit
5. DTLS: AES-CBC
6. IPsec: DES-CBC, 3DES, AES-CBC
7. 802.1AE MACsec encryption

O. Authentication, authorization, and accounting (AAA)

1. IEEE 802.1X
2. RFC 2548 Microsoft Vendor-Specific RADIUS Attributes
3. RFC 2716 PPP EAP-TLS
4. RFC 2865 RADIUS Authentication
5. RFC 2866 RADIUS Accounting
6. RFC 2867 RADIUS Tunnel Accounting
7. RFC 3576 Dynamic Authorization Extensions to RADIUS
8. RFC 3579 RADIUS Support for EAP
9. RFC 3580 IEEE 802.1X RADIUS Guidelines
10. RFC 3748 Extensible Authentication Protocol (EAP)
11. Web-based authentication
12. TACACS support for management users

P. Management

1. Simple Network Management Protocol (SNMP) v1, v2c, v3
2. RFC 854 Telnet
3. RFC 1155 Management Information for TCP/IP-Based Internets
4. RFC 1156 MIB
5. RFC 1157 SNMP
6. RFC 1213 SNMP MIB II
7. RFC 1350 TFTP
8. RFC 1643 Ethernet MIB
9. RFC 2030 Sntp
10. RFC 2616 HTTP
11. RFC 2665 Ethernet-Like Interface types MIB
12. RFC 2674 Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering, and Virtual Extensions
13. RFC 2819 RMON MIB
14. RFC 2863 Interfaces Group MIB
15. RFC 3164 Syslog
16. RFC 3414 User-Based Security Model (USM) for SNMPv3
17. RFC 3418 MIB for SNMP
18. RFC 3636 Definitions of Managed Objects for IEEE 802.3 MAUs

Q. Management Interfaces

1. Web-based: HTTP/HTTPS
2. Command-line interface: Telnet, Secure Shell (SSH) Protocol, serial port
3. Cloud based or on premise Network Management Software support

R. Interfaces and Indicators

1. 20Gb of uplink capacity minimum (2 x SFP+ or greater)
2. 1 x console port: Serial port (RJ-45 or USB)
3. LED indicators: Network Link, Diagnostics

S. Regulatory compliance

1. CE Markings per directives 2004/108/EC and 2006/95/EC Safety:
 - a. UL 60950-1 Second Edition
 - b. CAN/CSA-C22.2 No. 60950-1 Second Edition
 - c. EN 60950-1 Second Edition
 - d. IEC 60950-1 Second Edition
 - e. AS/NZS 60950-1
 - f. GB4943 2001
2. EMC - Emissions:
 - a. 47CFR Part 15 (CFR 47) Class A
 - b. AS/NZS CISPR22 Class A
 - c. EN55022 Class A
 - d. ICES003 Class A VCCI Class A
 - e. EN61000-3-2 EN61000-3-3 KN22 Class A
 - f. CNS13438 Class A
3. EMC - Immunity:
 - a. EN55024
 - b. CISPR24
 - c. EN300386
 - d. KN24

T. Warranty three (3) year license with maintenance

2.5 WIRELESS ACCESS POINTS

A. Basis of Design: Aruba 515

B. The Owner requires a new wireless data network that will attach to the wired data network in the communications room. The system shall consist of wireless access points (AP) and management software.

C. The AP's shall be 802.11ax standard, WiFi compliant utilizing multi-band transceivers and shall conform to the following minimum specifications:

1. Indoor 802.11ax 4x4:4 Wi-Fi AP with 2.5Gbps Backhaul
2. Maximum PHY Rate
 - a. 2.4GHz: 575Mbps (11ax)
 - b. 5GHz: 4.8 Gbps (11ax)
3. Wi-Fi Technology

4. Radio Chains:Streams
 - a. 2.4GHz: 2x2:2
 - b. 5GHz: 4x4:4
 5. Antenna Gain (Max) Up to 7.5dBi
 6. USB
 7. Ethernet Ports
 - a. 1x 1/2.5/5 Gbps port (Nbase-T compliant, RJ-45)
 - b. 1x 10/100/1000 Mbps port, RJ-45
 - c. Bluetooth 5 and Zigbee (802.15.4)
- D. Changes to the AP's shall be able to be made globally from one interface.
- E. The AP shall be able to be deployed across any Layer 2 or Layer 3 network and bridge traffic onto the local network, tunnel to a central location
- F. AP shall be able to be deployed as a stand-a-lone AP or as part of a centrally managed wireless LAN
- G. Each AP shall have at least two (2) Gigabit Ethernet ports for aggregated bandwidth
- H. The wireless network access points shall be equipped with 802.11 a/b/g/n/ac/ax radios for multiple connectivity. Each access point shall meet the following specifications.
1. Wi-Fi Standards
 - a. IEEE 802.11a/b/g/n/ac/ax
 2. Supported Rates
 - a. 802.11ax: 4 to 4800 Mbps
 - b. 802.11ac: 6.5 to 3467 Mbps
 - c. 802.11n: 6.5 to 600 Mbps
 - d. 802.11a/g: 6 to 54 Mbps
 - e. 802.11b: 1 to 11 Mbps
 3. Supported Channels
 - a. 2.4GHz: 1-13
 - b. 5GHz: 36-64, 100-144, 149-165
 4. MIMO
 - a. 4x4 MU-MIMO
 - b. 4x4 SU-MIMO
 5. Spatial Streams
 - a. 4 MU-MIMO
 - b. 4 SU-MIMO
 6. OFDMA
 - a. Uplink and Downlink
 7. Channelization
 - a. 20, 40, 80, 160 MHz
 8. Security
 - a. WPA-PSK, WPA-TKIP, WPA2 AES, 802.11i,
 - b. WIPS/WIDS
 9. Other Wi-Fi Features
 - a. WMM, Power Save, TxBF, LDPC, STBC, 802.11r/k/v
- I. Networking
1. Mesh--Self-healing Mesh

2. IP--IPv4, IPv6
3. VLAN 802.1Q (16 BSSIDs / radio)
4. VLAN Pooling--Port-based, Dynamic, per user based on Radius
5. 802.1X--Wired & wireless Authenticator & Supplicant
6. Policy Management Tools
 - a. Application Visibility and Control
 - b. Access Control Lists
 - c. Device Fingerprinting

J. RF

1. Antenna Type (2.4GHz Antenna)
 - a. Omni: 2 Antennas
 - b. Adaptive: 2 Antennas
2. Antenna Type (5GHz Antenna)
 - a. Omni: 4 Antennas
3. Antenna Gain (Max)
 - a. Up to 3.8dBi in 2.4GHz and 4.6dBi in 5GHz
4. Frequency Bands
 - a. 2.4 - 2.484 GHz
 - b. 5.17 - 5.33 GHZ
 - c. 5.49 - 5.71 GHz
 - d. 5.735 - 5.835 GHz

K. The AP's shall provide for rapid traffic forwarding and capabilities that will enable effective real-time and air traffic-management through load balancing.

L. Traffic management shall be used to ensure maximum network uptime. Clients shall be routed around a failed access point to the closest available alternative on a real-time basis without manual intervention.

M. Each AP shall be able to support VoIP wireless phones and dynamically throttle back non-VoIP traffic.

N. Each AP shall have dual channels (2.4GHZ and 5 GHz) and conform to IEEE 802.11ax.

O. Integrated antennas

2.6 ANTENNAS

A. Provide each access point with the integral antennas based upon system configuration and site survey results. Utilize wall mounted antennas for exterior applications.

B. Exterior—Shall be rated for outdoor environment and shall be provided with lightning protection on the cabling. Provide drip loop on cabling entering the building. Both AP and antennas must be external and outdoor rated.

2.7 NEMA RATED ENCLOSURES

A. Used for rugged areas, areas exposed to moisture and outdoor areas.

- B. Basis of Design: Oberon 1021 or equal.
- C. Design: Rugged polycarbonate AP enclosure designed for surface mounting AP indoors or outdoors, including wall mounting, or light pole mounting. Conceal and protect AP, antennas, and cabling
- D. Performance: Designed to NEMA 1, 2, 4, 4X, 12, and 13, and IEC529-IP66 specifications for indoor/outdoor wet, dirty, or corrosive environments. UV-stabilized for exposure to direct sunlight. Transparent to wireless signals. Paintable
- E. Oberon Skybar™-shaped screw on cover with gasket; cover screws must be torqued to 8 in-lbs.; cover screws are recessed into cover
- F. Includes internal universal T-bar bracket and universal mounting panel
- G. Large enough for external antenna, and AP
- H. AP max. operating temperature should be de-rated by 5° C inside the enclosure, when solar loading is not present (See Oberon application note in resources section below)
- I. For outdoor installation, the 1021 is white to reduce solar loading. Painting the 1021 a darker color will increase solar loading. Avoid mounting the 1021 where it is directly exposed to the sun. Temperature rating: -40 to 120° C
- J. Construction: White UL 94 V-0 Polycarbonate Enclosure, Gray UL 94-HB ABS Plastic Universal Mounting Panel, Gray UL 94-HB ABS Plastic Wall Mount Brackets, 18 Ga. White Powder Coated Steel T-bar Bracket

2.8 WIRELESS MANAGEMENT SOFTWARE

- A. RF Management
 - 1. In-band per Spectrum Analysis
 - 2. Dynamic Channel Configuration
 - 3. Dynamic Cell Size Configuration
 - 4. Monitor radio for threat assessment and mitigation
 - 5. Wired and Wireless Packet Captures (including all 802.11 headers)
 - 6. Radio Assurance for radio self-test and healing
 - 7. RF Monitor
- B. High Availability Supports Hot Stand-by for mission critical areas
- C. Supports ability to turn off radios based on schedule configuration or automatically when not in use
- D. Wireless Protocols:
 - 1. IEEE 802.11
 - 2. IEEE 802.11 a
 - 3. IEEE 802.11 b
 - 4. IEEE 802.11 d

5. IEEE 802.11e
 6. IEEE 802.11g
 7. IEEE 802.11h
 8. IEEE 802.11i
 9. IEEE.802.11n
 10. IEEE 802.11ac
 11. IEEE 802.11ax
- E. Wired Protocol
1. IEEE 802.1p—Layer 2 Traffic Prioritization
 2. IEEE 802.1q—VLAN Tagging
- F. RFC Support
1. RFC 768 UDP
 2. RFC 791 IP
 3. RFC 2460 IPV6 (Bridging only)
 4. RFC 792 ICMP
 5. RFC 793 TCP
 6. RFC 1122 Requirements for Internet Hosts - Communication Layers
 7. RFC 1542 BOOTP
 8. RFC 2131 DHCP
- G. Security
1. IEEE 802.11i WPA2, RSN
 2. RFC 1321 MD5 Message-Digest Algorithm
 3. RFC 2246 TLS Protocol Version 1.0
 4. RFC 3280 Internet X.509 PKI Certificate and CRL Profile
 5. RFC 4347 Datagram Transport Layer Security
 6. RFC 4346 TLS Protocol Version 1.1
 7. WEP
 8. WPA™ - Personal
 9. WPA™ - Enterprise
 10. WPA2™ - Personal
 11. WPA2™ - Enterprise
 12. EAP Type(s)
 13. EAP-TLS
 14. EAP-TTLS/MSCHAPv2
 15. PEAPv0/EAP-MSCHAPv2
 16. PEAPv1/EAP-GTC
- H. Encryption Type
1. Open
 2. WEP 64 and 128-bit
 3. TKIP
 4. CCMP/AES
 5. SSL and TLS (RC4 128-bit, RSA 1024-bit, RSA 2048-bit)
 6. L2TP/IPsec

7. PPTP (RFC 2637)
- I. Authentication
 1. IEEE 802.1X
 2. RFC 2548 Microsoft Vendor-Specific RADIUS Attributes
 3. RFC 2716 PPP EAP-TLS
 4. RFC 2865 RADIUS Authentication
 5. RFC 2866 RADIUS Accounting
 6. RFC 2867 Tunnel Accounting
 7. RFC 2869 RADIUS Extensions
 8. RFC 3576 Dynamic Authorizations Extensions to RADIUS RFC 3579 RADIUS Support for EAP
 9. RFC 3748 Extensible Authentication Protocol
 10. Web Page Authentication
 11. WPR, Landing Page, Redirect
 12. Support for Internal WPR Landing Page and Authentication
 13. Support for External WPR, Landing Page and Authentication
- J. Channel Support 2.4GHz
 1. 1 2 3 4 5 6 7 8 9 10 11
- K. Channel Support 5GHz
 1. Uni I - Non-DFS Channels
 2. 36 40 44 48
 3. UNI I DFS Channels
 4. 52 56 60 64
 5. UNI II DFS Channels
 6. 100 104 108 112 116 120 124 128 132 136 140
 7. UNI III Non-DFS Channels
 8. 149 153 157 161 165
- L. Management Interfaces
 1. Command Line Interface via serial console, SSHv2, Telnet
 2. Web Interface (http / https)
- M. Management
 1. SNMP v1, v2c, v3
 2. RFC 854 Telnet
 3. RFC 1155 Management Information for TCP/IP Based Internets
 4. RFC 1156 MIB
 5. RFC 1157 SNMP
 6. RFC 1213 SNMP MIB II
 7. RFC 1350 TFTP
 8. RFC 1643 Ethernet MIB
 9. RFC 2030 Simple Network Time Protocol SNTP
 10. RFC 2616 HTTP 1.1

11. RFC 3636 Definitions of Managed Objects for IEEE
12. RFC 2674 Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions
13. RFC 2819 Remote Network Monitoring Management Information Base
14. RFC 2863 The Interface Group MIB
15. RFC 3164 BSD Syslog Protocol
16. RFC 3414 User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)
17. RFC 3418 Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)

2.9 RADIO OPTIMIZATION MANAGEMENT

- A. Shall individually control band selection (2.4GHz or 5GHz), transmit power, and channel allocation.
- B. Shall have option of controlling band selection either automatically or manually.
- C. Shall support Auto Channel which provides an automatic means of allocating Wi-Fi channels between radios in a deployment.
- D. Shall provide Auto Channel. System scans the RF environment on a radio-by-radio basis, coordinated among all AP's in the network, to determine the best channel of operation per radio.
- E. Auto Channel function shall be scheduled periodically to tune the design in response to potential environmental changes.
- F. Shall support Auto Cell – an automatic, self-tuning mechanism that balances cell size between AP's. Shall ensure sufficient coverage while limiting the RF energy that would extend beyond the organizational boundary between AP's.

2.10 RESOURCE MANAGEMENT

- A. Shall continuously monitor wireless client behavior for potential issues.
- B. If a client is detected encountering connectivity or performance issues, a notification is logged.
- C. Elements to be monitored:
 1. Authentication failures
 2. Packet error rates
 3. Packet retry rates
 4. Data rates
 5. Signal strength
 6. Signal-to-noise ratio.
- D. Shall execute local testing of radio resources and self-healing to ensure wireless service availability.
- E. Automatic interference mitigation, optimized for high-density environments

- F. AP shall be able to perform WIDS and spectrum analysis as well as serve clients simultaneously.
- G. Wireless network controller shall actively monitor the status of key wireless network elements, including RADIUS servers, NTP servers, SNMP trap hosts, and DNS servers. If any of these elements are unreachable, a notification is logged.
- H. The System shall be optionally configured to disassociate users proactively if network resources are not available so that clients do not remain connected wirelessly with no network service.

2.11 DEVICE OPTIMIZATION MANAGEMENT

- A. Wi-Fi devices shall be identified by type upon connecting to the network, e.g. laptop, tablet, smartphone, gaming device, etc.
- B. This information is then used to map the device to specific resources as desired. Dedicated radios and wireless networks (SSIDs) can be assigned to devices that need high bandwidth or are operating in a specific mode.
- C. Shall provide Station Load Balancing

2.12 SECURE WIRELESS NETWORK

- A. Shall perform packet encryption and decryption. All encryption processes are performed at line-rate in hardware.
- B. Wireless encryption supported shall include the standard three encryption options:
 - 1. Wi-Fi Protected Access with AES
 - 2. Wi-Fi Protected Access (WPA2, WPA3) including WPA2 and WPA3 Enterprise
 - 3. WEP-40bit or WEP-128bit --only use this for legacy devices that cannot support a stronger encryption type.
 - 4. WPA3 and Enhanced Open support without hardware upgrade
- C. Should also support TKIP and AES protocols simultaneously on the same SSID to support mixed and dynamic client environments
- D. Shall include PCI and FIPS140-2 audit modes of operation to monitor for compliance.
- E. Shall monitor, detect, mitigate and report on active or potential wireless threats to your network. These include:
 - 1. Continuous 24x7 monitoring of the wireless RF environment
 - 2. Detection of potential rogue or malicious APs, ad hoc, and stations
 - 3. Rogue device classification
 - 4. Automatic alerts, alarms, and logging of rogue devices
 - 5. Key rogue device information such as first seen, last seen, manufacturer, SSID, channel
 - 6. Ensures compliance with wireless security policies and regulations through automated reporting
 - 7. Continuously monitor all 802.11 channels for throughput, signal, noise, errors, and interference levels continually per channel.

- a. Administrators centrally collect data from their desk and monitor the entire network at one time.
 - b. Monitor all 802.11 channels, not just the ones that are currently being used for data traffic.
 8. Provides device locating via analysis of Received Signal Strength Indication (RSSI) data collected by radios. This capability is available via the CLI, Web interface or Network management application, and interfaces/applications at different levels of functionality.
 9. Aggregate data from multiple AP's to determine device positioning. Multi-AP design provides for even greater accuracy than single AP methods.
 10. Locating in normal conditions shall provide accuracy within a 5-meter radius or better.
- F. User access control protocols and features designed to classify, assign and monitor associated and unassociated clients. These include:
1. RADIUS 802.1X
 2. Fully support 802.1X authentication servers.
 3. MAC Access Control Lists (ACLs) supports 512 ACL entries.
 4. Web Page Redirect (Captive Portal) capabilities.
 5. Web based authentication against internal or external RADIUS server
 6. Local host or remotely hosted captive portal or web page redirect (log-in/splash screen)
 7. Failover capability by allowing the specification of primary and secondary RADIUS servers and timeout values.
 8. Each SSID can specify a unique RADIUS server set enabling each SSID independent authentication control
 9. Identify devices by operating systems, such as iOS®, Microsoft®, BlackBerry®, or Android™
 10. Identify devices by type, such as tablet, laptop, or smartphone.
 11. The device ID, along with the user ID, can be used together to map the device to a policy to control a user's reach and behavior.

2.13 GUEST SERVICES

- A. Captive Portal or Web Page Redirect (WPR), allows a guest to be presented with a web browser welcome screen before gaining access to the wireless network.
- B. Directory Integration--Shall integrate with the same systems used for the wired network.
- C. Policy Management--Bandwidth limits can be configured to ensure guest users do not overrun employee traffic usage. Restrictions can be placed on time of day access and day of the week access. Policies can be set to enforce use policies for different device types. Policies can be set and enforced on a user, role, device, and time basis.

2.14 VOICE AND MULT-MEDIA SUPPORT (QoS)

- A. Optimize application support so all standard QoS (802.11e) and Wireless Multi-Media (WMM) features including multiple traffic queues (4) and packet level identification of voice traffic. Wired to wireless QoS mapping (802.11p/q) support. Separate protocol support for the leading providers of 802.11 handsets.

- B. Enable end-to-end QoS support and tag 802.1p packets
- C. Shall have multicast-to-unicast conversion and IGMP snooping to optimize the performance of multicast in a Wi-Fi environment. IGMP (Internet Group Management Protocol) is used to establish and manage the membership of multicast groups. The following configuration options are available
 - 1. Send multicasts unmodified.
 - 2. Convert to unicast and send unicast packets to all stations.
 - 3. Convert to unicast, snoop IGMP, and only send to stations subscribed (send as multicast if no subscription).
 - 4. Convert to unicast, snoop IGMP, and only send to stations subscribed (don't send packet if no subscription).
 - 5. Each SSID can define separate traffic controls based on business requirements, including QoS (VoIP) and QoS tags can also be updated based on policy rules via the integrated firewall.

2.15 SYSTEM REQUIREMENTS

- A. Self-Healing—The system shall detect and automatically re-route traffic due to loss of communications with an access point.
- B. Load Balancing—The system shall monitor AP usage in real-time and shift traffic between adjacent or over-lapping Aps to ensure the most efficient use of wireless bandwidth. The system shall also be able to dynamically allocate signal power between Aps to compensate for changing network traffic and system configuration.
- C. The contractor shall be required to fully review the existing infrastructure and conditions.
- D. The Contractor shall verify that space is available in existing racks/cabinets for all new wireless equipment.
- E. All wireless controller equipment shall mount in standard 19" relay racks or cabinets.
- F. All patch cables required for the entire connectivity of the wireless network shall be provided and installed by the contractor.
- G. The overall intent of the wireless network is to provide complete coverage of the specified area(s) as shown on the detailed drawings.
- H. All electronics provided for the system shall be from the same manufacturer and shall be fully supported by the management system provided by the contractor.
- I. In each communications room the equipment shall be directly connected to a ground bar that is connected to the electrical ground in the building.

2.16 SPARE AP

- A. The contractor shall include with the bid, 10% but no less than ten (10) additional APs that will be applied as needed during the site survey to correct for RF coverage issues. The contractor

shall include 250' of data cable along with termination and testing with each AP for a fully installed and operational AP. In the event that the additional Aps are not required, they shall be turned over to the Owner as “attic stock”.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The Contractor shall make construction manager aware of any the site issues prior to submission of the Bid Response.

3.2 GENERAL INSTALLATION

- A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of system components.
- B. Prior to installation of cabling for access points, the contractor shall perform an on-site validation survey. This survey shall be utilized to obtain actual site conditions including RF environment and RF properties of the construction. The validation survey shall be used by the contractor to fine tune the AP design/lay-out, and set the final quantities and locations of access points. The site validation survey shall be conducted to meet the following minimum requirements:
 - 1. Utilize the appropriate RF sensing equipment to locate, identify and document any sources of RF activity within the area that could degrade or interfere with the WLAN.
 - 2. Evaluate construction and possible obstacles to RF operation to determine final location of all Aps and proper selection of antenna types.
 - 3. Evaluate potential for RF signal leakage outside the building and adjust AP locations, power settings and antennas typed to minimize leakage. The exception is specific areas of the site specifically requested to have WLAN coverage.
 - 4. It is the Contractor's responsibility to program the devices in this section according to the Owner's Network requirements. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming.
 - 5. Provide any miscellaneous equipment such as identification tags, cable tie, wiring harnesses, patch cables (both copper and fiber), stacking cables, etc. necessary for a complete TURNKEY system.
 - 6. Provide all required jumper and patch cables and coordination with the Owner to connection the wired LAN.
 - 7. Install and setup all UPS equipment. Review power down procedures with the Owner.
 - 8. Review and modify document design to achieve minimum -65dBm coverage throughout the building and to support true 1-to-1 client support. Provide detailed report to engineer indicating any proposed changes to the quantity/locations of APs shown on the bid documents.
 - 9. After the system is installed, the contractor shall perform a Network Validation Survey. This survey shall test the actual RF environment with the access points operating and the WLAN system functioning including all APPS designed to operate via the WLAN. The network validation will test, document and provide certification that the various operating

parameters of the WLAN are being met to a degree required by the various APPS running over the WLAN. The network validation survey shall be conducted to meet the following minimum requirements.

10. Finalize channel and power settings of each AP based upon location, proximity to adjacent APs, desired data throughput, desired exterior WLAN coverage and possible sources of RF interference.
11. Review antenna selection and make adjustments to individual APs as required.
12. Verify that the system can meet or exceed the minimum recommendation of 20- 25dB SIR for VoWiFi applications.
13. It is the Contractor's responsibility to program the devices in this section according to the Owner's Network requirements. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming.

3.3 WIRELESS ELECTRONICS PLACEMENT

- A. The Contractor shall be responsible for the placement of the wireless electronics and all of its components in the assigned Communications Rooms.
- B. As per the Drawings, wireless AP cabling drops have been shown based on standard cabling design for AP's.
- C. The actual AP placement on the drawings is for reference only and a means of showing quantities to provide.
- D. Once the RF survey has been completed the contractor shall mount the AP's based on the actual field data gathered from the surveys. This may require the contractor to run patch cords from the existing AP cable drop locations to final mounting locations.
- E. All equipment shall be secured in communication racks using the maximum number of screws as there are holes provided by vendor equipment.

3.4 INTALLATION AND CONFIGURATION

- A. Contractor shall provide and install a wireless system and all associated cabling, POE devices, central controllers/switches and console.
- B. It is the Contractor's responsibility to program the system in this section according to the Owner's wishes. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. The programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.
- C. WLAN Electronics shall provide seamless communications between Windows and Apple machines running TCP/IP protocol. Access points shall be able to accept, route and process Ethernet traffic from either platform provided they are using WiFi compliant client adapters.
- D. Develop a minimum of three levels of wireless access.
 1. Guest
 2. Staff

3. People
 4. Coordinate access privileges, VLAN, Sub-Net Assignments, Resource Allocation, etc. for each group.
 5. Contractor shall configure the wireless network to support Seamless Roaming and Fast roaming among all access points
- E. Enforce User Load Balancing to continually monitor user load and automatically redirect new users to alternative APs.
 - F. Configure Dynamic RF Management to calculate optimal 802.11 channel assignments and radio power transmission levels for all associated APs and adapts to user load, interference, RF obstacles and jamming attacks.
 - G. User RF Optimization shall assimilate client RF data and usage patterns along with basic RF data from access points for improved RF tuning and user performance.
 - H. The switch shall be configured to be VPN and Firewall Compatible. It shall be configured to provide local control of access points and not require any reconfiguration of WAN routers, VPN gateways or firewalls.
 - I. Configure the network to take advantage of the latest Security Standards. It shall include WPA, WPA2, WPA3, 802.11i/802.1x with WEP, Dynamic WEP, TKIP, CCMP, EAP-TLS, TTLS and PEAP, PEAP-TLS.
 - J. Rogue Access Point Protection shall be configured to identify, classify and locate rogue APs.
 - K. Configure the system to allow patrons simple and immediate access to the internet if so directed by the owner.
 - L. The system shall allow administrators to get to local and wide area applications.
 - M. Contractor shall be onsite and shall complete a wireless site survey to coordinate placement of the data cables for the wireless access points. Complete a site survey to ensure that the AP's are placed so that they will cover the entire building for both wireless voice and data and video connectivity.
 - N. Provide the results of the site survey to the owner and engineer prior to installation of the Access Points.
 - O. Balance wireless access points to ensure complete coverage with minimal services degradation.
 - P. Setup Wireless Security and provide for CIPA compliance.
 - Q. The contractor shall be responsible for establishing the graphical floor plans of each building, along with the information required for complete RF management on a building-by-building basis. The floor plans shall be updated with final AP Layouts.
 - R. Then contractor shall be responsible for developing and programming RF characteristics of major building components (walls, floors, windows, doors) of each floor plan to ensure more accurate RF design tool predictions.

- S. The Contractor shall take information from the Owner with regards to wireless assets (laptops, PDA, wireless phone, etc.) and popular asset database to accomplish asset tracking.
- T. Provide complete policy creation and enforcement as required by Owner IT staff. Coordinate with network administrators to create virtual LAN (VLAN), RF, quality of service (QoS), and security policies. Provide multiple unique service set identifiers (SSIDs) with individual security parameters in each building. For example, a “guest” SSID can be secured with Web authentication; a “voice” SSID might be required to take advantage of the WEP, and normal data traffic can be secured using 802.11i or IPsec.)
- U. Provide additional programming related to the radius server in each building to establish additional policy, authentication, and user based privileges.

3.5 IDENTIFICATION/LABELING

- A. Contractor shall identify all major items of equipment and tag all cables with permanent markers to demote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.
- B. All labeling and recording shall be approved by the Owner and the Engineer prior to application.
- C. Provide a printed, computer generated record of each connected port in each switch. Label shall indicate AP served, port and switch label and closet label.
- D. Supply a label for each AP that is installed above the ceiling with the Owner designated coding.

3.6 GROUNDING

- A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.
- B. All grounding and bonding shall be in conformance with the NEC article 250 and as recommended by EIA/TIA—607.
- C. The Division 26 Contractor has provided 120V branch circuitry for use by the contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the system equipment. In no case shall the installation compromise the integrity of the Building Electrical Grounding System.

3.7 TESTING

- A. The Contractor shall be responsible for energizing and testing Aps. The contractor shall be responsible for ensuring that the WLAN is in proper working condition.
- B. The Contractor shall perform a minimum series of on-site RF survey with network verification and include the results in the O&M manuals

1. Visual Inspection—Note condition of interior spaces along with potential barriers/obstacles to RF transmission that may not be shown on the architectural floor plans.
 2. RF Spectrum Test—The Contractor shall walk the site and record the general RF environment that currently exists throughout the building. Special attention shall be paid to RF signals in the 802.11 band.
 3. Ping Test—The Contractor shall walk the site recording a continuous network ping test to validate that there are no significant quantities or response time out events. Areas which result in a high number of time-out request (more than 5%) consistently long ping times (more than 5 ms) shall be flagged for further evaluation in the RF survey and AP configuration.
 4. Packet Analyzer—The final AP configuration showing channel utilization, SSIDs, device MAC addresses and associated compiled signal strength measurements of a site walk.
 5. Active Test—Perform active network tests in a minimum of 5 rooms throughout the building. The Media Center, and the Cafeteria utilizing a variety of typical network applications such as email, Web browsing, file downloads, and streaming video. Test shall be witnessed by the Owner/Engineer.
- C. After the system is installed, the contractor shall perform a Network Validation Survey while building is fully occupied. This survey shall test the actual RF environment with the Aps operation and the WLAN system functioning including all applications designed to operate via the WLAN. The network validation with test, document and provide certification that the various operating parameters of the WLAN are being met to a degree required by the various applications running over the WLAN. The network validation survey shall be conducted to meet the following minimum requirements:
1. Finalize channel and power settings of each AP based upon location, proximity to adjacent Aps, desired data throughput, desired exterior WLAN coverage and possible sources of RF interference.
 2. Review antenna selection and make adjustments to individual Aps as required.
 3. Verify that the system can meet or exceed the minimum recommendation of 20-25dB SIR for VoWiFi applications.
- D. The Contractor shall be responsible for testing and verifying that all software and management level functions of the system as required by the Owner's Network system are programmed and operating properly. This includes but is not limited to:
1. Set-up and segregation of user groups. VLANs, security and authentication as required by Owner.
 2. Set-up of multi-level security including authentication and encryption.
 3. Set-up and administration of prioritization, quality of service, VoIP, etc.

3.8 TRAINING

- A. Provide a minimum of sixty (60) hours of training to the Owner's personnel and/or designated representative. Plan for multiple training trips to the site. Training session(s) shall cover the following topics at a minimum:
1. System Equipment Connectivity
 2. Device Configurations

3. Operation, maintenance, and upgrade procedures.
 - B. Trainer must be certified by the manufacturer.
 - C. Training shall be coordinated with the Owner. Coordinate time, use and availability of equipment with the Owner.
 - D. Demonstrate adjustment, operation and maintenance of the system including each component and control.
 - E. Provide a copy of a sign off sheet (signed by Owner staff) for the completed training with the close-out documents.
 - F. Provide two (2) video copies of the training sessions.

3.9 AS-BUILT DOCUMENTATION

- A. The contractor shall furnish the Owner complete as-built manuals in an indexed PDF format. They shall contain:
 1. System Operating Instructions
 2. System Functional Block Diagrams
 3. System Schematic Diagrams
 4. System Wiring Diagrams
 5. As-Built Drawings of Entire System including Equipment Rack elevations
 6. Component Service Manual
 7. Software Operating Manuals
 8. Final Endurance Test Report
- B. Maintenance Manual: The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

3.10 WARRANTY

- A. If any defects are found within the three (3) year full warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor. Provide a statement of this warranty with the O&M Manuals.
- B. During the warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. Resolve any previous outstanding problems.
- C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- D. The contractor shall be responsible to provide service during normal working hours on a normal business day within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system components operation, or the loss of the main switch or other head end equipment which renders

the entire system beyond 50% inactive or un-usable. Provide an on-site authorized factory technician within 24 hours if required.

- E. If equipment cannot be repaired within 24 hours of service visit, the Contractor shall provide “loaner” equipment to the Owner at no charge.
- F. APs shall have a “Limited Lifetime” warranty minimum.

3.11 CERTIFICATION

- A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

END OF SECTION 272133

(This page intentionally left blank)

SECTION 273123 - IP TELEPHONE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes a VoIP solution by Mitel or NEC solution. The handsets are to include necessary hardware, licenses, etc. Voice mail will be set up and programmed, licenses are to be provided for each phone.
- B. This section includes providing all the equipment specified within this section and installing all physical connections for the system to be fully operational and integrated with other systems specified within the building. Provide installation of the equipment per this specification. Provide all documentation required within this document and onsite technical assistance for, what has been provided, during the owner's implementation and integration to the system. All programming and configuration for the IP voice communication system shall be coordinated with the owner.
- C. Provide all analog connections within the building to each device needed as defined in the construction documents and specifications from the local service provider demarcation.
- D. Manufacturer support for Open System Standards: The manufacturer should be committed to supporting open system industry standards, such as H.323, 802.1p and 802.1q, MGCP, TAPI, JTAPI, etc.
- E. Voice Messaging: Scalable, cost-effective voice messaging solution that supports industry standards, such as AMIS-A, VPIM, LDAP and IMAP.
- F. Provide all additional devices, connections, and programming as needed for intercom devices and auxiliary annunciator as shown on drawings.
- G. The telephone system shall adhere to the following:
 - 1. Keri's Law – requires direct dial 911 without using a code.
 - 2. Ray Baum's Act – requires the call origination location be identified

1.3 SCOPE OF WORK

- A. Provide all new phones and provide limited call availability via local POTS lines in the event of communications failure.
- B. Coordinate installation with Owner.

- C. The VoIP telephone system shall be inter-connected with the Central Sound System to provide paging, time tone and emergency tone activation from any telephone on the system with proper access code.
- D. UTP patch cables to connect telephone system patch panel/cabling in each wiring closet are furnished under the specification Section 27 15 13. This contract shall be responsible for installing and labeling all patch cables between patch panels to activate telephone handsets.

1.4 SYSTEM DESCRIPTION

- A. Contractor shall coordinate the installation of central office services. The campus system shall provide a single point of connection to incoming telephone services and the ability to share these incoming lines with each building.
- B. System shall provide analog trunk ports and access to the paging system. Provide hardware and wiring to interface with building paging system. Provide eight (8) interconnection ports in each building.
- C. Provide Power Failure Transfer (PFT) unit for 911 and emergency back-up including one (1) PFT emergency backup phone.
- D. Provide five (5) analog lines within each building. Coordinate exact location with Owner.

1.5 QUALITY ASSURANCE

- A. All equipment shall be UL listed.
- B. Compliance with the National Electric Code.
- C. Compliance with FCC rules.
- D. Comply with latest NENA E-911 requirements.
- E. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.
- F. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.
- G. All materials furnished under this contract shall be new, of highest quality, and shall be of a regularly manufactured line, currently in production at the time of installation.

1.6 CONTRACTOR QUALIFICATIONS

- A. The handsets shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the system contractor to utilize a subcontractor for any portion of the work, unless the subcontractor has been approved in writing by the Architect/Engineer based upon adherence to the qualifications listed herein.

- B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Architect/Engineer.
- C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.
- D. The Contractor shall have had a minimum of one (1) year experience with the specified telephone system. This experience shall include having completed a minimum of two (2) installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.7 SHOP DRAWINGS

- A. A complete list of materials with mode and part numbers and references to the Part 2 specification paragraph numbers.
- B. Manufactures Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.
- C. Qualifications
 - 1. A statement of contractor’s qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.
- D. Software data—The data package shall consist of manufacturer’s data sheets of all system and application software being provided with sufficient information to verify that all specified features and functions are being addressed.

1.8 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted below under the following conditions and then only after arranging temporary utility services according to requirements indicated:
- B. Notify Architect not less than two days in advance of proposed utility interruptions.
- C. Do not proceed with utility interruptions without Architect's written permission.

1.9 COORDINATION

- A. Coordinate Work of this Section with the owner, owner’s integrator, owner’s ITC-site, CM and Architect.
- B. Meet jointly with representatives of above organizations and Owner’s representatives to exchange information and agree on details of equipment arrangements and installation interfaces.
- C. Record agreements reached in meetings and distribute record to other participants.

- D. Adjust arrangements and locations of distribution frames, patch panels, and cross connects in equipment rooms and wiring closets to accommodate and optimize arrangement and space requirements of all related equipment.
- E. Confirm a schedule time frame that all equipment will be installed, all documentation will be delivered that is needed for the implementation, and service provider requirements and installation time frame.
- F. Coordinate telephone system with requirements of local telephone exchange carrier. The telephone service shall be a 10Mbit fiber connection through the A-site local router then to the router specified within, and analog lines for the router for remote survivability. Connect all analog lines assigned by owner to router. Remaining lines will connect to auxiliary devices as indicated by the owner.
- G. Coordinate with all other trades and provide connection interfaces as applicable.
- H. Coordinate all power and load requirements with UPS requirements so that all UPS equipment is properly sized for submittals.

1.10 WORK BY THE LOCAL TELEPHONE COMPANY

- A. The local telephone company shall provide the main entrance from their telephone grid outside through the building to the telephone room as shown on the Drawings.
- B. This Contractor must coordinate all requirements with the local serving utilities.

1.11 CHARGES AND REQUIREMENTS BY THE LOCAL TELEPHONE COMPANY

- A. The Technology/Telephone System Contractor shall install the telephone enclosure, conduits, cable and trench complete as directed or as required by the local telephone company. Additionally, the contractor shall initiate the calls for the owner as they engage the local Telco to adapt and/or upgrade their telephone service.

1.12 SYSTEM WARRANTY

- A. Provide one (1) year warranty of the IP telephones against defects in material and workmanship. If any defects are found within the warranty period, the defective equipment shall be replaced at no extra cost to the Owner for parts or labor.
- B. The telephone vendor shall be responsible to provide service during normal working hours within (8) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of outside line capacity, the loss of 25% or more of telephone stations, or the loss of the main console.
- C. If equipment cannot be repaired within 24 hours of service visit. Contractor shall provide “loaner” equipment to the Owner at no charge.

PART 2 - PRODUCTS

2.1 GENERAL

- A. This specification is intended to establish a carefully planned minimum level of quality and performance for all components, and will be rigorously enforced by the Owner. Acceptable manufacturers of components described herein are:

1. Ericsson-LG iPECS UCP Basis of Design
2. NEC
3. Mitel

2.2 IP TELEPHONES

- A. This specification is intended to establish a carefully planned minimum level of quality and performance for all components, and will be rigorously enforced by Owner.

B. General Requirements

1. The telephone sets shall be multifunction fully digital sets with full duplex speakers.
2. All telephones shall receive Power-Over-Ethernet from powered switches. All telephone sets shall be IEEE 802.3af compliant. Power supplies at the handsets are not acceptable.
3. All telephone sets shall be the latest model available.
4. Provide all required licenses for all telephones.
5. System shall be provided with all equipment to support connections to equipment such as distance learning, video conferencing equipment, digital fax, etc.
6. As a minimum, the system telephone sets shall support the following features:
7. Access Codes (for restricting long distance or local calling)
8. All call, zone call, and room call Voice Page with integration to PA system.
9. Automatic Dialing Buttons
10. Automatic Hold/Park Recall
11. Automatic Location Identifier
12. Automatic Number Identification Support
13. Automatic Off-Hook Line Selection
14. Background Music (while on hold)
15. Call Accounting
16. Call Conferencing
17. Call Forwarding on busy
18. Call Hold.
19. Call Transfer
20. Direct Inward Dialing
21. Do Not Disturb
22. Flash Button
23. Handsfree full duplex speakerphone
24. Hearing Aid Compatible
25. Malicious Call Trace/Hold

26. Message Waiting Light
27. Modular Handset and Line Cord
28. On-Hook Dialing
29. Programmable panic button
30. Repeat Last Number Dialed
31. Ringing Line Preference
32. Saved Number Redial
33. Station Speed Dial (50 Numbers Per Station)
34. User Programmable Feature Buttons
35. Volume Control

2.3 ATTENDANT CONSOLE TERMINAL—PROVIDE TWO (2) IN EACH SECRETARIAL AREA

- A. LIP-9030 Ericsson-LG iPECS with LIP-9048DSS side car.
- B. IP multi-lined keyset
- C. Minimum of 32 Character LCD Display.
- D. Display day, date and time.
- E. Display call durations.
- F. Display caller name and extension/telephone number and incoming caller-ID information.
- G. Hands free, Full-Duplex, Speakerphone.
- H. Pre-programmed E-911 button that automatically puts the phone into a hands-free mode, and initiates a 3-way conference call with the Emergency Attendant Console, records and sends email alerts as well as provide overhead page alerts while contacting the local 911 center.
- I. Shall have a system display panel capable of showing all system extension numbers and their status and capable of extending calls via single touch operation.
- J. Provide a button and LED in attendant console for each telephone in the building. This will show which phones are in use in the system, and will allow “one button” connection to all extensions. A separate console must be provided for each building.
- K. Provide any additional licenses required.
- L. Provide each set with a 12’ connector cord to interface with the specified voice jacks.
- M. Provide Unit Price

2.4 EXECUTIVE DISPLAY DIGITAL VOICE TERMINAL—ADMINISTRATION ONLY

- A. Ericsson-LG iPECS **LIP-1020i**
- B. Provide executive phone for all administrative areas, conference rooms, small group rooms, and offices.
- C. At least sixteen characters display window.
- D. At least **sixteen** user programmable keys.
- E. Hands free, Full-Duplex, Speakerphone.
- F. Display caller name and extension/telephone number.
- G. Message Waiting Lamp.
- A. Pre-programmed E-911 button that automatically puts the phone into a hands-free mode, and initiates a 3-way conference call with the Emergency Attendant Console, records and sends email alerts as well as provide overhead page alerts while contacting the local 911 center.
- B. Provide any additional licenses required.
- C. Provide Unit Price
- D. Provide six (6) additional phones and licenses

2.5 STANDARD DISPLAY DIGITAL VOICE TERMINAL

- A. Ericsson-LG iPECS LIP-9008 (10/100) or LIP-9008G Gigabit
- B. Provide one standard 8 button phone for all other areas not covered above in section 2.3.
- C. At least sixteen characters display window.
- D. At least eight (8) programmable keys.
- E. Hands free, Full-Duplex, Speakerphone.
- F. Display caller name and extension/telephone number.
- G. Message Waiting Lamp.
- H. Pre-programmed E-911 button that automatically puts the phone into a hands-free mode, and initiates a 3-way conference call with the Emergency Attendant Console, records and sends email alerts as well as provide overhead page alerts while contacting the local 911 center.
- I. Provide any additional licenses required.

- J. Provide Unit Price
- K. Provide six (6) additional phones and licenses

2.6 Analog Telephone Adapter

- A. UCP-SLTM4
- B. 4-port analog telephone adaptor to turn analog phones into IP phones.
- C. Power supply
- D. Provide a minimum of one.

2.7 LIGHTNING PROTECTION

- A. Provide UL listed combination primary/secondary protector between the Telco. DMARC primary protector and the telephone switch CO port connections. Protector shall provide solid state surge protection and PTC self-resetting sneak current protection. Coordinate proper surge voltage rating for incoming lines with telephone company prior to application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. FCC registration number and certificate shall be provided.
- B. Install systems in accordance with NEC 760 and other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.
- C. Coordinate complete system installation, and Technology Head End Integration with Owner and other Technology Trades.
- D. Coordinate installation and interconnect with local and long-distance Service
- E. Provider (SP). Contractor shall be responsible for all final cross connects and system Data Base loading and verification.
- F. Contractor shall connect to, and interface with the in-house paging system and provide paging from any telephone handset.
- G. Connect system to IP Data Network and program required VLANs and 803.11e support.
- H. Interconnect with existing systems via VoIP trunking.
- I. Integrate system with Owner's Numbering Plan.

3.2 NETWORKING LICENSE

- A. Provide all necessary IP networking licenses as required to provide a complete working solution for all network devices.
- B. Provide a network licenses for spare equipment and all identified attic stock.

3.3 GROUNDING

- A. Ground cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Bond all rack mounted equipment to the Common Grounding Network within the equipment rack or cabinet using an equipment bonding jumper kit. The cabinet/rack grounding busbar shall be bonded to the electronic equipment bonding pad using a minimum #6 AWG insulated copper bonding conductor with a green jacket and yellow horizontal stripe using compression style lugs. Using the manufacture supplied grounding lug when available, attach one end of the binding jumper to the equipment bonding pad. Attach the remaining end to the equipment grounding busbar in the equipment rack/cabinet. If an equipment bonding pad is not available, follow the equipment manufacturer's recommendations for bonding the equipment chassis. Provide bonding conductor length as required to reach the grounding busbar.

3.4 SYSTEM PROGRAMMING

- A. Contractor shall provide the Owner/architect with a complete set of forms for the
- B. entire system and extension features for final programming.
- C. Final programming of the system shall be co-developed between the Owner/architect and the contractor and must be approved prior to being implemented for system start-up.
- D. Contractor shall supply the "latest" software updates as part of the system
- E. configuration for two (2) years after system acceptance.

3.5 IMPLEMENTATION

- A. Provide on-site technical assistance that is capable of all installation criteria within this specification for the scheduled implementation by the owner and the owner's owner representative. Assist with any identification of system components and connections as needed. On-site assistance is to assure there are no issues with the scope of this specification during the implementation.
- B. The implementation will include final system configuration by the owner's representative, and testing with owner of all call routing, user functions from each handset device, remote survivability testing, paging, and all other analog and telephone adapter devices.
- C. The owner's representative will perform the following:

1. Review topologies and bill of materials.
2. Configure the following:
 - a. Network switches
 - b. UCP gateways
 - c. UCP call Manager
 - d. Telephone sets
 - e. Develop dial plan.
 - f. Final testing of all network devices.
 - g. Phone feature deployment.
 - h. End-user Training.

3.6 FIELD QUALITY CONTROL

- A. Testing agency to perform the following field quality-control testing:
- B. A factory trained/certified technician shall test connectivity and operation of instruments at the completion of the installation of the telephone equipment and shall provide the Owner and Architect/Engineer a checklist test report showing that the system is fully operational.
- C. Notify the Owner and Construction Manager/Engineer at least 72 hours prior to start of the test.
- D. All deficiencies discovered in cabling, wiring, etc. provided by other trades, shall be reported to the Owner and Architect/Engineer for correction by the trade providing the work.
- E. All deficiencies discovered with equipment provide within this specification shall be replaced, such as equipment dead on arrival or failing during burn in time.

3.7 IDENTIFICATION/LABELING

- A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.
- B. The Contractor shall be responsible for generating and programming the labeling for camera information within the recorder software.
- C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.8 TELEPHONE SERVICE

- A. Provide all labor and material required to make all final connections to the telephone service provider(s) Demarcation location and equipment. Coordinate with Owner selected telephone service provider(s).

3.9 TRAINING

- A. Contractor shall provide a minimum of sixty (60) hours of system user training. Sixteen (16) hours of attendant console training and forty hours (40) of system programming and

administration training to the Owner. Training shall be provided to all staff and shall be scheduled in advance with the Owner.

- B. Provide all training and utilize specified manuals and record documentation. Training shall be provided to all staff at the project site and coordinated with the Owner.
- C. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.
- D. Demonstrate adjustment, operation and maintenance of the system including each component and control.
- E. All training shall be recorded and stored in digital content for the Owner's future use. Contractor is responsible for providing required video recording and digital encoding equipment.

3.10 PROJECT RECORD DOCUMENTS

- A. Submit in accordance with Section 27 05 00 for the complete system. Record drawings shall include and indicate all components of the installed systems, including the routing of conduit, raceways and cable.
- B. Drawings shall be coordinated and referenced to the O&M manuals and related wiring diagrams. Floor plan drawings shall be 0.125"=1' AutoCad drawings to provide for clear, legible documents. Provide the Owner a digital copy containing all final AutoCad drawing files of the entire system and the floor plans.
- C. Component Operation Manual including technical data sheets
 - 1. Control Settings
 - 2. Amplifier load
- D. Information for reordering replacement parts
 - 1. Provide a replacement parts list
 - 2. Provide a list of recommended parts, tools, and instruments for testing maintenance purposes.
- E. Wiring Diagrams/details
 - 1. System functional block diagrams
 - 2. System schematic diagrams
 - 3. System wiring list
 - 4. Identify terminals to facilitate installation, operating and maintenance
- F. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.
- G. Component Service Manual: Include information for testing, repair, troubleshooting, assembly, disassembly, and required/recommended maintenance intervals.

END OF SECTION 273123

SECTION 27 32 44 - EMERGENCY RESPONDER RADIO COVERAGE TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Conditions, Special Conditions, Instruction to Bidders and all applicable portions of Division 1 – GENERAL are part of this Section as if written in full herein. Contractor is held to have familiarized himself with these provisions contained herein.

1.2 DESCRIPTION OF WORK

- A. Provide radio frequency testing for emergency responder radio coverage throughout the building for all first responder radio frequencies in use by the Authority Having Jurisdiction.

1.3 QUALITY ASSURANCE

- A. Codes and Regulations

- 1. Ohio Fire Code, Rule 1301:7-7-05, Paragraph (J)(2) 510.2
- 2. NFPA 1
- 3. NFPA 72 – Chapter 24
- 4. TIA TSB-88.1-D – Wireless Communications Systems Performance in Noise and Interference - Limited Situations Part 1: Recommended Methods for Technology - Independent Performance Modeling

- B. Qualifications

- 1. A valid FCC issued general radio operators license and certification of in-building system training issued by a nationally recognized organization, school or a certificate issued by the manufacturer of the equipment being installed; or
- 2. A professional engineer license or certification (i.e. P.E. or RCDD).

- C. Definitions

- 1. AHJ – Authority Having Jurisdiction
- 2. RF – Radio Frequency
- 3. DAQ – Delivered Audio Quality

PART 2 – PRODUCTS

- A. Not Used

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Contractor shall submit the following:

1. Copies of Contractor certifications as required in section 1.03-B.
2. A list of the frequencies to be tested.
3. Cut sheets of the instruments used for testing. Instruments shall be approved by the Owner or Engineer.
4. Contact information of the AHJ official.

3.2 TESTING

A. Before testing, the Contractor shall verify and/or coordinate the following with the AHJ:

1. All frequencies used by the first responder radio system.
2. Utilization of repeaters or boosters in the radio system, and if so, where they are located.
3. AHJ representation during the test. If representation is required, any costs involved shall be included in the Bid.

B. The radio frequencies used by the AHJ shall be tested to ensure two-way coverage on each floor of the building to ensure the following:

1. Measurements in 95 percent of all areas on each floor of the building meet the following signal strengths:
 - a. Minimum signal strength into the building shall be -95 dBm.
 - b. Minimum signal strength out of the building shall be -100 dBm.

C. The following testing procedure shall be followed:

1. RF Signal Strength Test
 - a. The test shall be conducted using a calibrated portable radio of the latest brand and model used by the public agency in question, talking through the agency's radio communication system.
 - b. Contractor shall verify with public agency officials on which frequencies are to be tested.
 - c. If the presence of public agency officials are required to be present for the test, it shall be at no expense to said agency.
 - d. Each floor of the building shall be divided into a minimum of twenty (20) approximately equal test areas.
 - e. A spot located approximately in the center of each test area shall be selected for the test, then the radio will be keyed to verify two-way communications to and from the outside of the building through the public agency's radio communication system. Once the test spot has been selected, that spot shall represent the entire test area and failure in the selected spot shall be considered failure of that test area. Prospecting for a better spot within the test area is not permitted.
 - f. Measurements shall be made with the antenna held in a vertical position at three (3) to four (4) feet above the floor to simulate portable radios worn on the belt or turnout coat pocket.
 - g. A maximum of one (1) or (5 percent) of nonadjacent test areas shall be allowed to fail the test per floor.
 - h. In the event that three or more (or >5 percent) test areas fail the 20 area test, in order to be more statistically accurate, the floor shall be divided

into forty (40) equal test areas. In such an event, a maximum of two (2) or (5 percent) nonadjacent areas will be allowed to fail the test per floor. If the system fails the 40 area test, the system shall be altered to meet the 95 percent coverage requirement per floor.

- i. The gain values of all amplifiers shall be measured and the test measurement results shall be kept on file with the building Owner so that the measurements can be verified during annual tests.
- j. As part of the installation, a spectrum analyzer or other suitable test equipment shall be utilized to ensure spurious oscillations are not being generated by the subject signal boosters.

2. Signal Quality Test

- a. For quality purposes, DAQ readings shall be taken at the same time as the above RF signal strength measurements. The DAQ scale is as follows:
 - 1) DAQ 1: Unusable. Speech present but not understandable.
 - 2) DAQ 2: Speech understandable with considerable effort. Requires frequent repetition due to noise or distortion.
 - 3) DAQ 3: Speech understandable with slight effort. Requires occasional repetition due to noise or distortion.
 - 4) DAQ 3.4: Speech understandable without repetition. Some noise or distortion present.
 - 5) DAQ 4: Speech easily understandable; little noise or distortion.
 - 6) DAQ 4.5: Speech easily understandable; rare noise or distortion.
 - 7) DAQ 5: Perfect; no distortion or noise discernible

3.3 DOCUMENTATION

- A. Upon completion of the testing, the Contractor shall provide test results for approval by the Owner or Engineer. The test results shall be in the form of building floor plans with each floor overlaid with the test grid used in the testing procedures above. Each grid on the drawings shall show the test results measured for uplink signal, downlink signal and DAQ measurement for that grid square.
- B. Test results shall indicate weather conditions at the time of the testing (i.e. temperature, humidity, fog, rain, snow, etc.).
- C. Small scale drawings (11" x 17" maximum) of these same test results shall also be included in the O&M documentation.

(This page intentionally left blank)

SECTION 274118 -- CONFERENCE ROOM AUDIOVISUAL SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. Provide a complete small conference room audiovisual system as defined in these specifications, floor plans and shown on the line drawings. All audio and video components will be professionally installed and fully integrated for ease of use. A complete system includes all audio and video components as well as connecting cables and hardware.
- B. Rooms:
 - 1. 141
 - 2. 132
 - 3. 110
- C. The work described by this section includes the furnishing of all materials, equipment, labor and service and the performance of all operations necessary for the installation of gym sound systems in operating condition as indicated on the drawings and herein.
- D. In general, the conduit, electrical circuits and outlets shall be furnished and installed by the Electrical Contractor. The entire responsibility of the system, its operation and function shall be that of the Systems/Electrical Contractor.
- E. Provide all licenses, permits as may be applicable
- F. Provision of submittal information
- G. Installation in accordance with contract documents, manufacturers' recommendations and applicable codes
- H. Programming and configuration of control and signal processing software
- I. Complete system testing and adjustments, including documentation thereof
- J. Demonstration of complete system operation for approval
- K. System operations training of owner's staff including set up and assistance of up to three events
- L. Testing and adjustments, including documentation thereof
- M. Provision of custom manuals to fully detail system operation and maintenance
- N. Maintenance and warranty services

1.3 APPLICABLE REFERENCES:

- A. National Electric Code (NEC)
- B. Underwriters Laboratories (UL)
- C. Sound System Engineering (Davis & Patronis) - 3rd Edition 2006

- D. Audio Systems Design and Installation (Giddings) 1990
- E. Telecommunications D NFPA 70 - National Electrical Code.
- F. Underwriter's Laboratory.
- G. TIA/EIA-607 Telecommunications Grounding.
- H. 11th Edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM).
- I. American with Disabilities Act.
- J. Federal Communications Commission Part 15.
- K. Sound System Engineering (Davis & Patronis) – 3rd Edition 2006.
- L. Audio Systems Design and Installation (Giddings) 1990.
- M. BICSI Telecommunications Distribution Methods Manual (TDMM)

1.4 QUALITY ASSURANCE

- A. The intent of these Specifications is to describe and provide for a complete Audiovisual Presentation and Sound Reinforcement System of professional quality and reliability. Professional performance standards as provided by a qualified and experienced sound systems contractor (hereafter referred to as Systems Contractor) will be required. References and documentation of the System Contractor's experience and following qualifications shall be provided, if requested.
- B. The Systems Contractor shall:
 - 1. An authorized dealer/service organization for all major items of electronic equipment furnished.
 - 2. Have completed, within the past two (2) years the satisfactory installation of at least three (3) systems of similar size and type as that herein specified.
 - 3. Maintain a factory trained service department on call 24 hours a day, 365 days a year, to service the specified product.
 - 4. Employ, on a full-time basis, a qualified audio/electronics Engineer under whose direction and supervision the entire installation shall be carried out. AVIXA CTS, NICET or C-EST audio certification required.
 - 5. Audinate Dante Level 2 Certification required
 - 6. Certified Crestron Programmer and DMC-E required. Or Equal certification from AMX or Extron.
- C. Employ, on a full-time basis, technician(s) who are experienced in the installation of sound reinforcement equipment, its interconnection and setup. Qualified technicians shall perform the assembly, wiring, interconnection setup and programming of all equipment, jacks and devices. AVIXA CTS, NICET or C- EST audio certification required.
- D. The Systems Contractor shall coordinate final utility rough-in locations with actual equipment furnished. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, manufacturer's recommendations and all applicable code requirements.
- E. In all cases, the Owner and Engineer shall determine the acceptability of the work based upon site visits and observations.

1.5 COOPERATION AND COORDINATION

- A. Cooperate and coordinate as required with the other contractors who are responsible for work not included in this section.
- B. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, manufacturer's recommendations and all applicable code requirements.
- C. Coordinate final utility rough-in locations with actual equipment furnished.
- D. Provide any and all information as required or requested by the Owner, Engineer, or General Contractor in order for this work to be completed to the satisfaction of the Owner, and in the best interests of the Project. Such assistance or information shall be transmitted in writing to the requesting party in all cases.
- E. Contractor is required to attend a minimum of 4 onsite meeting with the construction team to review and coordinate all cabling infrastructure, pathways, device rough ins, device mounting, etc. It is the contractor's responsibility to make sure onsite rough in for the audiovisual is provided by the construction team to meet the needs of the system they are providing.

1.6 SYSTEM WARRANTY

- A. Guarantee all parts, labor and workmanship furnished under this contract for the minimum period of twelve months from the date of substantial completion, or first formal use by the Owner, whichever is last to occur.
- B. During the warranty period, report to the site and repair or replace any defective materials or workmanship without cost to the Owner. Warranty service shall be rendered within 24 hours after request by the Owner. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.
- C. Where manufacturers' warranties on certain equipment exceed twelve months, the guarantee period on that particular equipment shall match the extended warranty period.
- D. Provide assistance to the Owner during the guarantee period of the system, as required to ensure maximum Owner satisfaction.
- E. Upon completion of the work, the contractor shall submit a signed Certificate of Warranty, stating commencement and expiration dates and conditions of the warranty. Incremental warranties for completed portions of the work may be negotiated at the discretion of the Owner, if delays occur beyond the control of the Contractor

1.7 SHOP DRAWINGS AND SUBMITTALS

- A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Blue-line drawings shall be prepared and submitted on 30" x 42" paper. Equipment lists, data sheets, etc. Shall be 8-1/2" x 11" size properly bound into a single or multiple volumes.
- B. Submit to the following for approval:
 - 1. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item referencing the section number in Part 2 of this specification.
 - 2. Manufacturer's data sheets on all equipment items.
 - 3. System block diagram(s)
 - 4. Equipment rack layouts showing all rack mounted equipment items.

5. Floor plans, prepared at a scale of not less than 1/8" = 1'0", showing loudspeaker locations and orientation, wall plates, and all other related device locations.
 6. Proposed construction details for all custom fabricated items, including interface panels, patch panels, and wall plates. These details shall show dimensions, materials, finishes and color selection.
 7. Riser diagrams showing conduit requirements with pull boxes, outlet boxes, part numbers of cable types used, and number of circuits in each conduit.
 8. Electrical power requirements for head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with Division 26.
 9. Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.
- C. Control System GUI submittal: This submission shall include all proposed control system screen shots with a functional description of every button press and a flow to the actions the buttons perform. The submission shall be provided in a storyboard form. The storyboard shall include programming for all the system functions of the system. All system functions and operation steps must be clearly outlined in the storyboard. The contractor shall plan for a minimum of one onsite meeting with the consultant and or owner to explain the proposed system operation and screen shots prior to control system approval. This submission can be provided as part of the above submittal or follow the approval of all the equipment. The objective of the control system is to be easy and intuitive to operate for anyone regardless of technical skill.

1.8 FINAL DOCUMENTATION:

- A. All final documentation shall be submitted and approved before final acceptance by the Owner will be granted. Within 45 days after completion of the work, deliver to the Owner, four (4) sets of the following:
 1. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers and quantities of each item.
 2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts and other designations and codings.
 3. Documentation of system performance measurements as noted elsewhere in this specification. Include diagrams or charts showing final setting of all control knobs in the system (mixers, equalizers, power amplifiers, etc.)
 4. Complete equipment rack layouts showing all rack mounted equipment items.
 5. Floor plans, prepared at a scale of not less than 1/8" = 1'0", showing loud speaker locations and orientation, wall plates, rack locations and other related device locations.
 6. Riser diagrams showing installed conduit with pull boxes, outlet boxes part number of cable types used, and number of circuits in each conduit.
 7. Operations instructions for each major item of equipment furnished.
 8. Manufacturer's warranty for each major item of equipment furnished.
 9. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

1.9 RELATED WORK BY OTHERS

- A. All conduits with pull strings, all electrical pull boxes, and all outlet boxes shall be furnished and installed under the electrical section of Division 26. Coordinate as necessary for proper installation. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.
- B. All 120 VAC power conductors and conduits associated with power circuits to all equipment locations shall be furnished and installed under the electrical section of Divisions 26. The 120 VAC power to the equipment racks shall be terminated inside the racks to Sound Contractor - supplied isolated ground plug strips or quad convenience outlets. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.
- C. An insulated #6 AWG stranded copper ground wire from each equipment rack to the building main service ground. Shall be furnished and installed under the electrical section of Division 16. Refer to the sound system drawings for additional details.

PART 2 – PRODUCTS

2.1 GENERAL

- A. All equipment items shall be new, unused and the latest version or model.
- B. Where quantities are not noted, they may be obtained from the drawing. In the event of a discrepancy between the specifications and the drawings, the greater quantity or better quality shall be furnished.
- C. Speaker locations are shown on the drawings for bidding purposes only. The exact speaker locations, aiming points and mounting angles shall be coordinated with the Engineer and determined through the use of an acoustical modeling program and/or good engineering practices and field conditions. Speaker aiming shall be adjusted as required after installation to provide optimal coverage and system performance.
- D. Substitutions
 - 1. Products specified herein by manufacturer's name and model number are intended to establish a minimal level of quality, performance and function. Proposed substitute equipment by listed equal manufacturers shall be equal in all respects to the specified product.
 - 2. Proposed speaker substitute requests shall additionally be supported by electro-acoustic modeling data showing proposed speaker location(s) and aiming points, maximum SPL levels and evenness of coverage at key frequencies, interaction between multiple speakers and intelligibility predictions (Alcons, STI). The following sections specifically list the acceptable equipment types and items for this project. Where quantities are not noted, they may be obtained from the drawing. In the event of a discrepancy between the specifications and the drawings, the greater quantity or better quality shall be furnished.
- E. Furnish an equipment rack for use in housing the equalizers, processors, power amplifiers and ancillary devices necessary to the operation of the system.
- F. Heat-producing components, such as power amplifiers, shall be mounted with one 1-3/4" vent panel installed between units. Fill all other unused portions of rack front sections with matching blank panels.
- G. Furnish five (5) keys for each type of equipment rack lock installed. Lock types shall be coordinated with Owner.

- H. Install the required number of units, of sufficient size to accommodate the equipment specified, at the locations indicated in the drawings.

2.2 WIRELESS MEDIA GATEWAY

- A. Manufacturer:
 - 1. Logitech Meet-up
 - 2. Polycom Studio
- B. All-in-One Conferencing Camera with integrated audio is designed especially for huddle spaces. It's the ideal camera solution for video collaboration sessions because its ultra-wide 125° horizontal FOV gets everyone in the picture, even in the smallest areas.
- C. 1080p/60 resolution. Two integrated speakers with wide dynamic range. Two built-in microphones with echo cancellation pick up participant's voices from up to 12 feet (4 m) away. A red blinking LED indicator tells participants when the mics are muted.
- D. Plug and play simplicity makes it extremely easy to use. For AV and IT managers, browser-based user interface makes it simple to manage multiple cameras across multiple sites for easy enterprise deployments. It works with all major cloud-based conferencing applications including Zoom, Microsoft Teams, Skype for Business, Cisco WebEx, GoToMeeting, and others.
- E. Can be placed on a table or mounted on a wall (wall mount kit is included).
- F. Includes:
 - 1. Camera (black or gray)
 - 2. Thin Profile Wall Mount (black or white) with mounting hardware
 - 3. Remote Control
 - 4. PoE+ Midspan Power Injector with AC cord set(s)
 - 5. 10 ft (3 m) cat-5 cable (black or white)
 - 6. 6 ft (1.8 m) USB 3.0 cable, type A to C
 - 7. 2 qty rubber feet for the bottom of unit if not wall-mounted
 - 8. Quick-Start Guide
- G. General
 - 1. Bluetooth® wireless technology
 - 2. RF remote control
 - 3. TV mount
 - a. Kensington security slot
 - 4. System Requirements
 - a. Windows® 7, Windows 8.1, or Windows 10 macOS® 10.10 or higher Chrome OST™ Version 29.0.1547.70 and higher
 - b. USB 2.0 port (USB 3.0 port and cable required for 4K video)
- H. Light
 - 1. Low-light compensation
 - 2. Video noise reduction

3. Low-light saturation optimization
- I. Sight
 1. Human figure detection
 2. Auto-frame participants at meeting start
 3. Auto-frame participants on-demand
 4. Auto-reframe when participants enter, leave, or change positions
- J. Sound
 1. Machine learning AI trained to distinguish human speech from other sounds
 2. AEC (Acoustic Echo Cancellation)
 3. VAD (Voice Activity Detector)
 4. Background noise suppression
 5. Auto-level loud and soft voices
 6. Peak-limiting algorithm eliminates even momentary speaker clipping to prevent distortion
 7. Anti-vibration enclosure
- K. Compatibility and Integrations
 1. Plug-and-play USB connectivity
 2. Certified for Skype™ for Business and ready for Teams
 3. Zoom™ Certified
 4. Fuze™ Certified
 5. Certified for Google Hangouts Meet Hardware
 6. Microsoft Cortana®
 7. Cisco Jabber®
 8. Compatible with BlueJeans, BroadSoft™, GoToMeeting™, Vidyo™, and other video conferencing, recording, and broadcasting applications that support USB cameras
- L. Camera
 1. Lens with 5x HD zoom and motorized pan (+/- 25°) and tilt (+/- 15°)
 2. Field of view: Diagonal: 120°, Horizontal: 113°, Vertical: 80.7°
 3. Total Room Coverage (field of view + pan and tilt): 163° wide x 110° tall
 4. 3 camera position presets
 5. Auto-framing (requires Windows 10 64-bit or macOS)
- M. Video performance:
 1. 4K Ultra HD video calling (up to 3840 x 2160 pixels @ 30 fps with customer-supplied USB 3.0 cable)
 2. 1080p Full HD video calling (up to 1920 x 1080 pixels @ 30 fps)
 3. 720p HD video calling (up to 1280 x 720 pixels @ 30 fps)
- N. Microphone
 1. Integrated microphone with 3 beamforming elements
 2. Pickup Range:
 - a. 4 meters (13.1 feet)
 - b. With Expansion Mic: 5 meters (16.4 feet)
 - c. Sensitivity: -27dB
 3. Microphone frequency response: 90Hz - 16kHz for full voice reproduction and high intelligibility without noise
 4. Beamforming performance: Factory-paired, very low distortion broadside beamforming algorithm steers the microphones directly at the talker for the best voice pickup and noise reduction
 5. AEC (Acoustic echo cancellation)
 6. VAD (Voice activity detector)

7. Microphone background noise suppression
 8. Microphone data rate: 32 kHz sampling rate
 9. Recommended # of participants: 6
 10. Recommended # of participants with expansion mic: 8
- O. Speaker
1. Volume adjustable to 95 dB SPL at 1/2 meter peak
 2. Speaker sensitivity 86.5+/-3dB SPL at 1/2 meter
 3. Distortion: 200 Hz - 300Hz < 3%, 3000 Hz -10KHz < 1%
 4. Anti-vibration enclosure improves voice clarity while limiting sound transmission to adjacent spaces
- P. Expansion Mic
1. Connection Type: Plug-and-play Indicator Lights (LED): LED indicator confirms video streaming, microphone mute, on-hold, and Bluetooth pairing, etc.
Microphone Type: Mono, wideband, noise canceling Buttons / Switch:
Microphone mute Cable Length: 20 ft (6 m)

2.3 LED DISPLAYS

- A. Manufacturers NEC, Samsung and LG
- B. The display size shall be as noted on drawings, 16:9 aspect ratio with HD resolution 1920x1080 at 5000:1 contrast ratio. The display shall be designed for commercial applications in landscape or portrait. The display chassis will be an ultra-thin construction and meet ADA compliance.
- C. The display will have the following inputs HDMI, VGA, Audio, Component, RS-232 control, IR, and IR ambient light sensing.
- D. Display shall be wall mounted with a standard VESA style mount. The wall mount shall be securely affixed to the wall. The mount will be a tilt style wall mount designed for the specific display. Manufacturers Chief, Premier, Peerless, and Crimson AV.

2.4 LOOSE EQUIPMENT

- A. 20' M-M HDMI cable

2.5 WIRE AND CABLE

- A. All wire and cables shall be new and unused.
- B. Wire not installed in equipment racks, not portable, or not installed in conduit shall be fire and plenum rated and meet all applicable codes.
- C. Speaker cable: West Penn 25225 stranded 16AWG twisted pair for equipment rack internal wiring and from the equipment rack pull box to the loudspeaker drivers.
- D. Microphone-level and line-level audio cable (installed in conduit, not portable): West Penn 291 stranded 22 AWG twisted pair with foils shield or approved equal.
- E. DANTE Audio network cables shall be CAT6. All Dante network inputs plates will 2 CAT 6 jacks on a single gang plate.

- F. Digital Media cable shall be a Belden certified HDbaseT CAT cable solution for digital media applications.
- G. SDI video cables shall be Belden 1694A.
- H. All HDMI cables for sources and displays shall be the locking style.
- I. Portable microphone cables: ProCo M-Series black flexible cable or equal by West Penn or Audio Technica.
- J. Other equipment control cables shall be stranded wire, appropriately shielded, of gauge and number of conductors required by the manufacturer for proper operation of the system or equipment item furnished.
- K. Wire and cable for all other devices shall be supplied in accordance with the recommendations of the device manufacturer and the National Electrical Code.
- L. Acceptable cable manufacturers: Belden, Carol, General or West Penn.

2.6 JACK CONNECTORS AND WALLPLATES

- A. All plate-mounted connectors shall be ground-insulated from the plates on which they are mounted.
- B. All other jacks shall be installed on standard stainless steel finish plates. Nomenclature shall be engraved into the plate with 1/8" block letters filled with black paint. All mic jack locations shall be numbered consecutively, starting from one (1).
- C. Unless otherwise specified, all jacks and connectors for the sound system shall be as follows:
 - 1. Microphone and line input receptacles shall be 3-pin XLR-F with locking tab equivalent to Neutrik model NC3FP-1 or equal by Switchcraft or Studio 1.
 - 2. Combination microphone/auxiliary input jack plates shall be impedance matching units suitable for interfacing one unbalanced high- or low-impedance source to a balanced low-impedance microphone preamplifier input. There shall be one ¼" 3-conductor phone jack marked "PROJ IN" and two RCA phono jacks marked "LINE IN L/R with a resistive mixing network to sum stereo line-level sources. A linear input level control will control the level of the auxiliary inputs. A "HUM CANCEL" rocker-type switch will selectively isolate the shields. A separate female XLR connector shall provide for a separate microphone input. There shall be no electrical connection between the impedance matching circuit and the microphone circuit. Provide Pro Co AVP-1V A/V interface jack plate assemblies or equal by Whirlwind or Conquest where shown on drawings.
 - 3. Cable-end Microphone Connectors shall be 3-pin XLR equivalent to Neutrik model NC3XX or equal by Switchcraft or Calrad.
 - 4. Remote Controls
 - a. Provide a remote volume control with an on/off power switch. Provide a wire cover with a key lock.
 - 5. Furnish and install the required number of jacks and connectors as indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All equipment shall be installed so as to provide reasonable safety to the operator.
- B. All work shall be performed in accordance with the recommendations of the equipment manufacturers.
- C. Furnish the system to facilitate expansion and servicing using modular, solid-state components. All equipment shall be designed and rated for continuous operation and shall be UL listed where applicable, or manufactured to UL standards. Furnish components, racks, wire, cabinetry, connectors, materials, parts, equipment and labor necessary for the complete installation of the systems, in full accordance with the recommendations of the equipment manufacturers and the requirements of the drawings and specifications.
- D. Installation shall follow standard broadcast wiring and installation practice, and shall meet or exceed industry standards for such work, with particular attention given to any installation instructions in Parts 1 and 2 of these Specifications.
- E. Equipment shall be held firmly in place with proper types of mounting hardware. All equipment affixed to the building structure must be self-supporting with a safety factor of at least six. All equipment shall be installed so as to provide reasonable safety to the operator. Supply adequate ventilation for all enclosed equipment items that produce heat.
- F. All overhead or wall-mounted speaker systems shall be supported from the building structure utilizing the materials and methods required by the speaker manufacturer and providing a load-rated safety factor of 6X. All required installation material and labor shall be deemed included in these specifications.
- G. Furnish the system to facilitate expansion and servicing using modular, solid-state components. All equipment shall be designed and rated for continuous operation and shall be UL listed where applicable, or manufactured to UL standards.
- H. Observe proper circuit polarity and loudspeaker wiring polarity. No cables shall be wired with a polarity reversal between connectors with respect to either end. Special care shall be taken when wiring microphone cables, to insure that uniform polarity is maintained. Balanced audio connectors shall be wired as follows:
 - 1. Wire Connector Signal
 - 2. Black Pin #3 or Ring Lo or Neg
 - 3. Red or White Pin #2 or Tip Hi or Pos
 - 4. Bare Pin #1 or Shield Ground
- I. Terminate all unused inputs and outputs with proper precision-shielded resistors. Build-out or terminate all link circuits containing active components to provide proper impedance matching. Record all pad values in the final documentation.
- J. All audio circuits shall be balanced and floating, except as noted in the specifications or directed by the engineer at the time of final equalization and testing. Shields of audio cables shall be grounding at one the sending end only of the various active interconnected equipment items in the system.
- K. Route cables and wiring within equipment racks and cabinetry according to function, separating wires of different signal levels (video, microphone level, line level, amplifier output, 120VAC, intercom, control, etc.) by as much physical distance as possible.

Neatly arrange and bundle all cables loosely with plastic cable ties. Cables and wires shall be continuous lengths without splices.

- L. All system wire, except spare wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heatshrink type tubing shall be used to insulate and dress the ends of all ground or drain wires.
- M. All cables in conduits shall be insulated from each other and from the conduit the entire length and shall not be spliced. All cables and wires are to be continuous lengths without splices.
- N. All solder joints and terminations shall be made with rosin-core silver solder.
- O. Temperature regulated soldering irons rated at least 60 watts shall be used for all soldering work. No soldering guns or temperature unregulated irons shall be used.
- P. Mechanical connections shall be made using approved connectors of the correct size and type for the connections. Wire nuts will not be accepted except in the case of distributed, constant-voltage speaker systems.
- Q. Each mechanical connector shall be attached using the proper size controlled-duty-cycle ratcheting crimp tool that has been approved by the manufacturer of the connectors. Conventional non-ratcheting type crimping tools are unacceptable, and shall not be used on the job site.
- R. Label all wires in racks and at consoles as to destination and purpose. Clearly and permanently label all jacks, controls and connections with permanent engraved laminated plastic labels or by engraving and filling mounting plates, unless otherwise noted. Attach laminated plastic labels with contact cement. Embossed or printed label tape, and press-on or lift-off lettering systems will not be accepted. All labeling shall be completed prior to final system inspections. If permanent labels cannot be furnished prior to final system inspections, temporarily label all controls with write-on tape.

3.2 LABELING

- A. Clearly and permanently label all jacks, controls and connections with engraved laminated plastic labels or with engraved and back-filled mounting plates. Attach laminated plastic labels with contact cement.
- B. Identify and permanently label all wires and cables at every point of termination and connection point with industry-standard cable markers. All cable identifications shall be logged, marked on drawings where appropriate and included in the owners' manual.

3.3 CABINETS, CABLES, CONNECTORS AND MISCELLANEOUS EQUIPMENT

- A. Equipment Cabinets
 - 1. Locate freestanding equipment cabinet(s) where indicated and provide service access to both front and rear without having to move cabinets.
 - 2. The 120 VAC power to the equipment racks shall be terminated inside the racks to plug mold plugstrips or quad convenience outlets.
 - 3. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.
 - 4. Install equipment in cabinets using solid and vented panels and fans as required to provide adequate ventilation in accordance with industry standard principles of thermal management and recommendations of specific equipment manufacturers.

Fill all unoccupied rack space with blank or ventilating panels finished to match cabinet color.

5. Connect all microphone, line level, DC control and speaker cables to equipment cabinets via approved audio terminal blocks. Use spade lugs if barrier strips are used. Do not buss commons together. Do not ground.
6. Locate patch panels and all frequently used controls at least 30" above floor.
7. Signal processing equipment with front panel controls that are to be permanently set (e.g. equalizers, limiters, digital delays) shall be furnished with security panels or sub-panel mounted behind blank panels. Provide plastic vision panels to allow viewing of operational indicators such as meters or clipping indicators.

B. Wiring and Interconnections

1. Observe proper circuit polarity and loudspeaker wiring polarity. No cables shall be wired with a polarity reversal between connectors with respect to either end. Special care shall be taken when wiring microphone cables, to ensure that uniform polarity is maintained. Balanced audio connectors shall be wired with shield at Pin #1, hi/positive at Pin #2.
2. Build-out all link circuits containing active components where necessary to provide proper impedance matching and optimum gain structure for maximum operating headroom and signal-to-noise ratio. Record all pad values in the final documentation.
3. All audio circuits shall be balanced and floating, except as noted in the specifications or directed by the Engineer at the time of final equalization and testing. Shields of audio cables installed between active interconnected equipment components shall be grounded at the sending end only.
4. All cables shall be installed in conduit except above accessible ceilings, where they shall be supported utilizing J-hooks or bridle rings on minimum 4 ft. centers. Provide an electrical wall box with conduit stubbed above accessible ceilings for all wall-mounted peripheral devices.
5. Separate conduits and/or cable harnesses shall be maintained for cables in the following categories:
 - a. Levels below -20 dBm (microphone).
 - b. Nominal levels from -20 dBm to +30 dBm (line).
 - c. Loudspeaker
 - d. Control
 - e. Power
6. Group and route all cables within equipment cabinets according to type and function and separate according to signal levels. All cables shall be continuous lengths without splices.
7. All system wire shall be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heat shrink type tubing shall be used to insulate and dress the ends of all ground or drain wires.
8. All solder joints and terminations shall be made with rosin-core silver solder.
9. Mechanical connections shall be made using approved connectors of the correct size and type for the connections. Wire nuts are not acceptable except in the case of distributed, constant-voltage speaker systems.

3.4 GROUNDING

- A. Ground active components, equipment cabinets and audio line shields to independent audio system ground and to the ground buss in the power panel.

- B. Ground all conduits ONLY to power system ground. Insulate all conduits and electrical boxes from sound system, including audio equipment cabinets and audio system ground.
- C. Insulate all conductors, including shields, from conduit, backboxes and from each other for the entire conduit length.
- D. Take such precautions as may be necessary to prevent and guard against electro-magnetic and electro-static hum and to install the equipment so as to provide normal and reasonable safety for the operator.

3.5 TESTING

- A. The completed sound system is to be inspected and tested for compliance with the Specifications.
- B. The testing and equalization work shall be performed after the installation work has been completed, but prior to any use of the system.
- C. The process of equalizing and testing the system may necessitate moving, adjusting or re-aiming certain loudspeakers. Adjustments shall be performed without claim for additional payment.
- D. Coordinate as necessary to ensure a totally quiet room during the sound reinforcement systems testing and balancing period.
- E. Prior to requesting systems acceptance testing, verify the following:
 - 1. All systems are in first class working condition and free of short circuits, ground loops, parasitic oscillations, excessive system noise beyond published specifications of the equipment, hum, RF interference, or instability of any form.
 - 2. All loudspeaker circuits have been tested, properly and are in perfect working order. Furnish impedance measurements of each circuit prior to final tests.
 - 3. All equipment controls are labeled, even if unused
 - 4. Operation manuals for every furnished equipment item are on hand at the job site.
- F. Should the performance testing show that the Contractor has not properly completed the systems, the Contractor shall make all necessary corrections or adjustments, and a second demonstration shall be arranged at the Contractor's additional expense.

3.6 SYSTEM PERFORMANCE

- A. After equalization and testing, the sound system shall meet or exceed the following specifications:
 - 1. System shall be free of short circuits, ground loops, parasitic oscillation, excessive system noise, hum, RF interference and instability of any form.
 - 2. Maximum SPL with band limited pink noise input to the system shall be 100dB before audible distortion or clipping occurs.
 - 3. Seat to seat variation of SPL at 4kHz octave band pink noise shall be within a tolerance of plus or minus 3dB.
 - 4. Acoustic response of the system shall be plus or minus 3dB along a line which is flat from 100Hz to 3000Hz and which rolls off at 2dB per octave to 20kHz.

3.7 TRAINING

- A. The Contractor shall furnish the Owner's representatives with training necessary to properly operate the systems. Demonstrate in detail all functions of the systems. Provide a **minimum of one (1) hours** of instruction and familiarization for this purpose.
- B. The training phase shall be accompanied by complete as-built documentation and the custom Technical System Operation manual.

END OF SECTION

SECTION 274119 - AUDIOVISUAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.

1.2 SCOPE OF WORK

- A. The work described in this section includes the furnishing of all components, materials, equipment, installation and technical labor and the performance of all operations necessary for the complete installation of audiovisual equipment in operating condition as indicated on the drawings and/or specifications.
- B. In general, the conduit and/or cable tray, junction boxes, electrical power circuits and outlets and terminal cabinets, as required for a complete operating system, shall be furnished and installed by the Electrical Contractor under a separate contract. The entire responsibility for the system, its installation, operation and function shall be that of the Systems Contractor.

1.3 SECTION INCLUDES

- A. Work consists of new A/V equipment including:
 - 1. Video display complete with wall/ceiling mounting hardware and connection to the local audio/video system as detailed on the drawings and as specified herein.
 - 2. Data projectors complete with wall/ceiling mounting hardware and connection to the local audio/video system as detailed on the drawings and as specified herein.
- B. A/V Distribution Systems are required to be complete with sources, inputs, displays, distribution, controls and connection to the data network and video distribution system as detailed on the drawings and specified herein.
- C. All material and/or equipment necessary for proper operation of the system(s), not specified or described herein, shall be deemed part of these specifications.

1.4 QUALITY ASSURANCE

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.

- D. All equipment and installation practices shall comply with the latest AVIXA Installation Handbook.
- E. All equipment and Installation Practices shall comply with the latest BICSI ® Telecommunications Distribution Methods Manual (TDMM).
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards as applicable.
- G. Performance Verification: All digital video systems shall be pre-tested to verify the complete compatibility of all sending, receiving and distribution components and the performance and integrity of the transmission media. The performance of each system shall be demonstrated, with all proposed components, in the presence of the Design Engineer and/or Owner prior to approval and installation. Any system failing to meet the specified performance requirements shall be rejected and re-configured as required prior to re-testing.
- H. A mock-up and meeting shall occur for typical presentation wall technology where interactive projectors and/or interactive flat panels occur. Wall shall be finished and projector markerboard and/or visual wall display wallcovering, interactive projector and/or interactive flat panel, data and AV connectivity, electrical and all accessories shall be installed. Construction manager, architect, projector markerboard and/or visual display wallcovering installer/contractor, technology installer/contractor, and electrical installer/contractor shall be present to review mock-up. Purpose of mock-up is to confirm interactive technology is functioning as intended, that there is proper coordination between the wall surface, the projector markerboard, or visual display wallcovering and the interactive projector and/or interactive flat panel. All final mounting heights for different rooms and spaces shall be confirmed at the mock-up review.
- I. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer.
- J. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.5 CONTRACTOR QUALIFICATIONS

- A. The A/V equipment package shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the A/V contractor to utilize a Subcontractor for any portion of the work, unless the Subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.
- B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.
- C. Equipment supplier shall have a service organization within 75 miles of the project site.
- D. The Contractor shall have on staff an AVIXA certified CTS-I AV systems engineer/project manager responsible for overseeing the project and the lead technician (not installers) shall have a CTS certification.

1.6 SHOP DRAWINGS AND SUBMITTALS

- A. Completely detailed shop drawings shall be prepared prior to the procurement of equipment or commencement of work. Blue-line drawings shall be prepared and submitted on 30" x 42" paper. Equipment lists, data sheets, etc. Shall be 8-1/2" x 11" size properly bound into a single or multiple volumes.
- B. Submit to the following for approval:
 - 1. A complete equipment list, with manufacturers' names, model numbers, and quantities of each item.
 - 2. Manufacturer's data sheets on all equipment items.
 - 3. System block diagram(s)
 - 4. Equipment rack layouts showing all rack mounted equipment items.
 - 5. Certain other submittals as noted elsewhere in this specification, and as may be required for various equipment items prior to construction, fabrication, or finishing of that item.

1.7 FINAL DOCUMENTATION: ALL FINAL DOCUMENTATION SHALL BE SUBMITTED AND APPROVED BEFORE FINAL ACCEPTANCE BY THE OWNER WILL BE GRANTED. WITHIN 45 DAYS AFTER COMPLETION OF THE WORK, DELIVER TO THE OWNER, FOUR (4) SETS OF THE FOLLOWING:

- A. A complete as-installed equipment list, listed by room, with manufacturer's names, model numbers, serial numbers and quantities of each item.
- B. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers, layouts and other designations and codings.
- C. Complete equipment rack layouts showing all rack mounted equipment items.
- D. Operations instructions for each major item of equipment furnished.
- E. Manufacturer's warranty for each major item of equipment furnished.
- F. Technical Systems Operations Manual, custom-written by the Contractor, for the purpose of instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventive maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.

1.8 COORDINATION

- A. Coordinate Work of this Section with the owner, owner's integrator, owner's ITC-site, CM and Architect.
- B. Meet jointly with representatives of above organizations and Owner's representatives to exchange information and agree on details of equipment arrangements and installation interfaces.

- C. Record agreements reached in meetings and distribute record to other participants.
- D. Confirm a schedule time frame that all equipment will be installed, all documentation will be delivered that is needed for the implementation, and service provider requirements and installation time frame.
- E. Coordinate with all other trades and provide connection interfaces as applicable.
- F. Coordinate all power and load requirements with UPS requirements so that all UPS equipment is properly sized for submittals.

1.9 STORAGE OF MATERIALS

- A. All materials shall be secured when not in use by the Contractor.
- B. It shall be the Contractor's responsibility to secure all equipment including all material to be installed as part of the contract. No changes shall be made to the contract due to loss or theft of equipment and materials not officially accepted by the Owner.

1.10 RELATED WORK BY OTHERS

- A. All conduit with pull strings, all electrical pull boxes, and all outlet boxes shall be furnished and installed under the electrical section of Division 26. Coordinate as necessary for proper installation. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.
- B. All power conductors and conduits associated with power circuits to all equipment locations shall be furnished and installed under the electrical section of Divisions 26. The power to the equipment racks shall be terminated inside the racks to Contractor - supplied isolated ground plugstrips or quad convenience outlets. All conduit systems shall be insulated from the equipment racks using non-metallic bushings or raceways.
- C. An insulated #6 AWG stranded copper ground wire from each equipment rack to the building main service ground.

1.11 WARRANTY

- A. The equipment shall be warranted by both the contractor and manufacturer for a period of one (1) year from date of substantial completion.
- B. Provide proof of warranty from manufacturer.
- C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- D. The vendor shall be responsible to provide service during normal working hours within (8) hours after notification by the Owner. If equipment cannot be repaired within 24 hours of service visit. Contractor shall provide "loaner" equipment to the Owner at no charge.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

- A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.
- B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications

2.2 LED TV MOUNTS

- A. Provide wall type, articulating arm LCD mounts with 20 degrees of forward tilt. Mounts shall be rated for commercial use and capable of supporting up to 75" flat panel Televisions.
 - 1. Manufacturers: Peerless, Premier or Chief
- B. Component Storage Panel, Sliding
- C. Chief Component Storage Panel, Sliding CSSMP15X10 attach directly to the display mount and offer convenient, local small device mounting. This option for locating technology behind the display features complete location flexibility. The included mounting arm attaches directly to any side of your chosen VESA mount, and features multiple locations for attachment of the mounting plate to the arm. Featuring our patented UMS pattern for mounting of small devices and components, this mounting plate offers 9" x 12" of mounting space.
- D. Mounts shall be installed in strict compliance with the manufacturer's instructions. Mounting configuration, method, and exact location of mounts to be approved prior to installation.

2.3 DIGITAL DISPLAY MONITORS

- A. Basis of Design Samsung 4K Smart TV, LG or equal
- B. Panel
 - 1. Size—Refer to drawings
 - 2. 4K UHD TV with Full Array Backlighting Resolution 3840 x 2160 Minimum
 - 3. Motion Rate 120 MHz
- C. Broadcasting System
 - 1. ATSC, Clear QAM/VSB
- D. Audio

1. Audio Output 40W
- E. Interface
1. USB 2.0 (3)
 2. HDMI (4)
 3. Ethernet (1)
 4. RF In (1)
 5. Digital Audio Out
 6. PC Audio Input
 7. Audio Out (Mini Jack)
 8. RS-232C
- F. Features
1. Smart TV with App
 2. Full Web Browser
 3. OSD Language—English, Spanish, French
 4. HDMI-CEC
 5. Channel Guide
 6. VChip
 7. Bluetooth
 8. Mirroring
 9. DLNA
- 2.4 2X4 HDMI SPLITTER
- A. As shown on drawings.
- B. 4K 2x4 HDMI® Splitter/Extender allows you to distribute a single HDMI signal to up to four displays. It transmits the split signals to receivers at distances up to 164 feet (50) away over a single Cat6 Ethernet cable. It provides 4.95Gbps bandwidth and supports video resolutions to 4K@30Hz, including 1080p@60Hz and 3D video. It supports POE feature, allowing you to install the receivers in locations without an available AC power outlet.
- C. Features:
1. Distributes up to two HDMI® signals to up to four displays
 2. Transmits video signals to distances up to 164 feet (50 meters) over a single Cat6 Ethernet cable
 3. 4.95Gbps maximum bandwidth
 4. Supports multichannel high-definition audio, including 7.1-channel LPCM and 5.1-channel Dolby TrueHD™ and DTS-HD Master Audio™
 5. Supports POE
 6. EDID® switch to set the video and audio modes for the HDMI source
 7. Wideband infrared extender allows control of the HDMI source device from each of the remote locations

2.5 AUDIO/VISUAL PATCH CABLE

- A. Provide all associated A/V patch cables for each equipment item for a fully operational system. All patch cable shall be equipped with ferrite bead devices.
 - 1. M/M 1/8th” audio cables 3FT
 - 2. HDMI Cables 3FT
 - 3. USB Cables 3FT

2.6 CONNECTORS AND PLATES

- A. Jackplates
 - 1. Outlet faceplates shall be custom fabricated, aluminum plates or all- metal modular frames with metal, screw/nut jack modules. Voice/data- style plastic plates/modules with “snap-in” jack modules are not acceptable.
 - 2. Each and every audio/video and CATV jack shall be labeled to indicate function (audio “L” and “R”, video, catv, etc.). Coordinate labeling scheme with Owner. Labels shall be engraved and backfilled or adhesive laminated plastic. P-touch labels or labels applied with pens or markers are not acceptable.
 - 3. Data jacks, where shown integrated into custom jackplates, shall be provided by the structured cabling provider and shall adhere to the provided channel solution. Custom cut-outs shall be coordinated with the structured cabling contractor to provide an exact fit for the RJ-45 module as provided, labeled and terminated by the structured cabling installer. Each data jack shall be labeled to corresponding patch panel and port.
 - 4. Jacks to be installed in floor boxes/poke-thrus to be installed in faceplates, compatible with floor box / poke-thru make / model and secured within floor box / poke-thru. The use of loose or un-mounted jacks shall not be acceptable.
 - 5. Refer to drawings for arrangement of various workstation jackplates including jack types and quantities within each jackplate type. All jacks associated with audio/video system indicated in each faceplate shall be deemed included in this specification unless specifically noted otherwise.
- B. Manufacturers: Ace Backstage, Panel Crafters, ProCo, Covid, RCI Custom or Hubbell.
- C. Provide any/all pre-made A/V patch cables as required for a fully operational system. All jackplates must be provided with a patch cable for all used/unused A/V jacks.
- D. Patch cable lengths may need to be adjusted in some situations to facilitate a neat and professional installation.
- E. The A/V Contractor shall be responsible for final dressing of all patch cables at each item of equipment to provide a neat and orderly appearance.

2.7 PATCH CABLE MANAGEMENT – END DEVICES

- A. Provides continuous abrasion protection for wires, cables, hoses and tubing. Highly flexible open weave will not trap heat or humidity, allows for irregular shapes. Lightweight and durable protection. Panduit Part# SE50PSC-CR0

- B. Miscellaneous – Provide all additional required equipment, connections, terminations, and cabling between items of equipment for a complete and operational system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount all equipment using manufacturer’s recommended hardware.
- B. Connect Devices to IP Network for Central Control.
- C. Adjust all Projectors for proper focus, keystone correction and display size.
 - 1. Projectors should project to both Interactive White Board and screen without needing adjustments made.
- D. Install all associated software monitoring and control programs.
- E. Equipment shall be furnished and installed in accordance with manufacturer’s recommendations in compliance with all local, city, state and national codes.
- F. Provide all hardware, framing members, etc. as required for mounting equipment.
- G. Coordinate all structural mounting points and locations and load requirements with Architect/General Contractor.
- H. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.
- I. The installation of all work shall be neat and of professional quality. Cooperate with other trades to achieve well-coordinated progress and satisfactory final results. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.
- J. Installation shall follow industry standard wiring and installation practice, and shall meet or exceed industry standards for such work, with attention given to any installation instructions in Parts 1 and 2 of these Specifications.
- K. Equipment shall be secured firmly with proper types of mounting hardware. All equipment affixed to the building structure must be self-supporting with a safety factor of at least three unless otherwise stated.
- L. All equipment shall be installed to provide reasonable safety to the operator.
- M. All overhead or wall-mounted speaker systems shall be supported from the building structure utilizing the materials and methods recommended by the speaker manufacturer and good rigging practices, providing a load-rated safety factor of six (6). All required installation material and labor shall be deemed included in these specifications.

- N. Furnish the system to facilitate expansion and servicing using modular, solid-state components. All equipment shall be designed and rated for continuous operation and shall be UL listed where applicable, or manufactured to UL standards.
- O. It will be the responsibility of this contractor to provide all programming.
- P. In addition to the GUI provided the technology systems contractor will provide an Ethernet based executable GUI for interfacing to the system.
- Q. Technical Systems Manual, custom-written by the Contractor, for instructing the Owner's operating personnel in the detailed step-by-step operation of the system and preventative maintenance procedures. This manual shall include descriptions of the system components and their relationship to system function. This manual shall be bound separately and labeled appropriately.
- R. Equipment shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all local, city, state and national codes.
- S. Provide all installation hardware as required for mounting video displays, projectors and speakers. Coordinate all structural mounting point locations and load requirements with architect and general contractor.
- T. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.
- U. The installation of all work shall be neat and of professional quality.
- V. Cooperate with other trades to achieve well-coordinated progress and satisfactory final results.
- W. Execute without claim for extra payment for minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.

3.2 FLAT PANEL INSTALLATION

- A. Contractor shall field verify the location of each flat panel with surrounding structural elements and room furnishings at the proposed mounting location to ensure proper installation prior to mounting equipment. Where field conditions will not provide the correct application for the proposed flat panel type/location/mounting method, the contractor shall notify the Engineer/Architect in writing. Notification shall include proposed alternatives for review.
- B. Flat panel displays shall be mounted straight, level and true.
- C. Contractor shall custom configure the flat panel video/image/setting menus once source equipment and AV system is operational. Flat Panels with tuners shall have the broadband CATV channels scanned and programmed once the system is active. Flat panel set-up shall be completed and the optimal settings stored for later recall.
- D. Programming of flat panels and centralized AV control software including all network assignments, passwords, schedules, etc.

3.3 WIRING INSTALLATION

- A. Observe proper circuit polarity and loudspeaker wiring polarity. No cables shall be wired with a polarity reversal between connectors with respect to either end. Special care shall be taken when wiring microphone cables, to ensure that uniform polarity is maintained. Balanced audio connectors shall be wired with shield at Pin #1, hi/positive at Pin #2.
- B. All audio circuits shall be balanced and floating, except as noted in the specifications or directed by the Architect/Engineer at the time of final equalization and testing. Shields of audio cables installed between active interconnected equipment components shall be grounded at the sending end only.
- C. All cables shall be installed in conduit except above accessible ceilings, where they shall be installed utilizing J-hooks or bridle rings on minimum 5 ft. centers or cable tray, where available.
- D. Separate conduits and/or cable harnesses shall be maintained for cables in the following categories
 - 1. Levels below -20 dBm (microphone).
 - 2. Nominal line levels from -20 dBm to +30 dBm (line).
 - a. Loudspeaker
 - b. Control
 - c. Power
 - d. Video
- E. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.
- F. Group and route all cables within equipment cabinets according to type and function and separate according to signal levels. All cables shall be continuous lengths without splices.
- G. Cables shall be handled and installed with extreme care. Tie wraps shall loosely hold cables; do not over-tighten. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less than 4 times the outer diameter of the cable. The cable manufacturer's recommended bending radius and maximum pulling tensions shall be strictly adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.
- H. Cable pathways shall provide the following minimum clearances (parallel or perpendicular)
 - 1. Motors and transformers – 48”.
 - 2. Conduit and cable used for electrical power distribution – 12”.
 - 3. Fluorescent lighting – 5”.
 - 4. Power lines up to 2kVA – 5”. e) Power lines over 5kVA – 24”.
 - 5. Hot water/steam lines - Bare –18”, Insulated – 6”.

- I. All cabling installed in underground conduit installations shall be outdoor rated cables, acceptable for use by the manufacturer in underground applications.
- J. All system wire shall be terminated by approved soldered or mechanical means. No unterminated wire ends will be accepted. Heat shrink type tubing shall be used to insulate and dress the ends of all ground or drain wires.
- K. All solder joints and terminations shall be made with rosin-core silver solder. No lead based solder shall be accepted.
- L. Mechanical connections shall be made using approved connectors of the correct size and type for the connections. Wire nuts are not acceptable except in the case of distributed, constant-voltage speaker systems.

3.4 PROGRAMMING

- A. AV Distribution System and touchpanel controller shall be programmed as described herein and as required by owner. Contractor to develop system programming through a series of meetings, storyboard submittals and a final virtual run-through prior to programming. Programming shall be submitted to Owner prior to application for approval.
- B. Program flow drawings shall be submitted by the contractor for review prior to any programming taking place. No fewer than three meetings shall take place regarding program flow and touch panel interface prior to any programming being started
- C. Program flow review with follow-up email communication and approval or in-person meetings as necessary.
- D. Technical review of touch panel (mock-up touch panel will be required at this meeting).
- E. End-user touch panel review of mock-up touch panel
 - 1. Present must be the AV Vendor Engineer and an Owner's representative.
 - 2. End users will also be present at the end-user review of mock-up touch panel.
- F. If necessary, access to the Owner's network for programming can be granted. Any request for this type of access should be submitted in writing no fewer than ten (10) business days prior to need.
- G. JPEG screen shots will be required of the touch panel once the design is final so that the end-user may begin to create a user instruction guide.
- H. Touch panel controller shall be programmed as described herein. Programming shall be submitted to the Owner as outlined in Supplemental Instructions below.
- I. Programming - Touch panel controller shall be programmable with graphic page as required to offer controls for A/V equipment connected to the system. Unit shall be programmed per the owner's requirements to provide the following controls at a minimum:

1. There shall be a welcome page with simple system on/off features and custom Owner logo and a home page with the most often used control features. For bidding purposes, plan for a minimum of 10 user pages with 5 additional technician level pages.
2. Controls for system on/off, system volume and mute, and user “blackout” shall be accessible as fixed hard buttons.
3. There shall be provided full component control of all sources.
4. DSP control shall allow for system-wide mute and volume control.
5. There shall be Technician level control pages, password protected that allow complete access to all component features including system menus.

3.5 TESTING

- A. Verify picture quality on all A/V inputs.
- B. Test all associated software control programs.
- C. Upon completion of installation and satisfactory testing of system by Contractor in presence of the equipment supplier, the Contractor shall test the system in the presence of the Owner and the Architect to demonstrate satisfactory performance.
- D. Upon completion of installation and satisfactory testing of system by Contractor in presence of the equipment supplier, the Contractor shall test the system in the presence of the Owner and the Engineer to demonstrate satisfactory performance.
- E. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer’s representative or equipment vendor; Submit report indicating result to the Engineer.
- F. A qualified technical representative of the system contractor shall do systems acceptance testing. Installation must be complete in all respects before acceptance testing. Acceptance testing and training must be scheduled on separate dates to allow time for corrections, if necessary. Once all functions and devices within the system have been adequately demonstrated to be working properly, a complete owner's manual will be presented to the Owner's agent. It shall contain a comprehensive list of all supplied equipment, a complete point-to-point system wiring diagram with "AS BUILT" wire numbers indicated, details of hook-up connections including build-out devices (active and passive), systems control settings record, the final test results including plotted frequency response curves, operation and maintenance manuals for each active device including schematic diagrams and parts list. A thoroughly completed commissioning checklist (re: InfoComm's AV Installation Handbook Appendix J: Audiovisual Systems Commissioning Tests Checklist) shall be included with the Owner's Manual.
- G. The Contractor shall be prepared to verify the performance of any portion of the system by demonstration, listening tests and/or instrument measurements.
- H. Measurement of frequency response, distortion, noise, or other characteristics shall be performed (or a demonstration test requested) if deemed necessary to determine proper operation.

- I. The Contractor shall make additional mechanical and electrical adjustments within the scope of the work and which are deemed necessary by the Engineer as a result of acceptance tests.
- J. Test Reports and Certification: Submit results of all tests conducted above and certification that the installation is complete and ready for checkout as specified.

3.6 IDENTIFICATION/LABELING

- A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both end and at each point where the cable is administered.
- B. The contractor shall be responsible for applying a permanent label to each cable to indicate source and destination.
- C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.7 WORK AREA

- A. The Contractor shall provide a clean and orderly area to work in during system installation.
 - 1. The work areas shall be cleaned daily. All packing trash and other assorted junk items shall be removed at the end of each workday.
 - 2. Dust shall be kept to a minimum during the installation. All dust shall be removed prior to the cutover, and then again just prior to project closeout.
 - 3. The Owner and Engineer shall have access to the work area at any time during normal working hours.
 - 4. The Owner and Engineer have the right to stop work and seek answers to questions and concerns that may come up during the installation of the new data network.

3.8 TRAINING

- A. 40 hours training by manufacturer or trainer certified by the manufacturer.
- B. Training shall be spread out over the length of the warranty (Ex: 8 hours at project turnover/completion, 8 hours at 3 months, 8 hours at 6 months, 8 hours at 1 year, 4 hours at 2 years, 4 hours at 3 year)
- C. Training to occur in maximum of 2 hour increments.
- D. Warranty certificate and agreement shall be provided to Owner IT personnel at initial training session.
- E. Provide a digital video copy of the training sessions.
- F. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

- G. Training shall include multiple four-hour sessions encompassing all instructions required for system operation. Provide operators manuals and user guides with training. Provide follow up training after initial training.
- H. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.
- I. Demonstrate adjustment, operation and maintenance of the system including each component and control.

3.9 AS-BUILT DOCUMENTATION

- A. The Contractor shall furnish the Owner two (2) CDs with complete as-built manuals and drawings in an indexed PDF file format. Drawings shall be a minimum of 11"x17" engineering format. These manuals shall contain:
 - 1. System Operating Instructions
 - 2. System Functional Block Diagram(s)
 - 3. System Schematic Diagram(s)
 - 4. System Wiring Diagrams
 - 5. As-Built Drawings of Entire System including Equipment Rack Elevations
 - 6. Component Technical Operation Manuals
 - 7. Component Service Manuals
 - 8. Software Operating Manuals
 - 9. Port and Switch Labeling
 - 10. Final Endurance Test Report
- B. Maintenance Manual: The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
- C. The contractor shall provide a new Owner network map indicating all new buildings included in this scope of work. Network map shall include equipment information, IP addresses, VLAN information, etc. Network map shall be prepared utilizing a computer drafting program such as AutoCAD or Visio, and shall be presented in electronic format.

3.10 WARRANTY

- A. If any defects are found within the three (3) year full warranty period, the defective system component shall be replaced at no extra cost to the Owner for part or labor. Provide a statement of this warranty with the O&M Manuals.
- B. During the warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. Resolve any previous outstanding problems.
- C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

- D. The Contractor shall be responsible to provide service during normal working hours on a normal business day within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system components operation, or the loss of the main switch or other dead-end equipment which renders the entire system beyond 50% inactive or un-usable. Provide an on-site authorized factory technician within 24 hours if required.
- E. If equipment cannot be repaired within 24 hours of service visit, Contractor shall supply “loaner” equipment to the Owner at no charge.

3.11 CERTIFICATION

- A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

END OF SECTION 274119

(This page intentionally left blank)

DIVISION

28

**ELECTRONIC SAFETY
AND SECURITY**

(This page intentionally left blank)

SECTION 281300 - ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specifications Sections, apply to this Section.
- B. 28 16 00 – Intrusion Detection System
- C. 28 23-00 – Video Surveillance System
- D. Door Hardware

1.2 SCOPE OF WORK

- A. The Access Control and Security Management System (ACS) shall function as an electronic physical access and situational control system and shall integrate the alarm monitoring, Video Management System (VMS), ID badging, and database management into a single executable application. The ACS shall function as the primary means of controlling all access and situational control needs. A scalable, open architecture and network ready solution shall allow for an assured access and alarm monitoring solution.
- B. The scope includes all hardware, software, training and services required to provide a fully operational system, programmed to the Contractor's requirements and containing all software and licenses required to perform the specified functions.
- C. Labor and Materials: Unless otherwise noted in the Drawings and Specifications, the Contractor shall provide and pay for all labor, materials, equipment, tools, utilities, construction equipment and machinery, transportation and other facilities and services necessary for the proper execution, operation and completion of the Work.
- D. Specification Language: Specifications and notes are written in imperative and abbreviated form. Imperative language of the technical specifications is directed at the Contractor, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting "shall", "shall be", "the Contractor shall", and similar mandatory phrases by inference. The words "shall be" is supplied by inference where a colon (:) is used within product specifications.
- E. Drawings and Specifications:
 - 1. Contractor shall be provided an electronic copy of the Drawings and Specifications for his use.
 - 2. Contractor shall carefully study the Drawings and Specifications, and shall at once report any error, unforeseen circumstances, inconsistency or omission upon discovery.
 - 3. The Project Manager shall be the interpreter of the requirements of the Drawings and Specifications, subject to the final approval.

F. Intent and Correlation:

1. The intent of the Project Drawings and Specifications is to include all items necessary for the proper execution and completion of the Work.
2. The Project Drawings and Specifications are complementary, and what is required by any one shall be as binding as if required by both.

1.3 REFERENCES

- A. Submit the project and customer information of customers for at least three other projects of similar size and complexity using similar technologies.
1. Shall include a minimum of the following:
 - a. Customer Name
 - b. Customer Point of Contact
 - c. Customer Point of Contact Phone Number and email address
 - d. Address of project
 - e. Title of Project
 - f. Type of project completed

1.4 DEFINITIONS

- A. Industry standard words and phrases are used throughout the Drawings and Specifications, except:
1. Words which have well-known technical or trade meanings are used in accordance with such recognized meanings.
 2. Whenever the following listed words and phrases are used, they shall be mutually understood to have the following respective meanings:
- B. The words “as indicated.” means: as shown on the Drawings, and in accordance with the Specifications.
- C. The words “as required.” means: as required to provide a complete and satisfactory Work in full conformance with the Drawings and Specifications.
- D. The word “New” means: new Work to be provided by Contractor.
- E. The word “Provide” means: furnish, install, connect, test and make ready for use.
- F. The words “Relocate existing” means: remove existing item from present location. Reinstall, re-connect, and test existing item and make ready for use at new location as shown on the Drawings.
- G. The words “Remove existing “ means: remove existing item and return item to Contractor.
- H. The word “Replace” means: remove existing item and return item to Contractor. Provide new item as indicated.

- I. The word “Work”: The Work is the completed construction required by the Drawings and Specifications, and includes all labor necessary to produce such construction, and all materials and equipment incorporated or to be incorporated in such construction.
- J. The word “Furnish” means: supply item as specified. Item to be installed by others.
- K. Access Card: A coded employee card, usually the size of a credit card, recognizable to the access control system and read by a reader to allow access. It can be used for photo identification of the cardholder and for other data collection purposes. Card technologies include magnetic strips, wiegand-effect, proximity (active/passive), barium ferrite, smart/intelligent cards, and NFC enable applications on mobile devices.
- L. Access Control System: An interconnected set of controllers, managing the entrance and exit of people through secure areas.
- M. Access Level: The door or combination of doors and/or barriers an individual is authorized to pass through.
- N. Anti-Pass back (Anti-Tailgating): This feature protects against more than one person using the same card or number. It defines each system card reader and card ID number as IN, OUT or other. Once a card is granted access to an IN reader, it must be presented to an OUT reader before another IN reader access is granted. Cards will continue to have access to all authorized OTHER readers.
- O. Alarm: A signal that indicates a problem.
- P. Alarm input: A device that is monitored by the access control panel. An alarm signal will be generated if the device is activated.
- Q. Badge: Badge is a template or a design for creating a card. WIN-PAK includes a full-featured badge layout utility for designing, creating, and printing badges. Badge design includes magnetic stripe encoding, bar coding, signatures, and so on.
- R. Bar Code: A method of encoding information using lines and blank spaces of varying size and thickness to represent alphanumeric characters.
- S. Biometrics: A general term for the verification of individuals using unique biological characteristics (i.e. fingerprints, hand geometry, voice analysis, the retinal pattern in the eye).
- T. Card and Card Holder: A card is an identity proof of a person and a card holder is a person who holds the card. Multiple cards can be assigned to a single card holder to provide different access.
- U. Controller: A microprocessor based circuit board that manages access to a secure area. The controller receives information that it uses to determine through which doors and at what times cardholders are granted access to secure areas. Based on that information, the controller can lock/unlock doors, sound alarms, and communicate status to a host computer.
- V. Card Reader: A device that retrieves information stored on an access card and transmits that information to a controller.

- W. Digital Video Recorder (DVR): A security system device that records the video from the surveillance cameras (IP and Analog) on a hard disk.
- X. Door: A generic term for a securable entry way. In many access control applications, a "door" may be a gate, turnstile, elevator door, or similar device.
- Y. Duress: Forcing a person to provide access to a secure area against that person's wishes.
- Z. Input: An electronic sensor on a controller that detects a change of state in a device outside the controller.
- AA. Integrated lockset: An integrated, intelligent locking solution that requires typically runs on batteries, but can be externally powered, that contains most of the door components, i.e. reader, door contact, and request to exit in a single, mountable unit.
- BB. Keypad: An alphanumeric grid which allows a user to enter an identification code. A flat device which has buttons that may be pressed in a sequence to send data to a controller, and which differs from a typewriter-like computer board.
- CC. Output Relay: A device that changes its state upon receiving a signal from a controller. Typically, the state change prompts an action outside of the controller such as activating or inactivating a device. The auxiliary relays found in access control panels or NODES that control external devices.
- DD. Shunt Time: The length of time a door open alarm is suppressed (shunted) after a valid card access or free egress request. This time should be just enough to allow a card user to open a door or gate, pass through, and then close it.
- EE. Time Schedules: Schedules that allow cards to function or not function depending on the time of day. This is used to limit access to the facility. The schedule may include not only time but which days of the week a card is valid.
- FF. Video Management System (VMS): An enterprise-class video management and storage solution

1.5 QUALITY ASSURANCE

- A. National Fire Protection Association.
- B. National Electric Code.
- C. American with Disabilities Act.
- D. Underwriter's Laboratory.
- E. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and Tenth Edition (or later).
- F. FCC Part 15 – Radio Frequency Device
- G. UL294 – Access Control Systems Units

- H. EIA RS485 - Electrical Characteristics of Generators and Receivers for use in Balanced Digital Multi-Point Systems
- I. Federal Information Processing Standards (FIPS)
 - 1. Advanced Encryption Standard (AES) (FIPS197)
 - 2. FIPS201-2: Open Options DNA Fusion FIPS in conjunction with an E2-SSP-D2-FIPS, NSC-100-FIPS, RSC-2-FIPS and other listed components will provide an access control solution that is fully FIPS 201-2 compliant.
 - 3. Personal Identity Verification (PIV) of Federal Employees and Contractors
- J. Homeland Security Presidential Directive 12 (HSPD12)
- K. BICSI Telecommunications Distribution Methods Manual (TDMM).
- L. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75 mile radius now rendering satisfactory service.
- M. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and /or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.
- N. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.
- O. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.6 CONTRACTOR QUALIFICATIONS

- A. Qualifications of Contractor
 - 1. Contractor shall be an installation and service contractor regularly engaged in the sale, installation, maintenance and service of access control systems.
 - 2. Contractor shall have three years' experience with the installation, start-up and programming of systems of a similar size and complexity to the one proposed.
 - 3. Contractor shall be a factory authorized dealer of the system proposed for at least two years.
 - 4. Contractor shall provide factory certified technicians to perform the installation of all intelligent controller components in this project. Evidence of the certification shall be in writing from the manufacturer and shall be on the technician's person at all times while on site.
- B. Supervision of Work
 - 1. Contractor shall employ a competent Foreman to be in responsible charge of the Work. Foreman shall be on the project site daily during the execution of the Work.

2. Contractor's Foreman shall be a regular employee, principle, or officer of Contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.

C. Qualifications of Technicians

1. All electronic systems Work shall be performed by electronic technicians thoroughly trained in the installation and service of specialty low-voltage electronic systems.
2. Electrician electrical workers may be used to install conduit, raceways, wiring, and the like, provided that final termination, hook-up, programming, and testing is performed by a qualified electronic technician, and that all such Work is supervised by the Contractor's Foreman.
3. All incidental Work, such as cutting and patching, lock hardware installation, painting, carpentry, and the like, shall be accomplished by skilled craftsperson regularly engaged in such type of work. All such Work shall comply with the highest standards applicable to that respective industry or craft.
4. All 120 VAC power wiring and connections are to be performed by a qualified Electrician, licensed to perform such Work.

D. Subcontractors

1. Definition: A Subcontractor is a person or entity who has a direct contract with the Contractor to perform any of the Work at the site.
2. Use of any Subcontractor is subject to the approval of Contractor. The Contractor shall identify all Subcontractors on the Bid Form. The Contractor shall make no substitution for any Subcontractor previously selected without approval from Contractor.
3. Contractor's Foreman shall be on the project site daily during all periods when Subcontractors are performing any of the Work. Contractor's Foreman shall be in responsible charge of all Work, including any Work being performed by Subcontractors.
4. By an appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by the terms of the Drawings and Specifications, and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these documents, assumes toward Contractor.

E. Supervision and Construction Procedures

1. The Contractor shall supervise and direct the Work, using his best skill and attention. Contractor is solely responsible for all construction means, methods, and techniques.
2. The Contractor shall employ a competent foreman who shall be in attendance at the project site during the progress of the Work. The foreman shall represent the Contractor and all communications given to the foreman shall be as binding as if given to the Contractor.

F. Regulatory Requirements

1. All Work is to conform to all building, fire, and electrical codes and ordinances applicable in the Contractor. In case of conflict between the Drawings/Specifications and codes, the codes shall govern. Notify Contractor Project Manager of any such conflicts.
2. Contractor shall secure and pay for all licenses, permits, plan reviews, engineering certifications, and inspections required by regulatory agencies. Contractor shall prepare,

at Contractor's expense, any documents, including drawings that may be required by regulatory agencies.

- G. Permits
1. The Contractor shall make application for and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.
- H. The Project Drawings represent the level of system design to be provided by Contractor. Contractor shall provide all additional system design work required, including:
1. Conduit layout and sizing.
 2. Wire and cable layout and sizing.
 3. Point-to-point wiring and equipment hook-up information.
 4. Equipment mounting details.
 5. Design of equipment cabinets.
 6. Other detailed design work required.
- I. Contractor's design shall conform to all applicable codes and ordinances. All electrical design, including the sizing and placement of conduit, raceways and conductors, shall be in accordance with NFPA 70: National Electrical Code, current version, unless local codes establish more stringent requirements.
- J. Contractor's design work is subject to review and approval by Contractor's Project Manager.
- K. Contractor's design shall also include:
1. The addition of all wire, cable, conduit, connectors and junction boxes required for system operation.
 2. The installation of conduit between the control components and all equipment at each door, as necessary.
 3. Completed "as-built" documentation of all security systems, including documentation of existing equipment, wiring, conduits, and raceways.
 4. Other Work as defined within the Project Drawings and Specifications.
- L. The contractor/subcontractor is required to answer all warranty and Service calls within 4 hours of the initial customer contact and provide an authorized technician onsite within 24 hours.
1. Proper identification is required and must be visible while onsite for warranty/service calls. Notification of completion must be provided to authorized personnel onsite before departing facility.
 2. Consult and coordinate with all trades providing adjoining work and make an Adjustment or relocation necessary to accommodate other equipment or to maintain proper function of existing equipment without claims for additional payment.
- M. These Specifications contained herein describe specific functional requirements of the ACS as required by the Contractor. It is the intent of these specifications to detail and describe the exact performance of the system. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

1.7 WARRANTY

- A. Provide a three (3) year full warranty of the system, including equipment, wiring and software against defects in material and workmanship from the date of system completion and acceptance. If any defects are found within the warranty period, the defective system component shall be replaced at no extra cost to the Contractor for parts or labor.
- B. During the first year's warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:
 - 1. Visual checks and operational test of the multiplexer, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.
 - 2. Correct all diagnosed problems.
 - 3. Resolve any previous outstanding problems.
- C. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.
- D. Contractor shall provide a parts and labor guarantee on all Work. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.
- E. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by Contractor, or acts of god.
- F. Contractor shall promptly respond to Contractor's requests for service during the guarantee period. Contractor shall provide repair service as soon as reasonably possible upon request from Contractor, but in no case shall service response exceed 8 hours from time of request.
- G. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- H. The Contractor shall be responsible to provide service during normal working hours within (4) hours after notification by the Contractor for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system component operation, or the loss of the video switcher or other head-end equipment. Provide an on-site authorized factory technician within 24 hours if required.
- I. If equipment cannot be repaired within 24 hours of service visit, Contractor shall provide "loaner" equipment to the Contractor at no charge.

1.8 SUBMITTALS

- A. Product Data: Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.
- B. Procedures

1. Provide submittals to Contractor's Project Manager.
 2. Submit electronic copy of each submittal.
- C. Shop Drawings
1. General Shop Drawings for the project as described elsewhere.
 2. Provide other Shop Drawings only if specifically requested by Contractor's Project Manager.
- D. Manufacturers Installation and Programming Instructions
1. Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.
- E. Project Record Drawings
1. Definition: Project Record Drawings are drawings that completely record and document all aspects and features of the Work. (Also known as "as-built" drawings.)
 2. The purpose of Project Record Drawings is to provide factual information regarding all aspects of the Work, to enable future service, modifications, and additions to the Work.
 3. Project Record Drawings are an important element of this Work. Contractor shall accurately maintain Project Record Drawings throughout the course of this project. Project Record Drawings shall include documentation of all Work, including the documentation of existing equipment, wiring, conduits, and raceways that are to be reused in the Work.
 4. Contractor Project Manager shall furnish Contractor with two (2) sets of site plans for Contractor's use in preparing Project Record Drawings. One set shall be used as a working set, the other shall be used to prepare the final record set.
 5. Contractor shall maintain the working set of Project Record Drawings at the project site throughout the course of the Work. The working set shall be updated on a daily basis as the Work progresses.
 6. Project Record Drawings shall accurately show the physical placement of the following:
 - a. Equipment and devices.
 - b. Conduit and raceways.
 - c. Junction and pull box locations.
 - d. End-of-line resistor locations.
 - e. Interfaces to external equipment.
 - f. Connections to power and telephone circuits.
- F. Project Record Drawings shall show the physical placement of each device and conduit or aerial center line, to be accurate to within one foot (1') of the nearest landmark. Where the site plan furnished by Contractor's Project Manager conflicts with actual conditions, Contractor shall amend site plan as required. Indicate exact description of conduit runs (above ground, two foot trench, along outside wall of building, etc.).
- G. Project Record Drawings shall show wire and cable runs, zone numbers, tamper circuit configuration, panel/circuit breaker numbers from which equipment is powered, and splice points. Such information may be shown on the site plans.
- H. Project Record Drawings shall be available for inspection by Contractor's Project Manager on a daily basis. Incomplete or inaccurate Project Record Drawings may be cause for delay of Contractor's payment.

- I. Upon completion of Work, and prior to Final Acceptance, Contractor shall prepare and submit to Contractor's Project Manager a final record set of Project Record Drawings. This set shall consist of all data transferred from the working set, supplemented by Riser Diagrams and other information. The final record set of Project Record Drawings shall be drafted by a skilled draftsman, under the supervision of Contractor. All final Project Record Drawings shall be provided to Contractor.
- J. System Documentation
 1. Definition: System Documentation is a complete collection of all installation, programming, operation, and maintenance manuals and work sheets relating to the equipment provided as part of the Work.
 2. Contractor shall maintain a file of System Documentation at the project site throughout the course of the Work. Such file shall be updated with new information as equipment is received and installed. System Documentation shall be available for inspection by Contractor Project Manager on a daily basis.
 3. Upon completion of Work, and prior to final Acceptance, Contractor shall prepare and submit to Contractor's Project Manager electronic sets of System Documentation.
- K. Closeout Submittals
 1. Provide a set of as-built drawings and manuals to the Contractor's Project Manager
 - a. As-Built Drawings
 - b. Mounting Details
 - c. Product Data
 - d. Installation Manuals
 - e. Operating Manuals
 - f. Maintenance/Service Manuals
 2. Provide the Contractor's Project Manager- with all programming sheets, keys to the equipment cabinets, as-built drawings, operating manuals, maintenance/repair manuals, spare fuses, all programming sheets and keys to the equipment cabinets, tools for tamper-resistant enclosures and tools for manual resetting devices.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Security of Contractor's Tools and Equipment: Contractor is not responsible for the care, storage or security of any of the Contractor's tools or equipment.

1.10 PROJECT/SITE CONDITIONS

- A. Environmental Conditions
 1. Power: Electrical power will be supplied by Contractor to the extent that the usage is compatible with available facilities in the vicinity of the work.
 2. Telephone: Contractor may use a telephone designated by Contractor for local and toll-free calls. The costs of long distance calls are the responsibility of the Contractor and shall not be charged to Contractor.
 3. Rest room Facilities: Contractor may use existing Rest room facilities designated by Contractor.

4. Parking: Contractor reserves the right to limit or restrict Contractor parking based upon the daily requirements of the other contractors on site.
5. Dust Control: Make provisions to control all dust, dirt, and foreign material caused by the performance of the Work.
6. Use of explosive type fastening equipment is prohibited.
7. Notify Contractor immediately of any damage or possible damage to any other equipment.

B. Clean-Up

1. Contractor shall clean-up, on a daily basis as the Work progresses, all dirt, dust and debris caused by Contractor's operations. Clean-up shall be completed by the end of each workday to the satisfaction of Contractor's on-site representative.
2. In the event that Contractor fails to clean-up, Contractor may elect to have clean-up performed by others, with the costs of such clean-up being charged to the Contractor.

C. Construction Aids

1. Definition: Construction Aids are facilities and equipment required by personnel to facilitate the execution of the Work. Construction Aids include scaffolds, staging, ladders, platforms, hoists, cranes, lifts, trenchers, core drillers, protective equipment, and other such facilities and equipment.
2. Contractor shall provide all Construction Aids required in the execution of the Work. Construction Aids that are the property of Contractor or other contractors shall not be used without permission.
3. Storage of Construction Aids shall be coordinated with Contractor's on-site representative.

D. Safety

1. The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work.
2. Contractor shall comply with all local, state, and federal regulations and laws for the safety of the work place.

E. Accident Reports

1. Serious or fatal accidents shall be reported immediately by telephone or radio to the Contractor's Project Manager.

F. Existing Conditions

1. Contractor does not warrant the condition of any portion of the existing wiring, conduit or raceway systems. Prior to submitting his proposal, Contractor shall examine all existing conditions and determine to what extent the existing wiring, conduit, and raceway systems may be reused.
2. Contractor's proposal price shall include the cost of replacing existing wiring, conduit, and raceways as required.

1.11 SEQUENCING

A. Description

1. This implementation plan describes the general approach that shall be followed in order to minimize the time for the access control systems to be operational.

B. Approach

1. Contractor shall plan and schedule all work in such a sequence as to minimize the time before the system is operational. The following is a suggested work sequence:
 - a. Order all equipment needed and notify any subcontractors to schedule their participation.
 - b. Perform all system layout work.
 - c. Insure there are an adequate number of power receptacles available to operate all security equipment and coordinate with Contractor as to where power is available.
 - d. Provide shop drawings to verify location of all equipment, conduit runs, power connections, etc. Submit shop drawings to Contractor Project Manager.
 - e. Coordinate with Contractor to provide space in each building's Communications Room for mounting of processors.
 - f. Provide training on how to fill out the programming sheets for access levels.
 - g. Prepare and pre-test all equipment to the greatest extent possible.
 - h. Install all equipment.
 - i. Provide training on the programming other various options.
 - j. Test and inspect all systems.
 - k. Perform all other Work as required.
 - l. Perform the Acceptance Test.
 - m. Provide training.
 - n. Provide as-built drawings.

1.12 SCHEDULING

- A. The Contractor, within five (5) days after being awarded the contract, shall prepare and submit for Contractor's information, an estimated progress schedule for the Work. The progress schedule shall be related to the entire project, and shall indicate start and completion dates.

1.13 SYSTEM STARTUP

- A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

1.14 CONTRACTOR'S INSTRUCTIONS

A. Coordination with Contractor

1. Contractor shall closely schedule and coordinate his activities with designated Contractor representatives.
2. Contractor shall provide Contractor's Project Manager with a work plan on a weekly basis. Such work plan will describe locations of intended activities, types of activities, and potential conflicts to facility operations.

B. Contractor's Right to Carry Out the Work

1. If the Contractor defaults or neglects to carry out the Work in accordance with the Project Drawings and Specifications and fails within seven days after receipt of written notice from Contractor to commence and continue correction of such default or neglect with diligence and promptness, Contractor may, after seven days following receipt of an additional written notice and without prejudice to any other remedy Contractor may have, make good such deficiencies. In such case, an appropriate Change Order shall be issued deducting from the payments then or thereafter due the Contractor the cost of correcting such deficiencies.

C. Minor Changes in the Work

1. Contractor shall have the authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time and not inconsistent with the intent of the Project Drawing and Specifications. Such changes shall be provided by written order.

1.15 COMMISSIONING

- A. Manufacturer shall provide the opportunity for Professional Services to assist Contractor with commissioning.
- B. After all Work is completed, and prior to requesting the Acceptance test, Contractor shall conduct a final inspection, and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.
- C. Contractor shall submit a request for the Acceptance test in writing to the Contractor Project Manager, no less than fourteen days prior to the requested test date. The request for Acceptance test shall be accompanied by a certification from Contractor that all Work is complete and has been pre-tested, and that all corrections have been made.
- D. During Acceptance test, Contractor shall demonstrate all equipment and system features to Contractor. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by Contractor.
- E. Any portions of the Work found to be deficient or not in compliance with the Project Drawing and Specifications will be rejected. Contractor Project Manager will prepare a list of any such deficiencies observed during the Acceptance test. Contractor shall promptly correct all deficiencies. Upon correction of deficiencies, Contractor shall submit a request in writing to Contractor Project Manager for another Acceptance Test.
- F. If, at the conclusion of the Acceptance Test, all Work is found to be acceptable and in compliance with the Project Drawings and Specifications, Contractor Project Manager will issue a letter of Acceptance to Contractor and Contractor.

1.16 MAINTENANCE

- A. Provide full procedures for all database back-ups.
- B. Provide full procedures for server/workstation hard drive maintenance, such as defrag, etc.

- C. Provide full procedures for maintaining physical and software firewalls.
- D. Provide full procedures for upgrading software.
- E. Provide full procedures for testing battery condition on all field panels for adequate back-up time.
- F. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

1.17 MANUFACTURERS

- A. Qualification of the Manufacturer:
 - 1. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 5 years and who shall be able to refer to similar installations now rendering satisfactory service.
 - 2. Perform all work under the on site supervision of a factory authorized, trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer's and Contractor approval. A CSR of the installing contractor or manufacturer shall train the Contractor's personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.
 - 3. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and/or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.
 - 4. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

- A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.
- B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

- C. This specification is intended to establish a carefully planned minimum level of quality and performance for all components, and will be rigorously enforced by Contractor. Acceptable manufacturers of components described herein are:
 - 1. RS2 Technologies
 - 2. Open Options
 - 3. AMAG

2.2 GENERAL

- A. All products not provided by Contractor shall be new and unused, and shall be of manufacturer's current and standard production.
- B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.
- C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.
- D. Product Availability
 - 1. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into his proposed Contract Time.
 - 2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify his ability to procure the products specified prior to submitting a proposal.
- E. Wire and Cable
 - 1. General: Provide all wire and cable required to install systems as indicated. Wire and cable shall be sized to provide minimum voltage drop and minimum resistance to the devices being supplied.
 - 2. All cables shall be specifically designed for their intended use (direct burial, aerial, etc.).
 - 3. Comply with equipment manufacturers recommendations for wire and cable size and type.
 - 4. Comply with all applicable codes and ordinances.
- F. Conduit and Raceway Systems
 - 1. General: The placing of surface mounted conduit on the exterior of any building shall be approved by Contractor prior to its installation.
 - 2. Interior Conduit:
 - a. Electrical Metallic Tubing (EMT)
 - b. Flexible Metal Conduit
 - c. Provide fittings and connectors as required for installation of EMT or flexible conduit.
 - 3. Surface Raceways:

- a. Sheet metal channel with fitted cover, suitable for use as surface metal raceway, WIREMOLD or approved equal.
- b. Provide fittings, elbows, and connectors designed for use with raceway system.
4. Exterior Conduit: (any of the following as determined by local code requirements):
 - a. Rigid Steel Conduit
 - b. Rigid Aluminum Conduit
 - c. Rigid Nonmetallic Conduit (only if buried 18" below ground surface).
 - d. Intermediate Metal Conduit
 - e. Provide rain-tight fittings and connectors as required for installation of exterior conduit.

G. Junction and Pull Boxes

1. Interior Boxes: Sheet Metal Outlet Boxes: Sizes to be determined in accordance with code requirements for conductor fill. No box shall be smaller than a single gang 1-1/2 deep. Provide box covers as required.
2. Exterior Boxes: All exterior boxes shall NEMA 4 or NEMA 3R, watertight and dust-tight
3. All interior and exterior boxes shall have their covers fastened using security screws.

H. Lightning Protection

1. The Contractor shall provide suitable lightning protection for all processors/controllers.
2. All lightning protection equipment shall be UL listed.

2.3 SYSTEM DESCRIPTION

- A. Furnish a system that provides a simple and easy-to-use graphical user interface.
- B. Furnish all licenses required for any readers, cameras, contacts, etc. necessary to make this system a complete operational system.
- C. The system shall provide local operational control of all access points and alarm
- D. The ACS System client and server software shall be used in conjunction with intelligent controllers to provide a distributed access control and alarms monitoring system.
- E. In the event of a communications failure between the host server and the remote controllers, the controllers shall continue to make local access control decisions and save all transactions in memory until communications are restored. At that time the controller shall upload all stored transactions to the Central Server.
- F. The ACS System shall seamlessly integrate the functions of Access Control, Alarm Monitoring and Response, Digital Video Imaging and Badge Design/Creation, and Visitor Management.
- G. Access Readers supporting various technologies shall provide data from proximity card presentations or biometric authentications via a door control unit that includes the electrical interface to the reader as well as inputs for door sensors and relays for outputs.
- H. The Door Controllers shall support industry-standard Wiegand communications to the associated readers.

- I. The Door Controllers shall support bi-directional, supervised, and encrypted communications to the readers.

2.4 MANUFACTURERS

- A. Open Options
- B. RS2 Technologies
- C. AMAG

2.5 SYSTEM USER REQUIREMENTS

- A. The ACS shall be a highly scalable, robust access control and security management system developed using the latest in development technology. The ACS shall provide a singular interface capable of controlling multiple, geographically independent sites and provide alarm monitoring, video management integration, ID badging, personnel and cardholder management, and situational control of all connected devices from a single application.
- B. The system shall provide local operational control of all access points and alarm
- C. In the event of a communications failure between the host server and the remote controllers, the controllers shall continue to make local access control decisions and save all transactions in memory until communications are restored. At that time the controller shall upload all stored transactions to the Central Server.
- D. Access Readers supporting various technologies shall provide data from proximity card presentations or biometric authentications via a door control unit that includes the electrical interface to the reader as well as inputs for door sensors and relays for outputs.
- E. The Door Controllers shall support industry-standard Wiegand communications to the associated readers.
- F. The Door Controllers shall support bi-directional, supervised, and encrypted communications to the readers.
- G. The ACS must support the Open Supervised Device Protocol (OSDP).
- H. A sufficient number of controllers and sub-controllers will be provided to monitor all credential reader, monitor point, and relay point locations shown on plan.

2.6 Capacities

- A. Maximum intelligent controllers per application server: 256
 - 1. Intelligent controllers can be geographically independent
 - 2. Must support IP and/or RS-485 communication methods.
- B. Maximum sub-controllers per controller: 32

1. This number varies per model of controller.
 2. Some controller models may have a smaller number for maximum sub-controllers.
- C. Maximum doors per intelligent controller: 64
1. This number varies per model of controller.
 2. Some controller models may have a smaller number for maximum doors
- D. Maximum pin digits: 15
- E. Maximum card formats: Unlimited
- F. Maximum Time Schedules per intelligent controller: 255
- G. Maximum holidays per intelligent controller: 255
- H. Maximum number of personnel records: Unlimited
- I. Maximum number of operators: Unlimited
- J. Maximum number of client connections: Unlimited

2.7 THE ACS SHALL BE CAPABLE OF THE FOLLOWING FEATURES:

- A. Multi-User/Network Capabilities: The ACS shall support multiple operator workstations via local area network/wide area network (LAN/WAN). The communications between the workstations and the server computer shall utilize the TCP/IP standard over industry standard IEEE 802.3 (Ethernet). The communications between the server and workstations shall be supervised, and shall provide the ability to generate alarm messages when the server is unable to communicate with a workstation.
- B. Operating Environment: The ACS shall be a 3-tier client/server, ODBC compliant application based on Microsoft tools and standards. The ACS application shall operate in the following environments: Microsoft Windows® Server 2008 R2 SP1, Microsoft Windows® 7 Professional SP1 (64-bit), Windows Server 2012 R2, Windows 8.1 Enterprise/Professional, and Windows 10 Enterprise/Professional.
- C. Multi-level Password Protection: The ACS application shall provide multi-level password protection, with user-defined operator name/password combinations. Name/password log-on shall restrict operators to selected areas of the program. The application shall allow the assignment of operator levels to define the system components that each operator has access to view, operate, change, or delete.
- D. NT Authentication: The ACS application will support the implementation of NT authentication, thereby utilizing the credentials supplied by the network administrator to authenticate during the login process of the system.
- E. Strong Password Enforcement: The ACS application shall have an option to enforce strong passwords and by setting minimum character lengths and complexity requirements.

- F. Graphical User Interface: The ACS shall be fully compliant with Microsoft Graphical User Interface (GUI) standards, with the look and feel of the software being that of a standard Windows application, including hardware tree-based system configuration.
- G. Concurrent Licensing: The ACS shall support concurrent client workstation licensing. The ACS application shall be installed on any number of client workstations, and shall provide the ability for any of the client workstations to connect to the application server as long as the maximum number of concurrent connections purchased has not been exceeded.
- H. ACS Suite: The ACS shall be a scalable application such that there is no requirement for separate tiers or editions of software. The same code set used for smaller, more localized installations, shall be the same code set used for enterprise system deployments.
- I. Relational Database Management System: The ACS shall support industry standard relational database management systems (RDMS). This shall include the following: Microsoft SQL Server 2012 Express/Enterprise Edition, Microsoft SQL Server 2008 R2 Express/Enterprise Edition, Microsoft SQL Server 2014 Express/Enterprise Edition, and Microsoft SQL Server 2016 Express/Enterprise edition.
- J. System Partitioning/Filtering: The ACS shall provide the option to restrict access to personnel and hardware data based on login and profile.
- K. Encryption: The ACS shall provide multiple levels of data encryption.
 - 1. Must support 128-bit or 256-bit AES data encryption between the host and intelligent controllers. The encryption shall ensure data integrity that is compliant with the requirements of FIPS-197 and SCIF environments. Master keys shall be downloaded to the intelligent controller, which shall then be authenticated through the Access Control and Security Management System based on a successful match.
 - 2. Transparent database encryption, including log files and backups.
 - 3. SQL secure connections via SSL.
- L. Industry Standard Panel Communication: The ACS shall communicate with the access control intelligent controllers via LAN/WAN connections utilizing industry standard communication protocols.
- M. Supervised Alarm Points: The ACS shall provide both supervised and non-supervised alarm point monitoring with the ability to specify custom values of resistance. On recognition of an alarm, the ACS shall be capable of switching and displaying the video from the camera connected to the video management system that is associated with the alarm point.
- N. Multiple Account Support: The ACS shall allow support for multiple accounts allowing separate access to the personnel database, badge layout, operator access, and reporting. Physical hardware may be filtered by profile level into “sites”. “Sites” may be assigned to one or more operator profiles. The system shall allow control of common areas between operator profiles. Access levels and time schedules shall be global to allow for easy administration and filtering. The global access levels and time schedules shall be capable of being used by one or more operator profiles.
- O. Video Management System Support: The ACS shall integrate with no less than 10 brands of video management systems (VMS).

- P. Camera Support: The ACS shall support, via integrated VMS platforms, pan, tilt, zoom, and touring features.
 - Q. Display Live Video: The ACS shall support an option to view live video from a camera connected to an integrated VMS. The cameras from the integrated VMS shall be able to be associated with any hardware device programmed in the ACS and opened automatically on any system event or operator initiated command sequence.
 - R. Global/Anti-Passback: The ACS shall support multiple modes of anti-passback, by which cardholders must follow a specified sequence of card reads in the configured areas.
 - S. Alarm Events: The ACS shall include a feature where alarm events with defined priorities shall be able to pop-up automatically in an Alarm event window for operator attention. The pop-up shall display the following information: description of the event, time, date, point description, if a card event the card number, type of event and cardholder name. An event counter shall also display the number of times the event was reported to the Alarm event monitor prior to Acknowledgement or Clearing the event. Event instructions shall be made available by double clicking on the event. The Alarm shall also display an icon to indicate that a camera is associated to the device. The Alarm event window shall allow the operator to initiate a physical response to the event as well as a written response. Responses shall include but not be limited to: acknowledge, clear, open a pre-programmed floor plan, activate, de-activate, pulse, time pulse, add comment, retrieve archived video, and bring up live video, disarm, or arm.
 - T. Global Device Control: The ACS shall allow manual control of one or more selected inputs, outputs, and doors. Global device control shall include pulse, timed pulse, and energize/de-energize or return to normal options for output points and arm/disarm or return to normal options for input points. For global control of doors the ACS shall include Disabled, Unlocked, Locked, Facility Code Only, Card Only, PIN Only, Card and PIN, Override Mode, and Cancel Override Mode.
 - U. Global Edit: The ACS shall support, by way of a multi-select function, a method to globally edit input points, outpoint points, doors, readers, personnel and cards.
 - V. Levels of System Operation: The ACS shall include a feature to define the levels of system operation for each individual operator using passwords and profiles. System operation for individual operators shall include, but not be limited to, restricted time periods for login, inactivity notifications, and lockout for failed logon attempts. Operator actions range from no view or control rights to basic monitoring including the ability to block the viewing of card and or personal identification numbers, to full control of the system including programming.
 - W. Distributed Processing: All the control components of the ACS shall utilize “Distributed-Processing” design. The distributed processing shall include the ability to download operating parameters to any field panel, thus allowing the field panel to provide full operating functions independent of the ACS application server.
- 2.8 The ACS shall have the major functional capabilities (considered essential for the system described in this specification) categorized as follows:
- A. All transactions and audits shall be logged by date and time to the database.

- B. The end-user shall have the ability to make any system configuration changes such as, but not limited to door open time, door contact shunt time, point and door names, when and where a cardholder is authorized, and the ability to add or modify personnel records at any time and without assistance from the manufacturer or system installer.
- C. Shall support Global Anti-pass back, feature allowing cardholders to enter/exit any such defined card reader area on any intelligent control panel provided they follow the required in/out flow.
- D. Anti-pass back modes shall include: hard (no forgiveness), soft (allows access but generates an alarm event) and timed for all readers on the intelligent controller, on specified reader or card for a definable period of time up to 1092 minutes.
- E. Shall support a Duress PIN feature that is configurable in operation by which the cardholder either adds a specified digit to their unique PIN or appends a specified digit to their unique PIN.
- F. Shall support Two Card Control on any door, by which two different credentials with the proper access must be presented at the same door within a 5 second window of time.
- G. Shall support a Photo Recall option with four separate, configurable windows that displays the photo(s) associated with the personnel records as the credentials are used. The Photo Recall windows shall be configurable to show the credential reads from all doors, or only specific doors. In addition, the Photo Recall window shall be configurable as to what system data will be displayed for each transaction.
- H. Shall support the scheduling of any system or custom system reports.
- I. Shall support Auto-Email function, by which any event or device in the system can be configured to send an email using replacement parameters. The replacement parameters shall be used to query data from the database for insertion into the body, subject line, or address field of the email.
- J. All updates and changes to the programming in the intelligent controllers shall take place real-time and will not require manual downloads to propagate system changes.
- K. Shall have an available Application Program Interface (API) built on current development technologies that allows the integration of third party programs or systems.
- L. Shall be an intuitive Graphical User Interface (GUI) that implements a multi-document layout. An operator will not be required to close or switch views to another part of the application in order to edit or view any aspect of the system. The GUI must be fully customizable allowing for an infinite number of operator views to be created and assigned. The GUI must support drag and drop functions within the multi-document interface.
- M. Shall support global I/O functions, by which any point in programmed in the system can be configured to control any other point on the system regardless of which intelligent controllers they reside on.
- N. All necessary system drivers shall run as Windows services and as such do not require the Operating System to be logged in on the application server.
- O. Shall have support for thick client, web client and mobile client applications that provide system management functions.

- P. Shall support a Situation Level Manager that provides five different states that can be initiated by clicking on a single, color coded button. The Situation Levels shall be configurable on the following objects: Doors, Time Schedules, Input Points, Output/Relay Points, and Credentials.
- Q. Shall provide intuitive Info-Ready™ reporting by which an operator must only right click on an object to run a Trace History Report, Has Access To, Who Has Access, Who Does Not Have Access, Last Used, and Non-Use.
- R. The GUI shall be developed in such a manner that any place that a personnel record or hardware device is shown that an operator can right click on it and open the properties or execute control functions.
- S. Shall support a method of controlling any device connected to the system in order to effectively change the state of a single point or group of points where supported by the hardware.
- T. Shall support Direct Commands, which allow the creation of a single button to control a single or multiple devices simultaneously by clicking one button, based on operator privileges.
- U. The Direct Commands shall be one of many ways to incorporate facility lockdowns and return to normal or all clear states.
- V. Shall support the ability to password protect the Direct Commands to require additional authentication prior to execution.
- W. Must support the ability to remove an input point from service, where by any change of state on that point is ignored, regardless of the point arm/disarm state. Removing a point from service goes beyond disarming the point, as it can be rearmed via a programmed or manual event, thereby reporting alarm conditions once again. A point that has been removed from service must be returned to service in order to see change of state events on it.
- X. Must support Override Modes on doors, whereby the current mode of the door can be overridden to another state. (i.e. Card Only, Card & PIN, Locked, Disabled). When the mode of door has been overridden, it will remain in that state, regardless of any scheduled commands or manual control initiated based on time or operator execution. When the override mode is canceled, the door will revert to the state that it is supposed to be in. I.E. if a time schedule has activated to unlock the door, then it will revert to that state without any additional programming or intervention from the operator.
- Y. Removal from service and override modes must be selectable with the following options:
 - 1. Indefinite – Meaning the state will remain until it has been canceled
 - 2. For a specified number of minutes.
 - 3. Until a specific time of the current day.

2.9 PERSONNEL AND CARDHOLDER MANAGEMENT

- A. Shall provide a personnel browser method of managing personnel data in a hierarchical tree. The personnel browser shall be sortable by any field of data stored in the personnel record.
- B. Shall have the ability to create unlimited custom personnel groups that personnel records can be assigned to where by personnel records can be assigned to one or more personnel groups.

- C. Shall have the ability to assign default access levels to custom personnel groups that cardholders will inherit or disinherit as they are added or removed to or from custom personnel groups.
- D. Shall have the ability to assign one or more credentials to a single personnel record.
- E. Shall support a maximum of 128 access levels per credential per intelligent controller.
- F. Shall support Precision Access Levels, by which an operator must only click and drag a door into the access level assignment window of the credential and associate a time schedule with it.
- G. Shall support a Vacation Start function on credentials to allow the temporary disabling of cards for a specified number of days.
- H. Shall support a Temporary Upgrade of Access Levels by which an operator can temporarily assign an access level with start and stop dates.
- I. Shall support an activation and deactivation date and time of a credential down to the minute within a day.
- J. Shall support the capture of personnel photos and signatures to be used for ID badge printing.
- K. Shall support the ability for any personnel or credential field to be retrieved and printed on an ID badge.
- L. Shall support the ability for any or all credentials activate or deactivate based on a system controlled Situation Level.
- M. Shall support Info-ReadyTM reports on personnel groups providing the following information: Last Used and Non-Use.
- N. Shall support the ability to assign/re-assign credentials to personnel records by way of a drag and drop convention.

2.10 TIME SCHEDULES AND HOLIDAYS

- A. Shall support up to 255 individual time schedules per time schedule set.
- B. Shall support up to 255 individual time schedule sets that are then assignable to intelligent controllers.
- C. Shall support up to 12 different start and stop intervals for each day, including holidays.
- D. Shall support time schedule templates to quickly build common time schedules.
- E. Shall support a copy feature to copy time schedules between time schedule sets.
- F. Time schedules shall be assignable to any or all access levels or precision access levels.

- G. Shall support the ability to manually control any or all time schedules programmed in the system by providing the following commands: Temporary Off, Temporary On, Override Off, Override On, and Resume Normal State.
- H. Shall support the ability for any or all time schedules to be manually controlled by the changing of the Situation Level Manager.
- I. Shall support up to 255 holiday sets that are then assignable to intelligent controllers.
- J. Shall support creating a holiday to span up to 365 days.
- K. Shall support up to eight different holiday types.

2.11 ACCESS LEVELS

- A. Shall support an unlimited number of access levels.
- B. Access levels shall be capable of being global or intelligent controller based.
- C. Shall support the option to assign activation and deactivation dates/times to access levels.
- D. Shall support three types of escort requirements for access levels: Not an Escort, Is an Escort, and Requires an Escort.
- E. Shall support a default time schedule to be assigned to the access level or separate time schedules to individual doors within the access level.
- F. Shall support eight different access level categories that can then be assigned to operator profiles granting rights to assign the category of access level or not.
- G. Shall support an Info-Ready report named Assigned To that provides a list of all credentials the access level is assigned to with the ability to remove the access level from cardholders directly from the result set window.
- H. Shall support a click and drag method of assigning access levels to a single credential, personnel record, or group of personnel records.

2.12 HARDWARE

- A. Shall support a browser based, hierarchical tree structure that displays the programmed hardware with current states and provides command and control capabilities based on operator privileges.
- B. The tree structure shall be developed in such a way that it is intuitive for the operator to navigate by providing common groupings of like devices and supports scrolling within the window by a scrollbar or mouse scroll wheel.
- C. The tree structure shall provide, based on operator privileges, the ability to group edit and control similar devices.

- D. The tree structure shall have an option to display a tooltip upon hovering over a specific device to obtain detailed status information. Tooltips will be configurable as to size, duration, and content presented when displayed.

2.13 INTEGRATED ID BADGING

- A. Shall have an integrated photo capture and ID badging module.
- B. The integrated ID badging module shall support an unlimited number of badge templates.
- C. The badging station shall include a badge designer to create badge templates.
- D. The badge designer shall allow any data field associated with a personnel record to be printed or otherwise used on the credential.
- E. The integrated ID badging module shall support a dedicated, high end photo badging camera basis of design: Valcam Model# 9000-628
- F. The integrated ID badging module shall support, through the use of a third party TWAIN Driver, the ability to use any TWAIN compliant USB camera.
- G. The badge designer shall provide scripting capabilities to create a robust and streamlined template process by which the layout of a single template can be edited based on data retrieved from the personnel record.
- H. The integrated ID badging module shall support a cropping mechanism in order to resize photos and select the printable area of the picture.
- I. The integrated ID badging module shall support any credential printer that has a Windows print driver
- J. The integrated ID badging module shall offer, depending upon the printer selected, the ability to create a template that will read the encoded card number from the credential as it passes through the printer during the printing process and then associate it with the personnel record automatically, thereby removing the need for the operator to manually enter the credential number. This feature will require a reader/encoder be installed inside the printer prior to setup.
- K. The integrated ID badging module shall provide a print preview function that allows the operator to verify the credential format prior to actually printing it.
- L. The integrated ID badging module shall support the capturing of signatures during the credentialing process.
- M. The integrated ID badging solution should support a batch printing function, by which operators can create batches to print based on specific search criteria.
- N. Batch printing module will support intelligent card printing functions, by which the encoded credential numbers can be read during the printing process and populate the personnel records with new card information.

2.14 INTEGRATED GRAPHICS MAPS

- A. Shall provide, with no additional licensing fees required, an integrated and robust graphical map module allowing for the importation of floor plans and other .JPG or .BMP files for use in plotting hardware and other connected devices programmed in the system onto the graphic layouts.
- B. Shall support the ability to assign a graphic map as a homepage of any point in the system, thereby linking that device to that map and allowing the system to automatically load the graphic upon an alarm condition from any point that is plotted on it.
- C. Shall support any command and control or reporting functions available in the Hardware Browser for any point that is plotted on a graphic map.
- D. Shall support the hyperlinking of graphic maps to one another, thereby creating a “drill down” effect.
- E. Shall support the ability to plot any camera that is integrated to the core application onto a graphics map and display the live video in a tooltip window upon the operator hovering over the icon, or displaying of live video in a video container window upon left clicking the camera icon.
- F. Shall support the real-time status updating of points that are plotted on a graphics map by configurable colors, shapes, or icons.
- G. Shall support the ability to plot the same device on a single graphic map multiple times to get varying states of status reported simultaneously.
- H. Shall support the ability to create buttons on the graphic maps which can then be linked to Direct Commands.

2.15 MOBILE APPLICATIONS

- A. Must have mobile applications supported on Android and iOS devices
- B. Mobile applications will be native applications and not remote/mobile browser solutions.
- C. Mobile applications will be available for download from the respective application markets, and will not require side loading of any kind.
- D. Mobile applications will utilize profiles established in the DNA Fusion system to control what the operator has the ability to do via the mobile application.
- E. Mobile application will support the following features:
 - 1. Secure login using SSL
 - 2. Alarm viewing/acknowledgement
 - 3. Door status and control
 - 4. Add personnel record and take photo using device camera
 - 5. Personnel control, to include adding access levels and taking photos using the devices camera
 - 6. Direct Command execution allowing for site or system lockdowns.
 - 7. Trace History reporting

8. Live camera viewing from supported/integrated Video Management Systems.

2.16 INTEGRATED IP BASED ACCESS CONTROL HARDWARE

- A. The ACS must fully support the intelligent, IP based readers
- B. The ACS must support the intelligent, IP based access control panel

2.17 INTEGRATED VIDEO MANAGEMENT SYSTEMS

- A. Shall support the integration of Digital Video Recorders (DVR) and Network Video Recorders (NVR) from the following manufacturers:
 1. Milestone
 - a. Corporate
 - b. Enterprise
 - c. Professional
 2. ONSSI
 3. ExacQ Vision
 4. Video Insight
 5. Salient Systems
 6. Avigilon
 7. S2
- B. Shall support the ability to associate cameras from DVR/NVR to hardware devices in ACS.
- C. Shall support, at minimum, the ability to launch live and recorded video based on a right click command in the ACS, or automatically based on a pre-programmed event based action.
- D. Shall support the ability to initiate presets or PTZ controls
- E. Shall support a bi-directional function, where by access control hardware, events, and controls are available in VMS application.

2.18 INTEGRATED BIOMETRICS

- A. Shall support an integration with biometric solutions
- B. The integration shall be direct, by which the biometric templates are captured via Access Control and will not require manual entry via 3rd party application.

2.19 INTEGRATED WIRELESS/INTELLIGENT LOCKS

- A. Shall support wireless/intelligent lock sets
- B. Must support Wake On Radio (WOR) function locks to remotely control the lock states via wireless communication.

- C. Must support the ability to initiate linking mode in order to link the wireless/intelligent to the Panel Interface Module (PIM).
- D. Must support the following modes on the locksets:
 - 1. Privacy
 - 2. Office
 - 3. Toggle Credentials
 - 4. Deadbolt
- E. Must support the ability to initiate linking mode, to link the lockset to the PIM device, via the ACS software, without using the Handheld Device (HHD).
- F. Must support Over the Network Re-Provisioning (ONR) of the firmware to the lockset.

2.20 INTEGRATED INTRUSION DETECTION SYSTEMS

- A. Shall support an integration with the following Intrusion Detection Systems (IDS) by providing real-time event reporting and control capabilities.
- B. Shall show in the Hardware Browser real-time states of the areas and zones from the IDS panels.
- C. Shall support right click functionality for controlling the arm/disarm states of the areas/zones.
- D. Shall allow for the areas/zones from the IDS panels to be plotted on graphic maps in the access control program.

2.21 INTEGRATED VISITOR MANAGEMENT SYSTEMS

- A. Shall provide a mechanism, Flex API, which allows for the integration 3rd party Visitor Management Systems.
- B. The integrated Visitor Management Systems shall be certified as an approved integrated solution by access control manufacturer.

2.22 INTEGRATED INTERCOM SYSTEMS

- A. Shall provide a means to integrate intercom master and sub-stations into the application
- B. The master and sub-stations shall be displayed in the Hardware tree in a hierarchical manner (i.e. Master station with associated sub-stations)
- C. The status of the connected devices shall be represented in the Hardware tree notated by the following colors:
 - 1. Green – Station is online and idle (i.e. ready for a call)
 - 2. Blue – Station is busy
 - 3. Red – Station is currently connected to another station (in a call)
 - 4. Black – Offline or non-existent

- D. Shall provide a means in which to control the connected devices by a right-click menu option to execute the following functions:
 - 1. Make Call – Initiates a call to the selected station
 - 2. Cancel Call – Terminates the current call in progress
 - 3. Answer Call – Opens communications for the incoming call
- E. Shall provide the ability to plot the intercom devices on a graphics map.
 - 1. Intercom devices on the map shall provide the ability to indicate status
 - 2. Intercom devices on the map shall provide the ability to control the connected devices
- F. Shall provide the ability for automatic camera call up on intercom device status changes (i.e. Incoming call from sub-station calls up a live camera view)
- G. Shall provide a means of triggering system or hardware control actions based on status changes of the connected intercom hardware
- H. Shall provide a software integration driver to directly interface with the elevator destination dispatch control solution.
 - 1. The solution will not require any inputs or outputs (relay logic) of any kind to function as described.
- I. The destination dispatch control solution shall provide the following functions
 - 1. Provide card reader security within the elevator(s) as required.
 - 2. Provide card reader security at the Destination Dispatch kiosk(s), as required.
 - 3. Allows Default Floor call registration upon card swipe.
 - 4. Allows for card flags such as VIP and ADA from a card swipe
 - 5. Enforce elevator access levels
- J. Provide card reader security within the elevator(s) as required.
- K. Provide card reader security at the Destination Dispatch kiosk(s), as required.
- L. Allows Default Floor call registration upon card swipe.
- M. Allows for card flags such as VIP and ADA from a card swipe
- N. Enforce elevator access levels

2.23 ACCESS CONTROL SYSTEM HARDWARE

- A. The access control hardware will be a distributed intelligence, open architecture platform capable of scalability.
- B. The access control hardware shall be offered in two form factors: as board only product or as enclosed product.
- C. The enclosed product shall be offered as a factory, pre-wired unit and must be a UL recognized assembly.

- D. The enclosed products must be offered as a 1U rack mountable intelligent controller or as a plenum rated poly carbonate enclosure.
- E. The access control hardware will be in use and deployed by a minimum of 10 access control manufacturers.
- F. The access control hardware shall work in a hierarchical structure, by which an intelligent controller is deployed and control downstream Reader Interface Modules (RIM) or Input/Output Modules (I/OM).
- G. The access control hardware shall support the following communication protocols:
 - 1. TCP/IP
 - 2. RS485

2.24 HIGH AVAILABILITY AND DISASTER RECOVERY

- A. The ACS shall support a variety of High Availability (HA) and Disaster Recovery (DR) solutions including:
 - 1. Fault tolerant servers for 99.999% rated availability
 - 2. Microsoft clustered server support for 99.99% rated availability
 - 3. Remote redundancy through backup servers of general purpose nature or as in 1.09C.1.a and 1.09C.1.b synchronized through software monitoring the operation of the paired server.
- B. To provide greater client software availability, software shall be installed so that in the event of a database server failure, client machines will quickly and without operator intervention, automatically connect to a standby server machine.
- C. The ACS product shall be capable of supporting options for 99.99% and 99.999% availability.
- D. The ACS product shall support a disaster recovery solution using off-site database replication.
- E. Encryption
 - 1. Encryption falls into two distinct areas, firstly between clients and their Server, secondly between client and local area network panels (LAN Nodes). LAN node links shall support AES encryption between the supervising client PC and its LAN Chains.
 - 2. For client to server connections, the ACS shall support a solution using industry standard network cards supporting IPSec and 3DES encryption.
 - 3. Web-based (thin client) ACS clients shall support SSL encryption.

2.25 REQUIRED STANDARD SOFTWARE FEATURES

- A. The installation of the server and client software shall utilize a “wizard” interface to guide users through the appropriate installation steps.
- B. The server and client software shall utilize a software-based licensing scheme. Systems requiring hardware based keys or dongles, except to store encryption keys, shall not be acceptable.
- C. The ACS shall utilize Microsoft .NET architecture.

- D. The ACS shall start up as part of the Operating System. The ACS server shall communicate to all clients (operator workstations and field hardware) through Windows services. The ACS shall run as a service in the OS, and there shall be no requirement to run an application after the operating system is ready.
- E. The ACS shall support a Graphical User Interface that minimizes training needs for even inexperienced users. The software shall include on line help displays to eliminate operator reference manuals.
- F. The ACS software shall be run using standard x86-based hardware, and the operating system shall be Microsoft Windows as follows:
- G. ACS server shall run on Windows Server 2008 32 bit, Windows Server 2008 R2 Server 32 or 64 bit and Windows Server 2012 R2 64 bit.
- H. ACS server shall support operation in a VMware ESX or ESXi environment and a manufacturer-supplied manual describing virtualization support shall be provided.
- I. ACS clients shall run on 32 bit Windows Vista Business or Ultimate, Windows 7 Professional or Ultimate 32 or 64 bit, Windows 8.1 Professional or Ultimate 64 bit.
- J. The system shall meet Microsoft requirements for “Designed for Microsoft Windows 8.
- K. The server shall use Microsoft SQL Server 2008® 32 or 64 bit, Microsoft SQL Server 2008 R2® 32 or 64 bit or Microsoft SQL Server 2012® 32 or 64 bit Standard or Enterprise database server. The system shall allow other authorized applications to gain access to the system’s database should wider integration of the system at the site become a requirement.
- L. The system shall use Microsoft Message Queue (MSMQ) for handling transactions between server and clients as well as between server and field hardware. Use of custom-coded or proprietary first-in-first-out (FIFO) buffers shall not be acceptable.
- M. It shall be possible to select any function, within a given Operators permission, independent of the currently displayed screen. Functions will be accessed via tool bar Icons, which will include Help prompts that will appear when the mouse pointer dwells on the selection button. It shall also be possible to link any standard Windows application to a custom toolbar icon.
- N. The ACS shall support an unrestricted number of hours definitions. An hour definition is a description of the times during a 24-hour period during which a function will be active. The system shall support a minimum of 10 intervals per hour definition.
- O. The system shall support an unrestricted number of time codes. A time code is defined as a set of hour definitions – one assigned to each day of the week (including Saturday and Sunday) as appropriate, and assigned to the various types of holidays (exceptions) defined in the system.
- P. The system shall support a minimum of 9 holiday types. A holiday type shall be assignable to an unrestricted number of dates on the calendar.
- Q. Operator Permissions
 - 1. System operators shall be associated with a log in Name and Password. A system option will determine whether strong operator passwords will be used. The minimum definition

of a strong password shall be a password that contains at least one upper case character, one lower case character, one numeral and one punctuation mark, with a minimum password length of six characters. Additionally the password cannot contain any full word of the operator's username.

2. The option to use a Secure Biometric or Smart card for system logon shall be provided. When used, this option will force the operator to present their Name, Password and Biometric or Smart card.
3. The operator's account shall be assigned to a role in the system. The role is a permission profile. This will determine the functions that shall be available to that operator when logged-on to the system. The system shall support an option to hide Personal Identification Numbers of cardholders when an operator is viewing a record.
4. The system shall show each operator only features and options for which he or she is authorized. Features and options for which the operator does not have permission must be hidden. Systems that display functionality that is unavailable due to inadequate permissions shall not be acceptable, even if such functionality is disabled or "grayed out".
5. Card record data entry shall be divided into operator permission areas, allowing separate permission categories to be assigned for the viewing of personal data, ID badge printing and access right management.
6. The ACS shall support an unrestricted number of operator accounts and operator roles.
7. For all operators, a means of re-arranging their Icon tool bar shall be provided to allow the most frequently used Icons to be repositioned by the operator.
8. The system shall store operator preferences based on logon information. This feature shall allow an operator to work with their preferred configuration independent of which workstation they occupy.
9. The system shall support an option to reset all window layouts to a pre-defined "Home Screen".

R. Video Badging

1. The system shall incorporate video imaging as a fully integrated function to customize access control cards by printing an identity badge directly onto the card. The badge design and image capture capabilities shall combine with the latest technology card printers to allow the production of an ID badge pass for each card holder at the time of registration.
2. For each cardholder both a facial image and a signature shall be able to be captured, or imported, and stored as part of the card record. These images shall be captured from a supported USB webcam or standard CCTV camera connected to the computer via a Video Card supporting DirectX 8 (or later) or MCI format, or imported if available as a bit map or JPEG file. The system shall use data compression techniques to ensure efficient use of the available hard disk space to maximize the number of images that can be stored on the hard disk.
3. Alternatively, system shall support use of an Axis IP camera with available utility to act as a badging camera. Any Axis IP camera in the system may be utilized.
4. System shall provide the ability to crop the image (live capture or imported from JPG, BMP, or WMF) to the desired area maintaining the proper aspect ratio.
5. Additionally, a signature may be imported from a signature capture terminal connected to the system via an RS-232 com port or USB port of the client PC local to where the card is being issued.

S. Badge Design and Printing

1. A comprehensive integrated badge design facility shall be provided as a standard feature of the software, with no separate licenses or license fees required to activate the feature.

The badge designer must allow an unrestricted number of custom badge layouts to be defined then saved with a suitable description as a reference. This shall make full use of the card record details such as name, card number, inactive date as well as allowing personal data to be included in the badge design. Company logos shall be imported as bitmaps (BMP) or JPEG images to provide a personalized corporate appearance to the card.

2. All elements incorporated into the design shall be able to be rotated.
3. Each badge design shall contain either a single sided design or a double-sided design. Each side of the card shall also be designated as being blank, or magnetic stripe side, or smart chip side, to ensure the designer is aware of the available space where printing may be incorporated for each card combination. The badge designer function shall be capable of supporting portrait, landscape, standard and custom-sized card designs.
4. When creating a new card record a badge preview screen shall also be included that displays the specific card's details on the selected badge design to allow confirmation prior to requesting the badge to be printed.
5. Each new cardholder record shall have the option to be flagged for future printing. Cards flagged in this manner shall be easily recalled at a later stage and processed for output to the printer in a single action. Selecting multiple cards for bulk printing shall also allow each card to be printed either with its specific badge design, as defined within each card's record, or alternatively printed with a selected common badge design. Encoding of magnetic stripe cards shall also be included as part of the bulk printing process.
6. The ACS shall support any manufacturer's ID badge printer with a Microsoft Windows (depending on the workstation configuration) compatible printer driver.
7. The ACS shall provide the option to encode a magstripe card during the print cycle shall also be incorporated. Applications that require on-site encoding can combine both actions in a single process. Encoding may only be supported on a limited set of printer models defined by the ACS manufacturer.
8. Each badge design shall include a default printer, validity period, and access rights.
9. Objects (images, or other fields to be printed to the card) shall support the ability to be enabled or disabled by the presence of a specific label in the cardholder record. For instance, a logo indicating a certain training would be printed only if the personal data field identified indicated such a certification for that cardholder. Solutions requiring a separate badge design for any change in badge graphical content shall not be acceptable.

T. Identity Verification

1. Identity verification shall include the ability to monitor up to 9 lanes; each lane shall comprise a single entry point.
2. There shall be up to three live video camera views available per lane on the same window to verify that each card offered is in fact being used by the person to whom it was issued. (for monitoring vehicles approaching and arriving at the entry point of each lane for example).
3. A method of granting access to the individual at each entry point with a single mouse click shall be provided.
4. Each lane shall automatically display the stored image for a card when used at a reader.
5. The operator shall be provided with a means to quickly search cardholder records by name to manually compare and verify basic card information.
6. Each lane shall provide configurable cardholder information to be displayed when a card is presented at the entry point reader (for example card expiry date and personal data)
7. This screen shall also be frozen and printed to provide a hard copy evidence of any abuse observed by the operator. For high security entry points, the system shall be configured to

not grant access until the operator has verified the stored and live images are the same person, with the door release being controlled by the system operator.

8. This screen shall provide manual operation of pre-defined commands as a means of rapid response to events for each lane.
9. Intercom station call and answer functionality shall be provided for each lane.

U. Report Generation

1. Extensive history reporting shall be a standard integrated feature; and shall include the ability to review all system alarms, access control activity, and operator actions. These reports shall be made available for review via the operator's display screen, or to a printer, or to another disk media. Extensive sort parameters shall include by any of the "Personal Details" fields or Titles, for example by "Department", and only Names commencing with "SM*".
2. The system shall support generation of reports detailing the system operation. The following reports shall be available in the software:
 3. Cards on site
 4. Hours on site
 5. Cardholders with access to each door
 6. Access rights of each cardholder

V. System Configuration

1. Scheduled and Conditional Commands defined
2. System operator transaction history
3. It shall be possible to replay video clips associated with events by directly interacting with the report as published to the computer screen.
4. The system shall demonstrate the ability to export data, for example reports, to other standard office word processing packages such as Microsoft Word®.
5. The system shall provide system management reporting, including detailed listings for all the operator actions and the current cardholder database for output to the display screen, printer or disk media.
6. The system shall have the ability to save frequently used report configurations and associate them with a "Title". Such predefined reports shall be available from a list to simplify the report selection. It shall be possible to request these reports to run immediately or schedule them to occur at a specified date and time.
7. Scheduled reports shall additionally have the option to be automatically repeated by specifying the number of days and reporting period to be included, for example a weekly report of Alarms to run at 10:30 am each Monday and including the previous 7 days of Alarms.
8. The system shall allow custom reporting options by providing an interface to a commercially available 'off the shelf' reporting product, such as Crystal Reports. The interface shall present all database fields in a structured format, which does not require detailed knowledge of the database design and table relationships.

W. History Reporting

1. Extensive reporting shall be included to provide the ability to review all system alarms, access control activity and operator actions. These reports shall be available for review on the operator's display, to a printer, or to a file.
2. Extensive sort parameters shall include any of the personal details fields of information such as by department, job title, vehicle registration, contractor company name or any other reference appropriate for each site.

3. Frequently run report configurations shall be saved allowing them to be selected and run on demand, or scheduled to run automatically as required. When scheduled to run automatically this shall have the ability to be repeated.
4. Total Hours Spent On-Site: This report shall provide a detailed audit of the arrival and departure times for cardholders and calculates the total time spent on site for the chosen reporting period. This report shall be filtered by any of the personal data fields of information associated with each cardholder.
5. Cards On-Site Reporting: This report shall provide a list of cardholders currently on the site. This may be for all persons within the site or just who, for a particular department or a particular contractor company, is currently present. The report may also be run to cover just a part of the site, for example, cardholders in a particular building or room.
6. Report Auditing/Archiving: The ACS shall have the option to automatically and without user intervention keep a separate archival copy of each generated report, whether the report is sent to screen, printer, or file. The archival copy must be generated at the time of each request and stored unmodified thenceforth. Systems that attempt to reconstruct the archival copy only when it is requested are not acceptable.

X. Clients

1. The system shall support an unrestricted number of clients to suit growing enterprise requirements. The system shall provide the means for multiple operators to simultaneously administer the system from convenient locations connected via a local area network (LAN) or across a wide area network (WAN).
2. Systems that operate on the SQL Express database server that restrict the number of clients shall be upgradeable to a fully unrestricted version of the software..
3. Clients shall not use mapped drives for server connections.
4. Clients shall not use UDP messaging.
5. System shall support a minimum of two pc monitors per client. The system shall additionally store the last position and size of all open dialog boxes and screens upon exiting the application on a per operator basis. The next time the operator logs into the application, the screen positions shall be restored. Such operation shall be independent of which workstation the operator uses.
6. The capability shall be provided to “lock” the window arrangement for each operator individually, such that each time they log on they have a fixed arrangement of windows that they do not have the ability to alter. Systems that cannot prevent an operator from closing or rearranging windows will not be considered. Systems that allow windows to be locked by workstation but not by user will also not be considered.

Y. Addition of Cardholders to the System Database

1. The system shall provide a means of assigning access control rights to each cardholder. Access control rights determine which access points are accessible to the cardholder based on date and time of day. The system shall support an unrestricted number of access rights.
2. The software shall also provide an ALTERNATE set of Access rights to a cardholder on a temporary basis. The change may be initiated at any time by an authorized operator, or automatically between specified dates. This shall provide the facility of automatically changing a card’s rights between a specified date range, after which the card will revert to its normal Doors and Times. Alternate access rights shall be able to be configured for multiple date ranges.
3. Each cardholder shall either be associated with standard door timings for door release, door open and door pre-held, or be given extended timings for disabled persons or someone who has to push a cart.

4. Cardholders who have not used a reader for some time shall be readily listed to allow their card's status to be reviewed. An additional feature shall allow cardholders to be automatically set inactive and therefore access denied should the card have not been presented at any reader on the system for a defined number of days.
5. Cardholders shall be assigned an expiration date, and more specifically an expiry time, after which a card shall automatically become inactive and therefore be rejected at all readers on the system. To further simplify card administration, the system shall have the ability to be configured to automatically purge expired cardholder records after a configurable number of days from the date of expiration.
6. Cardholders who have mislaid or forgotten their issued card(s) shall be provided with a means of temporary card assignment. All cards issued for the cardholder shall automatically be inactivated whilst the temporary card is active.
7. The system shall allow for the definition of Access control rights to be associated with a badge design. Each user that selects that badge design shall be provided with the associated access control rights that can further be customized for the specific cardholder.
8. The system shall allow access control rights to be defined for a cardholder on a reader basis. A timecode will be associated with each reader as it is assigned to the cardholder's access control rights.
9. The system shall allow access control rights to be defined for a cardholder on a reader group basis. Reader groups are groups of readers. A timecode will be associated with each reader group as it is assigned to the cardholder's access control rights.
10. The system shall allow access control rights to be defined for a cardholder on an access code basis. An access code is a group of access control rights.
11. The system shall have a note field associated with each cardholder record. The note field shall be free form text and shall support a minimum of 256 characters. The note field shall further support the ability to attach a file (of any type or size) to the cardholder record.
12. When viewing a cardholder record the last twenty-five (25) valid door access transactions shall be displayed to help locate a cardholder.
13. A driver's license scanner shall be supported to simplify data entry of cardholder information. The scanner support shall include, at a minimum, the ability to automatically read, through optical character recognition, the most common fields from valid driver's licenses issued by all 50 states; and populate these fields into the appropriate user-defined personal data fields in the cardholder record.
14. The system shall support a field for assigning an approving official to the cardholder record that defines the individual who authorized the assignment of a credential. Approving officials shall have an associated validity period and image of their signature. As an option, the assignment of an approving official shall be mandatory.
15. The ACS shall allow the user to enroll biometric data as part of the cardholder enrollment process. The number of verifications to determine applicability of the enrolled biometric data shall be configurable.

Z. Cardholder Details

1. Cardholder information shall include first and last name, card number, PIN code and valid period to provide automatic expiration. Each cardholder record shall also incorporate at least 50 user-defined personal data fields, independent of user-defined fields for visitor management.
2. PIN numbers shall be configurable from 4 to 8 digits in length.
3. Data entry shall be simplified by remembering previous entries of personal data and allowing selection from a pick list to minimize repetitive typing when creating each

cardholder's record. The cardholder database and the history log shall also be sorted by any of the additional fields of information making them a powerful tool for filtering data.

4. Personal data fields shall support free entry text, picking an entry from a previously configured list, or picking an entry from an updatable list. Each of these entries shall further be categorized as a date, a time, general input, card inactive date or customized input. Each category shall support the masking of input data to assure data integrity. For instance, a date mask might look like "mm/dd/yyyy" to indicate that the date input should be a two-digit month followed by a two-digit day followed by a four-digit year all separated by the slash character. The mask shall be required for customized input.
5. Personal data fields shall have the option of being configured as mandatory.

AA. Locator

1. This feature shall provide a quick method of locating cardholders by displaying the last 25 valid history events along with the time, date and access point used. This information shall be available for an individual or group of persons by name, card number or by personal data.

BB. Card Watch Feature

1. Any cardholder shall be easily tracked as they move around a large site by selecting card watch. As the person uses their access control card, the system shall have the ability to automatically notify the operator of the person's presence at each location.

CC. Key Card Mode

1. Key card mode authority shall be assigned to special cardholders, such as site key holders, and can be enabled on a per reader basis. This shall allow a person when vacating an area or building to change the reader's mode of operation from normal access control to Key Card Out operation.
2. When in this condition only persons with key card privileges shall gain access through the door, all non-key card users are rejected regardless of their card's current access rights.
3. This special feature shall be activated/deactivated by the key cardholder, using a card swipe followed by a special code entered via the reader's keypad.

DD. Serial Device Interface

1. The software shall allow the definition of ASCII commands to be sent out over a computer serial port (physical or virtual) or through the RS-232 interface of the DBU. These serial commands shall be available through the user interface as well as in the conditional logic described herein.
2. Automatic Holiday Override
3. The software shall be programmed by the operator to recognize special or holiday dates, which in turn can be linked to operational changes in how the site is to be managed on these specific days. This feature shall notify a system operator of individual holiday dates up to seven days prior provides a useful check on the date's current validity. Multiple types of holiday dates shall also be provided so that partial days or early closing requirements on specific dates can be accommodated.
4. Cardholder definitions shall be provided with the ability to add vacations in a quick and convenient manner. Dates and time periods shall be defined during which access is denied to all access points and an alarm generated if access is attempted.
5. The ACS shall provide a calendar function to enable scheduling of events up to five (5) years into the future.
6. The ACS shall provide the ability to schedule one-time events for up to five (5) years into the future.

EE. System Partitioning

1. The access point readers, monitor points, and auxiliary outputs shall be managed on a partition basis by simply defining which devices are to be included in a partition.
2. The ACS shall be supplied with the ability to manage up to 64 partitions, and shall have an option to manage up to 999 partitions.
3. Multiple private or public entities shall be able to share the system with database segregation for card records and Contractorship of readers, monitor point inputs and switching outputs dependent upon the operators assigned permissions. Each company partition shall allow for autonomous system administration, allowing partitioned card administration, reports, and alarms.
4. Operator permissions shall be created and assigned globally or by the owning company. When created and assigned globally an Operator's password shall be associated with one or more companies.
5. Alarm reporting shall be routed to a client located at the company owning the monitor point or reader and can be automatically redirected to a different PC at pre-programmed times and selective days of the week.
6. Common areas, such as the main entrance, shall have the ability to be shared so that all companies may access these doors, even when different card customer/site codes have been configured.

FF. Alarm Management

1. Alarm and activity management must be handled in the same executable program as other access control functions such as cardholder management, badging, and hardware configuration. Systems utilizing a separate application for alarm handling shall not be acceptable.
2. Alarms must be displayed in a separate window from (non-alarm) activity. Systems which display both alarms and non-alarm activity in a single window shall not be acceptable. It must be possible to display either the alarm window, the activity window, or both at any time.
3. The Alarm window shall provide a method to filter alarms for all available alarm field parameters. Configured filters shall be saved per user with the option of sharing to all users. Filtered records shall be displayed in a separate view within the alarm window.
4. The system must provide separate permissions for alarms and activity, and allow users to be individually granted rights to view and or process either, neither, or both. Systems which cannot separately grant privileges for alarms and for non-alarm activity shall not be acceptable.
5. Alarm handling shall be efficiently managed with up to 99 priority levels and user definable instruction messages to ensure the operator monitoring the site takes appropriate responses. The facility shall have the ability to customize audible alerts for each type of alarm is provided using standard or custom generated multimedia wave files. Each alarm type shall also be presented in a user-defined color.
6. To provide additional information when reviewing alarm signals, the operator shall either enter custom comments or simply select from a predefined pick list to provide a time-stamped record of all the actions taken throughout the incident. Predefined manual commands shall be uniquely assigned for each alarm, and readily activated by the operator via a command button provided on the alarm acknowledgement screen. Additionally automatic conditional commands shall be configured to automatically operate in response to any given alarm condition.
7. The ACS shall be optionally configured to require operator comments when acknowledging alarms.

8. The ACS shall support the ability to selectively choose alarms to acknowledge and/or clear.
9. Each alarm shall be configurable to have a specified color and sound.
10. Each alarm shall be capable of linking video from network video recorders (if applicable) for incident playback.
11. The Alarm Monitor screen shall provide an indication that cardholder information is available for a specific alarm. A “Card” button shall be available that when pressed will display the cardholder badge image.
12. Alarm monitor screen shall support the display of alarm statistics, shall provide up to ten alarm filters to be displayed in different tabs on the alarm screen, and shall provide the ability to sort based on each different column.
13. Each alarm shall be time-stamped in the local time zone (not the server time zone), and the system shall support the additional display of labels associated with different geographical time zones such as PST, EST, GMT, etc. The labels for time zones shall be customizable.
14. The system shall permit the routing and display of real time activity at any standard client machine. Activity shall be shown in a dedicated activity window that is updated automatically when new transactions occur. This option shall not be limited to routing transactions to one location and shall support the simultaneous routing and display of real time activity at multiple locations.
15. Alarms shall be capable of being routed to specific client machines by time of day or day of week.
16. Unacknowledged alarms shall be capable of being routed to alternate client (or Email – see Software Options below) based on age and priority of alarm.
17. The display of reader door alarms shall be automatically enabled or disabled by the use of timed commands, either by reader or by a group of readers.
18. The system shall support a generic ASCII input capability that allows the system administrator to define specific ASCII input strings as alarms to be displayed in the alarm monitoring window as well as on the graphical map interface if so configured.

GG. Task Management

1. A method to allow any ad-hoc or regular tasks to be completed by operators shall be provided.
2. Tasks shall define actions to be completed by specific users, or any user with a specified user role.
3. Each task shall be assigned a due date and time, if the task is not marked as completed before the due time is reached it’s status shall automatically change to ‘overdue’.
4. The tasks selection window shall show all completed and uncompleted tasks, each task displaying subject, due date and time, the user name or role that the task is assigned to and current status.
5. The tasks window shall provide filters for viewing task records and the ability to add new tasks, or open existing tasks (to mark them as complete or add comments for example).
6. Tasks shall allow alarm generation when they become overdue or on the immediate creation of a new task.
7. It shall be possible to add details to each task (for example, how to complete the task) and comments to facilitate management.
8. Tasks shall be configurable for re-occurrence (for example every Tuesday or every day). Once the task is completed a new instance of the task shall be created.
9. A means to attach files to tasks shall be provided.
10. Overdue tasks appearing in the alarm window shall be cleared by opening the alarm and selecting ‘complete’. If the task is configured as ‘re-occurring’ a new task shall be generated depending upon the settings in the tasks recurrence window tab.

11. Completed tasks shall be deleted automatically after the period specified by the 'Purge daily logs after' value configured for the ACS.
12. The number of unacknowledged task alarms shall be displayed in the ACS status bar along the bottom edge of the main window -a blue background shall distinguish them from system alarms.
13. The task Manager shall be a standard feature of the ACS with no separate licenses or license fees required to activate the feature.

HH. E-mail Alarms

1. The ACS shall support the ability to automatically e-mail alarm condition messages.
2. Each alarm definition shall allow a destination e-mail address to be defined. The e-mail address may be an address group as defined in the e-mail MAPI application.
3. E-mail alarm messages shall be controlled by time of day and day of the week. For example, e-mail to the Facility Security Supervisor would only be generated when alarms occur during after-hours times.

II. Graphical Site Maps

1. To further enhance the presentation to the operator, the system shall have the ability to import and use graphical maps. Maps shall be linked together using a tiered tree structure. To speed the location of an incident, each map level shall contain a clearly visible indicator as to which sub map the operator should select next to find the device that is in alarm.
2. Maps shall also have the ability to be configured to appear automatically on presentation of a new alarm, providing the operator with prompt visual indication that an alarm has occurred.
3. The status of readers, doors, monitor points and auxiliary outputs shall be requested from any map by simply selecting the icon representing the device and its current state will be displayed.
4. The icons on the graphic map shall dynamically indicate the status of the device they represent. For example, a door icon shall change to show the door open when the door position sensor indicates such, and shall change to the original icon when the door is again secure. Additionally, monitor points shall also change to show their current state.
5. Should the operator wish to change the current setting, simply pressing the right mouse button shall cause the appropriate command options list to appear for selection.
6. Having selected a command, confirmation shall be provided by reflecting the change in status on the display.
7. Maps shall be created using standard office tools such as Paint® or drawing packages such as AutoCAD®. It shall be possible to import drawings in the following formats: JPEG, Bitmap, Windows metafile or DXF.
8. Icons representing access points, monitoring points, switching outputs, alarm inputs, cameras or intercom call stations shall be placed on any map at the required location in a drag and drop manner.
9. It shall be possible to define on the map the location of readers, access doors, alarm monitored points, output switching relays, cameras, intercom call stations and alarm panel devices. The map display shall allow the operator to switch the video display of any defined CCTV camera to any defined CCTV monitor. The map display shall allow the display of live and stored Digital Video Clips.
10. It shall be possible to define on the map the location of reader groups and camera groups. Such groups shall be placed and appear as a single icon, but actions taken on them shall affect the entire group.

11. It shall also be possible to change the status of readers, reader groups, floor groups, alarm monitored points or output switching relays and confirm the successful execution of such commands from the map display. This functionality shall be capable of being restricted per device based on operator permission.
12. The map display shall include the option to display a group of similar devices as a single icon. Once devices are grouped it shall be possible to change their status. For example, it shall be possible to unlock all entrance doors by executing a single command from the map display.
13. It shall be possible to display a device on any map, on multiple maps, or on no maps. It shall also be possible to display the same device in multiple locations on the same map. Systems that do not allow devices to be placed multiple times on the same or multiple maps shall not be acceptable.

JJ. Manual and Automatic Commands

1. Operators shall be provided with a wide choice of manual commands embracing the control of readers, monitor points, output switching relays and door locking devices. Also the operator shall have the ability to check the status of single, or multiple devices. This shall ensure the operator is always able to check the operational status of the system and make any adjustments as requirements change. When graphical maps are utilized, status requests shall be simply initiated by “clicking” on the device icon within the map. This functionality shall be capable of being restricted per device based on operator permission.
2. Automatic commands shall be included and may operate on a timed or event basis.
3. Scheduled commands shall easily be defined linking complimentary commands to occur at the start and stop times of any chosen timecode.
4. Event triggered commands shall provide an extremely powerful means of creating IF/THEN/WHEN associations encompassing a wide selection of IF conditions to the automatic execution of THEN commands subject to a WHEN timecode being active. A minimum of 10 THEN actions shall be available per trigger command.
5. Devices shall be managed on a partition basis by grouping readers, monitor points and auxiliary outputs. This feature shall allow multiple devices to be actioned by a single command when using manual, timed and conditional commands. This functionality shall be capable of being restricted per device based on operator permission.
6. The ACS shall support an unrestricted number of automatic (scheduled and trigger) and manual commands. These commands shall be capable of spanning across multiple field controllers.

KK. Card Initiated Commands

1. The software shall allow authorized cardholders to initiate powerful trigger commands manually from selected reader locations when certain models of readers are used in conjunction with the field panels.
2. Up to 99 predefined commands shall be invoked by an authorized card allowing, for example, a patrolling guard to switch on outputs, disable monitor points, lock doors, providing remote management of the system during a patrol of the site.
3. The system shall only permit assigned users to enter command codes at keypad readers. Such assigned users shall not be restricted as to when or where they can enter a command code – such restrictions may be placed on the commands themselves.

LL. User Code Mode

1. The ACS shall support the ability to put a keypad-equipped reader into User Code Mode. This feature shall allow a cardholder to gain access by entering a valid card’s number at a reader keypad, therefore not requiring the holder to carry a card.

2. User code mode shall be enabled on a per reader basis.
3. This mode shall support card number only, or card number and its assigned PIN code.

MM. Visitor management

1. Visitor Management shall be incorporated as a standard feature of software, with no separate licenses or license fees required to activate the feature. Operators shall be able to pre-enroll visitors using a Web (thin) or Standard (thick) client. The thin client shall connect to the server via Microsoft™ Terminal Services and Microsoft™ Internet Explorer to permit any operator with visitor permissions assigned the ability to pre-enroll visitors without the need to install client software on their local machine.
2. Visitor Management shall be fully integrated with other key areas of the system, such as access, alarms management, muster and Video ID Badging. Visitor records shall have 50 personal data fields with user definable data titles independent from the personal data fields defined for cardholders. All visitor transactions and movements shall be recorded and may be reported on and filtered, using the extensive reporting capabilities of the software. Visitors may exist without being assigned a card number if access control is not required.
3. Data entry shall be simplified by remembering previous entries of personal data and allowing selection from a pick list to minimize repetitive typing when creating each visitor's record. The cardholder database and the history log shall also be sorted by any of the additional fields of information making them a powerful tool for filtering data.
4. Personal data fields shall support free entry text, picking an entry from a previously configured list, or picking an entry from an updatable list. Each of these entries shall further be categorized as a date, a time, general input, or customized input. Each category shall support the masking of input data to assure data integrity. For instance, a date mask might look like "mm/dd/yyyy" to indicate that the date input should be a two-digit month followed by a two-digit day followed by a four-digit year all separated by the slash character. The mask shall be required for customized input.
5. Personal data fields shall have the option of being configured as mandatory.
6. Visitor time of arrival and time of departure shall be tracked by the system. This feature shall be available even if a visitor is not issued a card or card number in the system.
7. It shall be possible to configure a reader to automatically inactivate presented visitor cards ready for reuse.
8. The system shall support a driver's license scanner including optical character recognition to ease data entry.
9. The ACS shall support capture of a business card image.
10. The ACS shall support the inclusion of a custom message for each visitor record.

NN. Area Occupancy Monitor

1. The system shall include the ability to monitor the occupancy of an area.
2. Occupancy thresholds shall be configured for the maximum and minimum values, and associated with automatic conditional commands. These shall be used for applications such as to disable the entry readers when all the garage spaces are occupied and switch a garage full indicator sign on.
3. Complementary commands shall also be provided to enable the entry readers and turn off the indicator as a vehicle leaves the garage. Similarly when the garage is empty, the lights could be automatically turned off.

OO. Device Configuration

1. The system shall support a notes field to be associated with each device configured on the system. The notes field shall be free-form text, and shall support a minimum of 256

characters. The notes field may be used for detailed device descriptions or for maintenance history.

2. The system shall allow a unique set of arbitrary files of any type to be associated with each device.
3. The system shall provide a hierarchical tree view of the system configuration supporting expansion and collapse of any and all branches.
4. Windows Daylight Saving Auto Adjustment
5. The system shall support Windows TimeSrv or Windows time management.

PP. History Archive and System Back up

1. The system shall be capable of retaining at least 25 years of activity in its online log file, disk storage space permitting. Systems that require offline storage of historical events shall not be acceptable.
2. The system shall allow on line archiving of history logs, along with database back up of system configuration and cardholder details. To further ease the burden of remembering to back up your system's database, this function shall be able to be automated to occur without intervention at a pre-set time.
3. The system backup and history archive shall be to a local or remotely accessible UNC path.

QQ. Support for Smart Cards and Biometrics

1. The system shall have the integrated capability to capture at least two forms of biometrics – preferably fingerprint and hand geometry.
2. Any proposed fingerprint solution shall support the enrollment and use of at least two fingerprints, which shall allow the cardholder to present either finger to gain entry.
3. On a timed or manual basis the system shall be configurable to allow entry using the smart card only, smart card plus fingerprint or smart card plus two fingerprints, thereby raising or lowering the level of security as required.
4. The system shall allow the assignment of a fingerprint for normal entry and a different fingerprint for duress entry. The cardholder shall have the ability to trigger a silent duress alarm by presenting the duress fingerprint. This provides the cardholder with a safe way to indicate a duress condition, without alerting anyone locally that the alarm has been triggered.
5. An option to recall the fingerprint acceptance threshold from the smart card to override the threshold stored at the reader shall be provided. By recalling the threshold from the smart card, overall site security is not compromised by a poor quality fingerprint, which would normally require a low acceptance threshold to be set at the reader.
6. The manufacturer of the ACS shall make available documentation on Server Hardening, which shall, at a minimum, detail the TCP/IP ports that are utilized by the system to allow other ports to be closed.

RR. Anti-Passback

1. The system shall support both “hard” anti-passback and “soft” anti-passback alarm reporting modes.
2. If the cardholder has access rights at a reader, but creates an anti-passback alarm, if the reader configured as hard anti-passback sends an anti-passback alarm and denies access to the door/portal.
3. Soft anti-passback sends an anti-passback alarm, but still allows access through the door/portal.
4. The system shall support timed anti-passback. The principle of timed antipassback is simple: once a card has been used at a timed antipassback reader, the card causes an anti-passback violation if it is used again at the same or another timed anti-passback reader

within a predefined period of time. The exception to this rule is when the antipassback reader has been defined to be for an exit route. In this case, the card can be used at any time without causing an alarm or event. This allows for situations where a person enters an antipassback-protected area, then wishes to exit the area immediately, perhaps, for example, because he or she forgotten something.

5. The use of an exit antipassback reader also causes the time delay for reuse of the card to be zeroed, so in the example, the person can re-enter the antipassback-protected area immediately, without having to wait. The delay can also be zeroed from the Card Holders screen or by means of an antipassback command. Sending a command may be useful if, for example, people have passed through an exit during a fire drill and the delay is long.
6. The system shall support zonal anti-passback. In the case of zonal antipassback, the building needs to be partitioned into zones. For example, zone 1 may be the main lobby, zone 2 the computer room, etc. For each reader that is defined as a zonal antipassback reader, you can specify which zone of the building the card is going from and which zone it is going to. For example, the reader may allow a card to go from zone 1 (e.g. main lobby) to zone 2 (e.g. computer room).
7. The system remembers which zone each card is in and updates this information whenever the card is used at a zonal antipassback reader. An antipassback alarm or event is generated if the reader's from zone does not match the card's currently-recorded zone. For example, an alarm or event is generated if the from zone of the reader is zone 3, but the card is currently recorded as being in zone 1. If a card's currently-recorded zone and the actual zone get out of step, either because of some violation of the system (e.g. a person has previously climbed over a turnstile) or for a legitimate reason (e.g. a person has passed through a fire exit during a fire drill), some means is obviously required to bring the two back into step. This can be accomplished from the Card Holders screen or by means of an antipassback command. Both methods put the card(s) into a "neutral zone", so that the next transaction at an antipassback reader is always accepted without violation, and the reader's to zone becomes the card's new zone.

SS. Elevator Control

1. Each cardholder shall have floor permissions assigned as part of the normal access rights. The system shall provide outputs to the elevator controls to uniquely verify which floors are authorized for each cardholder. The system shall be capable of tracking which floor was enabled/selected by that person.

TT. Threat Level Manager Option

1. The TLM option shall provide the ability to make system-wide changes by simply changing the threat level.
2. The Threat Level shall be selected from one of five levels that can be labeled and defined by the user. Each threat level shall also have a specified color associated.
3. The present state of the system threat level shall be visible from any view within the software.
4. The system shall restrict the ability to change threat level to the appropriate operator(s).
5. The system shall allow the configuration option to require the approval of two authorized operators to change the threat level.
6. The ability to change the threat level shall be integrated into the site map by right clicking on an appropriate icon.
7. The system shall automatically disable access rights for individuals that have a threat level threshold below the selected level. The same access rights will automatically be enabled when the threat level changes to a level below their threshold.

- UU. Digital Video Monitoring and CCTV Matrix Switch Control Option (See Section 28 23 00 for more details on Digital Video requirements)
1. The software shall allow operator to view live video from network cameras and encoders, and playback recorded video from NVR systems. The same software option shall allow the system administrator to configure NVR and VMS systems from all supported manufacturers simultaneously. The software shall allow instant replay of recently recorded video from any digital video source.
 2. An operator with appropriate privileges shall be able to control supported CCTV matrix switchers in order to display any available CCTV video source on any available CCTV video monitor.
 3. When the system is integrated with a Network Video recorder or VMS, it shall be possible to recall and replay stored video clips associated with the selected alarm using the alarms management screen.
 4. Live video from any configured camera shall be available and viewed within the ACS by right-clicking on an appropriate map icon.
 5. The video components including, but not limited to, analog cameras, supported network cameras, supported NVRs, and supported encoders shall be included in management reports. Management reports are to include, at a minimum:
 6. A tree view of all devices configured in the system,
 7. Camera Configurations,
 8. User audit trail of changes such as Who sent What commands that affected configuration (i.e. frame rate changes),
 9. Reporting of trigger operations.
 10. The video management module shall provide a graphical time and calendar tool for configuration of frame rate, resolution, pre-sets and other features.
 11. Virtual Matrix
 - a. The system shall provide a “virtual matrix” interface that shall contain:
 - 1) Software PTZF controls (only displayed when appropriate cameras are selected),
 - 2) Ability to view up to 36 video feeds per virtual matrix (including cameras connected to supported NVR, supported IP cameras, cameras connected to Symmetry Visualizer and other supported encoders, and other URL including web page or web interface to other devices),
 - 3) Ability to select from at least 25 pre-configured screen layouts,
 - 4) Ability to display active alarms in virtual matrix screen,
 - 5) Ability to display real-time events in virtual matrix screen,
 - 6) Provide a tree view of all cameras and other multimedia (such as web pages) configured in the system,
 - 7) Ability to save screen configurations and to restore previously saved screen configurations,
 - 8) Ability to perform a virtual guard tour by sequencing live video from various cameras into the main cell.
 - 9) The system shall support multiple instances of the virtual matrix.
 - b. The live video management screen shall display software pan/tilt/zoom/focus (PTZF) controls for those cameras that support such features through a software interface. The software shall also have a means of sending the PTZ camera to a pre-set position. At least 999 pre-set positions shall be supported by the Video Management software.
 - c. The video functions (live video display, instant replay of recently recorded video, playback of stored video, and configuration of the video functions) shall be available

- to any operator (with appropriate privileges) on any workstation connected to the system.
- d. System shall provide (through graphical map interface or through the virtual matrix) a simple means for a guard or other operator to quickly initiate recording on a specific camera (if it were not otherwise recording).
 - e. The system shall permit the operator to use drag-and-drop functionality to select cameras from the tree view of available sources and place them in desired positions on the virtual matrix. A double-click operation shall display the video feed from the selected camera in the next available cell.
12. Video Playback
- a. The system shall provide a video playback interface that shall support the following functionality as a minimum requirement:
 - b. Ability to replay up to four recorded video streams simultaneously in a 2 x 2 virtual matrix.
 - c. Ability to synchronize the video playback time of up to four recorded video streams.
 - d. A video playback time line will show the start and end time of the selected video stream
 - e. The video playback time line shall highlight any gaps in the selected video.
 - f. The video playback time line shall indicate in a different color any alarm activity that relates to the recorded video.
 - g. The video playback timeline shall show the alarm description and time when the mouse is positioned over the alarm in the timeline.
 - h. Ability to change the video playback speed to include the following options: 0.5x, 1x, 2x, 4x, 8x, 16x, 32x, 64x, and 128x normal speed.
13. The video management module shall support still image capture and video clip export from the video stream.
14. The video management module shall support the export of video clips to CD or removable flash memory for archiving and for off-line review. The archived data shall playback on standard video viewers such as Microsoft Windows Media Player or Apple QuickTime Viewer.
15. The system shall limit operator access to video based on individual permissions.
- a. Events received from Intrusion Detection Systems, Access Control, or others shall be capable of triggering video recording, to stop video recording, to display live video in the virtual matrix (or otherwise modify the view of the virtual matrix), and to display video playback.
 - b. The system shall allow the programming of event-based triggers to cause:
 - c. Live video from a named camera to be displayed in a particular cell of the virtual matrix,
 - d. Live video from a named camera to be displayed in the next available cell of the virtual matrix,
 - e. Reconfiguration of the virtual matrix display based on previously stored data,
 - f. Playback of pre- and post-event video.

VV. Data Connect Option

1. The system shall provide an option to import and/or export both cardholder details (including facial images and signatures) and system alarm information to/from an external source. This option may be used to speed initial commissioning of the security management system's database, or in some cases, to allow synchronization with other employee

management systems. This option may also be used to pass common data to other employee-related systems or databases. It shall be possible to manually start or schedule the data import. It shall also be possible to start the data import process from an external application, thus providing the means for real time import.

2. The interface requirements shall be fully defined and support either a comma delimited ASCII text file or a Microsoft SQL® database import mechanism. Fully detailed supporting documentation shall be provided to enable a third party to design and implement this facility without needing reference to the system's manufacturer.
3. Imported data shall reside in an intermediary table within the database until an integrity check can be applied to the data. Only after satisfying this test will data be included in the ACS data tables.
4. The data connect option will be provided without extra charge for the Enterprise Edition ACS,

WW. XML Developers Toolkit

1. The system shall support the ability to send and receive commands to/from external web services through an XML interface, the XML Developers Toolkit. All operations through this interface shall be accompanied by a logon username and password that will be associated in the security management system with operator privileges, which will limit what is permissible. The interface shall use standard security provided by web services.
2. The XML Developers Toolkit shall support the import of cardholder details. An external software system may use web services, for example, to add new cardholders, delete cardholders, modify existing cardholder data, make cards inactive, and change access rights.
3. The XML interface shall allow an external software system to obtain the details of cardholders that are already in the ACS database.
4. The XML interface shall allow an external software system to view, acknowledge, and clear outstanding ACS alarms.
5. The XML interface shall allow an external software system to send a command to a device already defined in the ACS (e.g. to open a door or display video from a network camera).
6. The XML interface shall allow an external software system to view the status of an ACS device (e.g. to determine whether a door is locked or unlocked).
7. The XML interface shall allow an external software system to import alarms from external equipment, such as intrusion systems.

XX. Smart Card Encoding

1. The system shall provide the ability to encode contactless smart cards with access control information. The system shall support encoding either Mifare or DESFire.
2. The software shall support the Philips Pegoda, GemPlus, and the OmniKey CardMan contactless card readers for the encoding and reading of Mifare and Mifare DESFire cards.
3. The system shall be capable of capturing fingerprint biometrics and storing them on a contactless smart card, which will then be read and used to verify the cardholder during an access control transaction.
4. Any proposed fingerprint solution shall support the enrollment and use of at least two fingerprints, which shall allow the cardholder to present either finger to gain entry.
5. An option to store the fingerprint acceptance threshold in the smart card or at the reader shall be provided. By storing the threshold in the smart card, overall site security is not compromised by a poor quality fingerprint, which would normally require a low acceptance threshold to be set at the reader.

YY. Magnetic Stripe Card Encoder

1. A magnetic stripe card encoder shall be included. This shall allow magnetic stripe cards to be encoded by the user on site. The existing cards shall have the access control data added onto either track 1 or track 2 of such cards.
2. The system shall encode the high security encrypted Micromax format, or be used to encode custom formats to suit specialized requirements. When a custom format is defined, this shall also be used by the system to allow card verification for the access control function, should spare tracks not be available specifically for the access control requirement.

ZZ. Dial-In/Out Alarms

1. The ACS shall support a dial-out (alarm transmission) alarms reporting capability. A complimentary dial-in (alarm receipt) capability shall also be supported. This option would be used, for example, when an alarms monitoring client is unmanned outside of normal office hours and alarms generated at these times to be copied to a central manned system located elsewhere not on the LAN/WAN.
2. The alarm messages copied to the alarms-receiving (dial-in) site shall be the same as those displayed at the local (dial-out) site. However, the alarm instructions (as displayed when acknowledging an alarm) may be different.

AAA. Intercom Integration

1. The system shall support a serial or other high-level connection to an intercom system. The intercom system shall be accessed by users through a call station; typically sited outside the building at doors, parking barriers, etc.
2. Visitors or other personnel generally ask permission to gain entry at the intercom call stations. These are known as call requests. The ACS shall allow call requests to be answered and managed by using a dedicated screen within the ACS application - the View/Intercom Control screen. The screen shall list all outstanding call requests, and allow the operator to communicate with the callers using simple screen buttons. The screen shall contain a Command button that is associated with commands programmed for use with the intercom. Typically, the command is used to open a door or barrier for the caller.
3. It shall also be possible to answer a call request by using the Connect button in the Acknowledge Alarms screen (if the call request is set up as an alarm) and from maps in the View/Maps screen.
4. Various alarm and/or event messages shall be associated with the use of the intercom interface. These shall be included in transaction reports generated by the ACS.

BBB. Integrated Intrusion Detection Option

1. The system shall offer an option for basic area arming, disarming, and status without the need for separate or additional panels or hardware. Systems requiring additional or separate panels to provide basic area arming, disarming, and status from keypad readers shall not be considered.
2. Integrated Intrusion Detection shall provide comprehensive control and status capabilities at the reader, including but not limited to:
 - a. Display area status at the reader
 - b. Allow cardholder to arm or disarm the system, depending on permissions
 - c. Provide visual and audible indication of entry and exit delays
 - d. Automatically disarm an area upon valid access grant at any entry reader in the area
3. The system shall prevent access control readers from granting access while an area is armed, unless programmed to allow certain readers and cardholders to automatically disarm on valid access grant.

4. The system shall allow multiple, individually controlled intrusion areas to be defined on a single DBU. Systems that allow only one area to be defined per DBU shall not be acceptable.
5. The system shall allow any intrusion keypad reader on a node to control any area defined on the node.
6. For panels that include integrated intrusion, facilities shall be provided to lock out host-based modifications to configuration and access.
7. In addition to native intrusion functionality, the system must also simultaneously have the ability to control the arming and disarming of external DMP XR500 Intrusion panels from the system's native intrusion keypads. Solutions that do not allow arming and disarming of DMP panel intrusion areas from the system's native keypad readers shall not be acceptable.

CCC. Re-use of existing door wiring

1. The system shall allow the re-use of existing wiring to door monitoring and control apparatus, without modification, rewiring, or need for additional conductors, as follows:
 - a. Reuse of existing door strikes, locks, etc., and associated wiring
 - b. Reuse of existing door position sensor(s) and associated wiring
 - c. Reuse of existing request-to-exit sensor(s) and associated wiring
2. Support shall be provided for at least the following types of door connections:
3. Discrete, home-run individual wiring of lock, door position sensor, and request-to-exit sensor
4. Discrete, home-run wiring of door lock, but a single pair loop connection of both door position sensor and request-to-exit sensor, utilizing existing loop resistances to differentiate between possible states of those sensors.
5. Systems requiring modifications or additions to the existing door wiring, end-of-line resistors, or door sensors shall not be acceptable. Systems not supporting BOTH of the preceding methods of door sensor wiring in a single system shall not be acceptable.

DDD. Intrusion Detection Panel Integration Option

1. The ACS shall support a high-level (serial or network interface) to an intrusion detection system (IDS). The third-party IDS shall be UL 1076 listed. The ACS shall support events to be recorded and displayed from the IDS system on the alarm management screen and in the transaction history reports.
2. The integration to the IDS shall support, at a minimum, secondary monitoring of all IDS alarm transactions while allowing it to still be monitored by a central station, if desired.
3. The IDS integration shall also include the ability to arm and disarm the IDS from the ACS user interface. This feature may not be available with all IDS products.
4. IDS alarms shall be capable of triggering a series of ACS events. For instance, when the IDS reports that the system was armed, the ACS shall be able to lock all doors.
5. IDS alarms shall be viewable on the ACS map interface.
6. The communication with the IDS control panel shall be monitored, and the ACS shall produce an alarm in the event of a communications failure.
7. The ACS must provide integration with both the DMP communication with the IDS control panel shall be monitored, and the ACS shall produce an alarm in the event of a communications failure.

EEE. Web

1. The system shall provide a web module to facilitate ACS web browser operations using Windows Internet Information Services web server technology.

2. Web shall allow users to easily manage cardholders, visitors and alarms from any standard web browser.
3. Users shall be able to enter cardholder and visitor details, print and encode badges, sign visitors in and out, view card status, view the last 25 valid card transactions and manage alarms.
4. Language translations shall be available together with a documented process for adding further languages at a later date.
5. User interface language selection shall include the ability to manually override automatic system detection.
6. Language selection shall determine localized input field formats (dates for example dd/mm/yyyy, mm/dd/yy etc.)
7. There shall be no requirement to install additional software on the client machine hosting the web browser.
8. The Web server software version shall not be dependent upon the version of Symmetry server it is connected to.
9. The ACS shall provide the ability to create, find, view modify, copy or delete workflows.
10. A workflow shall be triggered automatically when a selected alarm or task based action is performed such as opening or acknowledging a new alarm or task.
11. When a trigger event occurs, the configured workflow action(s) shall be performed (for example, opening an ACS window, clearing a specified alarm type, displaying an instruction or sending an email)
12. Each workflow trigger shall allow more than one action to be performed.
13. Workflow actions shall allow question prompts and answer inputs. Answers shall be able to determine the path for further actions.
14. The order in which the actions are placed within each workflow shall determine the order in which they are executed.
15. Multiple Workflows shall be allowed for each trigger. The priority of multiple workflows for a single trigger shall be configurable.
16. Workflow Manager shall utilize a graphical flow chart design.
17. Workflow Manager shall be able to execute predefined commands.
18. Different workflows shall have the ability to automatically initiate for any device or any alarm type.
19. Workflows must have the ability to display alarm instructions.
20. Workflows shall have the ability to send automated emails or create tasks in the Task Manager.

2.26 SOFTWARE LICENSES

- A. Provide all necessary licenses for a fully operational system.

2.27 ACCESS CONTROL READERS

- A. Manufacturer:
 1. Basis of Design: Schlage MTB.
 2. HID
 3. Kantech
- B. Requirements: Read Only Mobile Enabled, Multi-Technology Contactless reader

1. Provide access control card readers manufactured by a global company who is a recognized leader in the production of access control devices. Card reader manufactured for non-access control applications are not acceptable
2. Provide mobile enabled, multi-technology contactless readers which can read access control data from both 125 kHz and 13.56 MHz contactless smart cards. Reader must be BLE, 2.4 Ghz and NFC, 13.45 MHz capable and enabled for use with a mobile phone. Provide mobile enabled, multi-technology contactless reader optimally designed for use in access control applications that require reading both 125 kHz Proximity and 13.56 MHz contactless smart cards by providing:
 - a. Configuration allows reader to be enabled to read smart, proximity or both technologies at the same time.
 - b. A migration platform to upgrade from the most popular 125 kHz proximity technologies to MIFARE or MIFARE DESFire by reading both 125 kHz proximity technology and 13.56 MHz contactless smart card technology.
 - c. Guaranteed compatibility to read all standard data formats ensuring card-to-reader interoperability in multi-location installations and multi-card/reader populations.
 - d. Secure access control data exchange between the smart card and the reader utilizing diversified keys and mutual authentication sequences.
 - e. Universal compatibility with most access control systems.
 - f. Ease of installation through industry standard wiring methods.
 - g. Compatibility with legacy 125 KHz proximity access control formats (all standard formats up to 37 bits, including HID Corporate 1000 formats).
 - h. Optimal read range and read speed for increased access control throughput.
 - i. Global availability.
 - j. Product construction suitable for both indoor and outdoor applications.
 - k. Customizable behavior for indicator lights and beeper.
3. Provide mobile enabled, multi-technology contactless readers complying with the following 13.56MHz-related standards to ensure product compatibility and predictability of performance:
 - a. ISO 14443, 14443B, 15693
4. Provide mobile enabled, multi-technology contactless readers configurable to read 13.56 MHz data simultaneously from the following cards (multiple credential support based on reader configuration):
 - a. Secure support - Mifare DESFire , Mifare Classic and Mifare Plus
 - b. UID/CSN Support – Mifare DESFire, Mifare Plus, Mifare Classic V0.06, HID iClass, ISOX (my-d).
5. Provide mobile enabled, multi-technology contactless readers configurable to read data from any compatible 125 kHz technology simultaneously with 13.56 MHz data. Compatible 125 kHz technologies include:
 - a. XCEEDID/Schlage/HID Prox (format in the card – formats up to 37-bits supported).
 - b. AWID PROX (SAME AS LENEL PROX - format in the card – formats up to 42-bits).
 - c. GE/CASI PROX - two possible format options.
 - d. Inside Pictotag, TI Tagit, ST Micro.
6. Provide mobile enabled, multi-technology contactless readers with the ability to read card access data stored in the secure access control sector/application area of the ISO 14443 MIFARE Classic or MIFARE DESFire card.
7. Provide mobile enabled, multi-technology contactless readers configurable to provide multiple hierarchical degrees of key compatibility for accessing the smart card access control data. Provide compatibility for the following key structure options:

- a. Compatibility with the default manufacture's key structure to ensure convenient off the shelf compatibility with manufacture's cards and readers.
- b. Compatibility with custom keys managed by manufacturer which provide a site-specific, unique, protected key structure.
- c. Compatibility with high security customer managed custom keys.
8. Provide mobile enabled, multi-technology contactless readers configurable to provide compatibility with all standard Prox formats up to 37 bits (including Corporate 1000®).
9. Provide mobile enabled, multi-technology contactless readers capable of accepting a mobile credential leveraging NFC, 13.56 MHz or BLE, 2.4 Ghz technology.
10. Provide mobile enabled, multi-technology contactless readers which allow reader configuration changes and firmware upgrades in the field without the need to remove the reader using the ENGAGE mobile app.
11. Provide mobile enabled, multi-technology contactless readers suitable for global deployment by meeting worldwide radio and safety regulatory compliance including:
 - a. FCC Certification (US)
 - b. CE (EU)
 - c. R&TTE Directive (15EU)
 - d. UL294 (US)
 - e. cUL (Canada)
 - f. IC (Canada)
 - g. FIPS201-2 / PIV I
 - h. IP65
12. Provide mobile enabled, multi-technology contactless readers fully compliant with Restriction of Hazardous Substances directive (RoHS) restricting the use of specific hazardous materials found in electrical and electronic products.
13. Provide mobile enabled, multi-technology contactless readers with universal compatibility with most access control systems by outputting card data in compliance with the SIA AC-01 Wiegand standard.
14. Provide mobile enabled, multi-technology contactless readers with universal compatibility with most access control systems by outputting card data in compliance with the most recent OSDP standard provided by SIA, V2.1.7.
15. Provide mobile enabled, multi-technology contactless readers with tamper resistant screws.
16. Provide mobile enabled, multi-technology contactless readers with the ability to transmit an alarm signal via and integrated optical tamper switch if an attempt is made to remove the reader from the wall. Provide tamper switch programmable to provide a selectable action to provide a selectable action compatible with various tamper communication schemes provided by access control panel manufacturers. The selectable action must include one of the following:
 - a. The reader open collector line changes from a high state (5V or above) to a low state (Ground).
 - b. If utilizing OSDP, provide protocol reader reporting a tamper condition via RS485.
17. Provide mobile enabled, multi-technology contactless readers with the ability to mount to standard electrical boxes using universal international mounting holes.
18. Provide multi-technology contactless readers with a quick connect wire harness.
19. Provide mobile enabled, multi-technology contactless readers with customizable reader behavior options either from the factory or defined in the field using the ENGAGE mobile app or pre-configured command cards. Reader behavior programming options must include:
 - a. LED & Audio configurations.
 - b. Ability to disable reading of specific card technologies or frequencies.

- c. ISO 14443/15693 CSN output configuration.
 - d. Wiegand output spacing and timing.
 - 20. Provide mobile enabled, multi-technology contactless readers with the following programmable audio/visual indication:
 - a. Provide an audio beeper tone sequence to signify: access granted, access denied, power up, and diagnostics.
 - b. Provide a light bar with clear visual status (red/green/amber).
 - 21. Provide mobile enabled, multi-technology contactless readers designed for low current operation to enable migration from most legacy proximity applications without the need to replace existing access control panels and/or power supplies. Provide contactless smart cards with the following power requirements:
 - a. Operating voltage: 5 – 28 VDC, reverse voltage protected. Linear power supply recommended.
 - b. Current requirements: 80 mA DC, 200 mA PEAK @ 12 VDC ; 45mA DC, 105mA PEAK @ 24V
 - 22. Provide mobile enabled, multi-technology contactless readers meeting the following physical specifications:
 - a. Dimensions: 5.1" x 3.25" x 0.76" (12.9 cm x 8.3 cm x 1.9cm)
 - b. Weight: 6.1 oz. (172.93 g)
 - c. Plastics: Consist of three-piece design with mounting plate, case and aesthetic cover.
 - d. Color: Black or Cream as approved by the project architect.
 - 23. Provide mobile enabled, multi-technology contactless readers meeting the following environmental specifications:
 - a. Operating temperature: -40 to 158 degrees F (-40 to 70 degrees C)
 - b. Operating humidity: 5% to 95% relative humidity non-condensing
 - c. Weatherized design suitable to withstand harsh environments
 - 1) Certified rating of IP65
 - 24. Mobile enabled, Multi-technology contactless reader cabling requirements:
 - a. Cable distance: (Wiegand): 500 feet (150m)
 - b. Cable type: 5-conductor #22 AWG
 - c. Standard reader termination: 18" (0.5m) wire harness
- C. Read Only Mobile Enabled, Multi-Technology Contactless Reader with Keypad
- 1. Provide access control card readers manufactured by a global company who is a recognized leader in the production of access control devices. Card reader manufactured for non-access control applications are not acceptable
 - 2. Provide mobile enabled, multi-technology contactless readers which can read access control data from both 125 kHz and 13.56 MHz contactless smart cards. Reader must be BLE, 2.4 Ghz and NFC, 13.45 MHz capable and enabled for use with a mobile phone. Provide mobile enabled, multi-technology contactless reader optimally designed for use in access control applications that require reading both 125 kHz Proximity and 13.56 MHz contactless smart cards by providing:
 - a. Configuration allows reader to be enabled to read smart, proximity or both technologies at the same time.
 - b. A migration platform to upgrade from the most popular 125 kHz proximity technologies to MIFARE or MIFARE DESFire by reading both 125 kHz proximity technology and 13.56 MHz contactless smart card technology.
 - c. Guaranteed compatibility to read all standard data formats ensuring card-to-reader interoperability in multi-location installations and multi-card/reader populations.

- d. Secure access control data exchange between the smart card and the reader utilizing diversified keys and mutual authentication sequences.
 - e. Universal compatibility with most access control systems.
 - f. Ease of installation through industry standard wiring methods.
 - g. Compatibility with legacy 125 KHz proximity access control formats (all standard formats up to 37 bits, including HID Corporate 1000 formats).
 - h. Optimal read range and read speed for increased access control throughput.
 - i. Global availability.
 - j. Product construction suitable for both indoor and outdoor applications.
 - k. Customizable behavior for indicator lights and beeper.
3. Provide mobile enabled, multi-technology contactless readers complying with the following 13.56MHz-related standards to ensure product compatibility and predictability of performance:
 - a. ISO 14443, 14443B, 15693
 4. Provide mobile enabled, multi-technology contactless readers configurable to read 13.56 MHz data simultaneously from the following cards (multiple credential support based on reader configuration):
 - a. Secure support - Mifare DESFire , Mifare Classic and Mifare Plus
 - b. UID/CSN Support – Mifare DESFire, Mifare Plus, Mifare Classic V0.06, HID iClass, ISOX (my-d).
 5. Provide mobile enabled, multi-technology contactless readers configurable to read data from any compatible 125 kHz technology simultaneously with 13.56 MHz data. Compatible 125 kHz technologies include:
 - a. XCEEDID/Schlage/HID Prox (format in the card – formats up to 37-bits supported).
 - b. AWID PROX (SAME AS LENEL PROX - format in the card – formats up to 42-bits).
 - c. GE/CASI PROX - two possible format options.
 - d. Inside Pictotag, TI Tagit, ST Micro.
 6. Provide mobile enabled, multi-technology contactless readers with the ability to read card access data stored in the secure access control sector/application area of the ISO 14443 MIFARE Classic or MIFARE DESFire card.
 7. Provide mobile enabled, multi-technology contactless readers configurable to provide multiple hierarchical degrees of key compatibility for accessing the smart card access control data. Provide compatibility for the following key structure options:
 - a. Compatibility with the default manufacture’s key structure to ensure convenient off the shelf compatibility with manufacture’s cards and readers.
 - b. Compatibility with custom keys managed by manufacturer which provide a site-specific, unique, protected key structure.
 - c. Compatibility with high security customer managed custom keys.
 8. Provide mobile enabled, multi-technology contactless readers configurable to provide compatibility with all standard Prox formats up to 37 bits (including Corporate 1000®).
 9. Provide mobile enabled, multi-technology contactless readers capable of accepting a mobile credential leveraging NFC, 13.56 MHz or BLE, 2.4 Ghz technology.
 10. Provide multi-technology contactless readers with integrated keypad functionality
 - a. 3 X 4, telephone keypad layout including numbers 0 through 9, * and # and backlight capability.
 - b. Configuration allows reader to be enabled to the following keypad formats
 - 1) 26A, Fixed Facility Code 55
 - 2) 4 Bit Burst
 - 3) 8 Bit Burst

- c. Configuration allows reader to be configured with keypad backlight on or off.
11. Provide mobile enabled, multi-technology contactless readers which allow reader configuration changes and firmware upgrades in the field without the need to remove the reader using the ENGAGE mobile app.
12. Provide mobile enabled, multi-technology contactless readers suitable for global deployment by meeting worldwide radio and safety regulatory compliance including:
 - a. FCC Certification (US)
 - b. CE (EU)
 - c. R&TTE Directive (15EU)
 - d. UL294 (US)
 - e. cUL (Canada)
 - f. IC (Canada)
 - g. FIPS201-2 / PIV I
 - h. IP65
13. Provide mobile enabled, multi-technology contactless readers fully compliant with Restriction of Hazardous Substances directive (RoHS) restricting the use of specific hazardous materials found in electrical and electronic products.
14. Provide mobile enabled, multi-technology contactless readers with universal compatibility with most access control systems by outputting card data in compliance with the SIA AC-01 Wiegand standard.
15. Provide mobile enabled, multi-technology contactless readers with universal compatibility with most access control systems by outputting card data in compliance with the most recent OSDP standard provided by SIA, V2.1.7.
16. Provide mobile enabled, multi-technology contactless readers with tamper resistant screws.
17. Provide mobile enabled, multi-technology contactless readers with the ability to transmit an alarm signal via and integrated optical tamper switch if an attempt is made to remove the reader from the wall. Provide tamper switch programmable to provide a selectable action to provide a selectable action compatible with various tamper communication schemes provided by access control panel manufacturers. The selectable action must include one of the following:
 - a. The reader open collector line changes from a high state (5V or above) to a low state (Ground).
 - b. If utilizing OSDP, provide protocol reader reporting a tamper condition via RS485.
18. Provide mobile enabled, multi-technology contactless readers with the ability to mount to standard electrical boxes using universal international mounting holes.
19. Provide multi-technology contactless readers with a quick connect wire harness.
20. Provide mobile enabled, multi-technology contactless readers with customizable reader behavior options either from the factory or defined in the field using the ENGAGE mobile app or pre-configured command cards. Reader behavior programming options must include:
 - a. LED & Audio configurations.
 - b. Ability to disable reading of specific card technologies or frequencies.
 - c. ISO 14443/15693 CSN output configuration.
 - d. Wiegand output spacing and timing.
21. Provide mobile enabled, multi-technology contactless readers with the following programmable audio/visual indication:
 - a. Provide an audio beeper tone sequence to signify: access granted, access denied, power up, and diagnostics.
 - b. Provide a light bar with clear visual status (red/green/amber).

22. Provide mobile enabled, multi-technology contactless readers designed for low current operation to enable migration from most legacy proximity applications without the need to replace existing access control panels and/or power supplies. Provide contactless smart cards with the following power requirements:
 - a. Operating voltage: 5 – 28 VDC, reverse voltage protected. Linear power supply recommended.
 - b. Current requirements: 80 mA DC, 200 mA PEAK @ 12 VDC ; 45mA DC, 105mA PEAK @ 24V
23. Provide mobile enabled, multi-technology contactless readers meeting the following physical specifications:
 - a. Dimensions: 5.1" x 3.25" x 0.76" (12.9 cm x 8.3 cm x 1.9cm)
 - b. Weight: 6.1 oz. (172.93 g)
 - c. Plastics: Consist of three-piece design with mounting plate, case and aesthetic cover.
 - d. Color: Black or Cream as approved by the project architect.
24. Provide mobile enabled, multi-technology contactless readers meeting the following environmental specifications:
 - a. Operating temperature: -40 to 158 degrees F (-40 to 70 degrees C)
 - b. Operating humidity: 5% to 95% relative humidity non-condensing
 - c. Weatherized design suitable to withstand harsh environments
 - 1) Certified rating of IP65
25. Mobile enabled, Multi-technology contactless reader cabling requirements:
 - a. Cable distance: (Wiegand): 500 feet (150m)
 - b. Cable type: 5-conductor #22 AWG
 - c. Standard reader termination: 18" (0.5m) wire harness

2.28 PROXIMITY CARDS

- A. Provide 500 cards
- B. 8920 Series Multi-Technology Card
- C. Access cards shall be used with access readers to gain entry to access control portals (e.g. doors, gates, turnstiles) and to hold information specific to the user.
- D. The card shall function at 125 kHz.
- E. The card shall function at 13.56 MHz.
- F. Presentation to the access control reader at any angle within a minimum distance of one half (1/2) inch shall result in an accurate reading of the card.
- G. The card shall have a read range of up to 6 inches.
- H. The card shall be compatible with HID, XceedID and Schlage proximity readers.
- I. This card shall be compatible with aptiQ multi-technology readers.
- J. The card shall be compatible with aptiQ, XceedID, and Schlage smart card readers.
- K. This card shall be compatible with aptiQ multi-technology readers.

- L. The card shall be made of a composite material for added durability.
 - M. The card shall have open memory architecture.
 - N. The card shall be GSC-IS® certified.
 - O. The card shall have an ISO MIFARE DESFire EV1 microprocessor.
 - P. The card shall have a passive design, requiring no batteries.
 - Q. The card shall have 16k bits of memory.
 - R. The card shall be ISO14443 compliant.
- 2.29 Several doors will have handicapped door openers and push plates to operate the openers. The security contractor is responsible for interfacing these door openers and push plates into the door access system. This integration shall consist of connecting the prox readers to the push plates (openers) so that it will be necessary to have a proper proximity badge to allow operation of the handicapped door. Without the proper card, the door should not operate during restricted hours.
- 2.30 Door position sensors – Provide connectivity to door contacts provided under the door contract. Refer to drawings for locations. Provide door contacts on all overhead doors as shown on the drawings (Ademco 958 or approved equal). Utilize sensors to provide door position status during occupied hours as required by Contractor’s programming. Refer to Door Hardware Section for additional information.
- 2.31 LATCH BOLT MONITORING
- A. Electronic door hardware – Provide wiring and controls to electronic door hardware to remotely lock/unlock selected doors. System shall provide the Contractor with the ability to remotely control doors from the remote access workstations, head end server, associated proximity readers, request-to-exit devices and the fire alarm system.
- 2.32 LOCK DOWN/PANIC BUTTON
- A. Multipurpose push button switches cover a wide range of applications both indoors and outdoors. Models used with LT-1UL Latching Timer Module are Listed for access control. Stainless steel backplate. Push buttons shall be ADA Compliant. Two (2) Form “C” contacts, DPDT, rated 10 amps @ 125/250 VAC, 1/2 HP, 6 amps @ 30 VDC.
 - B. Indoor/outdoor cover helps stop false alarms and can protect Stopper Stations against damage as well as malicious or accidental activation. It consists of a clear polycarbonate shield that fits easily over any STI Stopper Station model. The protective cover options include: dome or low profile, flush mount, surface mount. Additional labeling may be placed on the Universal Stopper.

2.33 Contractor shall include all necessary wire, cable and accessories for a complete working system.

PART 3 - EXECUTION

3.1 ACCEPTABLE INSTALLERS

- A. The system shall only be provided by Contractors who are factory authorized to install, service and maintain the system by the access control manufacturer.
- B. The Contractor must have been a factory authorized dealer with the proposed manufacturer for a period of at least two (2) years before the Bid Opening Date.
- C. The Contractor's installers and technicians must also be factory trained and certified to perform such tasks.

3.2 CONTRACTOR/CONTRACTOR COMMUNICATION

- A. Contractor shall obtain the following programming information from the Contractor:
 - 1. The IP addresses typically used for Access Control Panels district/city wide, NVRs, or Intercom devices.
 - 2. Whether or not panic and door release buttons are to function as normally intended or if there is a specific set up for them.
 - 3. Specific type of training required for the Access Control System. (personnel, specific system functions, etc.)
 - 4. The groups to be created for Access Control and the doors typically found within each group.
 - 5. Whether or not a Knox Box card will need to be programmed, and if so, what doors and permissions will the card have.

3.3 EXAMINATION

- A. The Contractor shall be required to visit the installation site prior to bidding the job.
- B. The Contractor shall report any discrepancies between the Specifications, Drawings, and Site Examination prior to the Bid Opening Date.

3.4 PREPARATION

- A. The Contractor shall order all required parts and equipment upon notification of award of the Work.
- B. The Contractor shall bench test all equipment prior to delivery to the job site.
- C. The Contractor shall verify the availability of power where required. If a new source of power is required, a licensed electrician shall be used to install it.

- D. The Contractor shall arrange for obtaining all programming information including access times, free access times, door groups, operator levels, etc.

3.5 INSTALLATION

- A. The Contractor shall coordinate with the Contractor's IT Department if connecting to their network.
- B. The Contractor shall carefully follow the instructions in the manufacturers' Installation Manual to insure all steps have been taken to provide a reliable, easy to operate system.
- C. The Administrator Terminal shall be connected to the remote terminals before connecting to any card reader processors.
- D. The Contractor shall coordinate with the Contractor's locksmith if converting from mechanical to electric locks.
- E. Perform all Work as indicated in the Drawings and Specifications.
- F. The Contractor shall install the appropriate cable from the CPU to readers, door contacts, request-to-exit devices, and electric locks at each door and/or gate.
- G. All communications cables shall be kept away from power circuits.
- H. The Contractor shall install the power supply(s) for electric locks in locations where they won't interfere with other operations.
- I. The Contractor shall also execute adequate testing of the system to insure proper operation.
- J. The Contractor shall provide adequate training of the system users to insure adequate understanding to prevent operating errors.

3.6 WORKMANSHIP

- A. Comply with highest industry standards, except when specified requirements indicate more rigid standards or more precise workmanship.
- B. Perform Work with persons experienced and qualified to produce workmanship specified.
- C. Maintain quality control over suppliers and Subcontractors.
- D. Quality of workmanship is considered important. Contractor Project Manager will have the authority to reject Work which does not conform to the Drawings and Specifications.

3.7 EQUIPMENT PRE-TEST

- A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench test per manufacturer's installation instructions.

3.8 WIRE AND CABLE

- A. Design, layout, size, and plan new wire and cable runs as required.
- B. All wire and cable from the processors to all devices at each door shall be “home-run” unless otherwise specified.
- C. All wire and cable, including any wire and cable that is existing and will be reused in the Work, shall be installed in conduit or surface metal raceway, except as follows:
- D. Wire or cable, in lengths of less than ten (10) feet, that is “fished” within walls, ceilings, and door frames.
- E. All wire and cable passing thru metalwork shall be sleeved by an approved grommet or bushing.
- F. Avoid splicing conductors. All splices shall be made in junction boxes (except at equipment). Splices shall be made with an approved crimp connection. Wire nuts shall not be used on any low-voltage wiring.
- G. Identify all wire and cable at terminations and at every junction box. Identification shall be made with an approved permanent label, Brady or equal.

3.9 WIRE AND CABLE TERMINATIONS

- A. Identify all inputs and outputs on terminal strips with permanent marking labels.
- B. Neatly dress and tie all wiring. The length of conductors within enclosures shall be sufficient to neatly train the conductor to the terminal point with no excess. Run all wire and cable parallel or normal to walls, floors and ground.
- C. Install connectors as required by equipment manufacturers.
- D. Terminations shall be made so that there is no bare conductor at the terminal. The conductor insulation shall bear against the terminal or connector shoulder.
- E. Do not obstruct equipment controls or indicators with wire or cable. Route wire and cable away from heat producing components such as resistors, regulators, and the like.

3.10 CONDUIT AND RACEWAY INSTALLATION

- A. Design, lay-out, size and plan new conduit and raceway systems as required.
- B. Indoor Requirements:
 - 1. Route exposed conduit and raceway parallel and perpendicular to walls and adjacent piping.
 - 2. Maintain minimum six (6) inch clearance between conduit and piping.
 - 3. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps.

4. Use conduit bodies to make sharp changes in direction, as around beams. Fasten conduits and raceways to structural steel using approved spring clips or clamps.
5. Where conduit penetrates fire-rated walls and floors, seal opening with UL listed fire rated sealer or other methods as approved by codes.
6. No exposed conduit, raceway, or junction box shall be installed within any office area.
7. Install all boxes straight and plumb.
8. Do not support conduit from mechanical, plumbing, or fire sprinkler systems.
9. Drill or core drill all holes in walls, ceilings, or floors where required for new conduits. Do not cause damage to any structural steel or other structural support member by drilling or cutting.
10. Do not use flexible conduit in lengths longer than six (6) feet.

C. Outdoor Requirements:

1. Where conduit penetrates exterior walls, seal opening around conduit in an approved manner to make watertight.
2. Use galvanized straps and fasteners on all exterior conduit.
3. All exterior boxes will only be used to aid in pulling the cable between points.

3.11 PENETRATIONS

- A. Do not penetrate any roof, flashing, exterior wall, or parapet without prior approval from Contractor's designated Construction Project representative.
- B. When penetrating a fire wall for passage of cables and/or conduit, always provide a fire-stop system that complies with code and the local authority having jurisdiction.

3.12 FIRE RATED DOORS AND FRAMES

- A. Do nothing to modify a UL. rated door or frame that would void the UL. label or fire rating.

3.13 GROUNDING

- A. Provide earth-grounding of equipment as required by equipment manufacturer. Earth ground shall be connected to ground rod or approved cold water pipe. Electrical or telephone ground connections shall not be used as earth grounds. Connections to mounting posts or building structural steel shall not be used as earth grounds.

3.14 POWER TO SECURITY EQUIPMENT

- A. Power all equipment from 120 VAC circuit dedicated for security use, except as noted. Mark all panel circuit breakers with labels worded "Security Equipment - Do Not Operate", or equivalent.
- B. All plug-in transformers shall be located at the security control panels. Secure all low-voltage plug-in transformers to outlet with screw or strap. Clearly label all transformers to identify purpose and use.

3.15 CUTTING AND PATCHING

- A. The Contractor shall be responsible for all cutting, fitting or patching that may be required to complete the Work.

3.16 PAINTING

- A. All surface raceway systems shall be painted to match the surfaces they are attached to.

3.17 PLYWOOD BACKING

- A. Install the processor(s), power supplies, and all other related equipment on a plywood backboard for testing in the shop. The mounted assembly will then be transported “as is” to the job site for mounting in the Communication Room.
- B. Fasten the plywood backing to the wall using a hanger bolt at the four corners which align with pre-drilled holes in the plywood. Secure with flat washers and a nut.

3.18 FIELD QUALITY CONTROL

- A. Upon reaching Substantial Completion, perform a complete test and inspection of the system. If found to be installed and operating properly, notify Contractor of your readiness to perform the formal Test & Inspection of the complete system.
- B. Submit the Record Drawings (as-builts) to Contractor for review prior to inspection.
- C. During the formal Test & Inspection (Commissioning) of the system, have personnel available with tools and equipment to remove devices from their mounts to inspect wiring connections. Provide wiring diagrams and labeling charts to properly identify all wiring.
- D. If corrections are needed, the Contractor will be provided with a Punch-List of all discrepancies. Perform the needed corrections in a timely fashion.
- E. Notify Contractor when ready to perform a re-inspection of the installation.

3.19 INITIAL PROGRAMMING AND CONFIGURATION

- A. Contractor shall provide initial programming and configuration of the security management system. Programming shall include defining hardware, doors, monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like. Input of all program data shall be by Contractor. Contractor shall consult with Security Consultant and Contractor to determine operating parameters.
- B. Contractor shall develop and input system graphics, such as maps and standby screens. Contractor shall provide floor plan drawings as the basis for the creation of maps. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits. Contractor

shall provide floor plan drawings, in the form of AutoCAD .DWG or .DXF files, as the basis for the creation of maps.

- C. Contractor, with the cooperation and assistance of Contractor, will input the cardholder data for each access card.
- D. Contractor shall maintain hard copy worksheets which fully document the system program and configuration. Worksheets shall be kept up to date on a daily basis by Contractor until final Acceptance by Contractor. Worksheets shall be subject to inspection and approval by Contractor. Provide final copies to Contractor prior to Project Close-out.
- E. Contractor shall maintain a complete, up-to-date magnetic tape backup of the system configuration and cardholder database. Backup shall be maintained throughout programming period until final Acceptance by Contractor. Submit back-up tapes to Contractor upon Final Acceptance.
- F. Approximately sixty (60) days after start-up of system, Contractor shall return to project to provide follow-up assistance with system configuration as requested by Contractor. Contractor shall include an allowance of forty (40) hours of labor for follow-up assistance in his Base Bid price.

3.20 TRAINING

- A. Contractor shall provide complete operator training on the Security Management System. Training shall consist of thirty-two hours of instruction for ten people selected by Contractor, plus two (2) hours of individual hands-on training for each of ten people selected by Contractor. Hands-on training shall include the opportunity for each person to operate the system, and to practice each operation that an operator would be expected to perform.
- B. Training shall cover all operating features of the system, including the following:
 - 1. System set-up and cardholder database configuration.
 - 2. Access control features.
 - 3. Alarm monitoring features.
 - 4. Report generation and searches.
 - 5. Card management and Badge Design/Printing
 - 6. Disk backup procedures
 - 7. Routine maintenance and adjustment procedures.
- C. Training sessions are to be held at Contractor's facility, and are to be scheduled at the convenience of Contractor. Contractor shall provide written training outline and agenda for each training session prior to scheduling.
- D. Weekly format of training sessions shall be as follows:
 - 1. Monday: Afternoon Session: Control Center Training
 - 2. Tuesday: All Day: System Administrator Training
 - 3. Wednesday: All Day: System Administrator Training
 - 4. Thursday: All Day: System Administrator Training
 - 5. Friday: Morning Session: Control Center Training

- E. Contractor shall provide written training materials for each of ten (10) people.

3.21 OPERATOR TRAINING

- A. Contractor shall provide complete operator training on the Security Management System. Two types of operator training shall be provided:
- B. System Administrator Training: Three-day comprehensive training course for system managers and maintenance personnel. Provide two (2) separate on-site training sessions.
- C. Training sessions shall include the opportunity for each person to operate the system, and to practice each operation that an operator would be expected to perform.
- D. Contractor shall provide written training materials for each of ten (10) people at each training session.
- E. Training sessions are to be held at Contractor's facility, and are to be scheduled at the convenience of Contractor. Some training sessions may be required to be held during evening hours and on weekends to accommodate users whose schedule does not permit attendance during regular hours.
- F. Contractor shall provide written training outline and agenda for each training session prior to scheduling.

3.22 MANUFACTURER PROFESSIONAL SERVICES

- A. Contractor shall coordinate with the manufacturer to provide the manufacturer's professional services team to assist the Contractor in coordinating the interfaces between the security management system and other on-site systems as necessary.
- B. Professional Services personnel shall be employed by the manufacturer of the security management system and shall be thoroughly knowledgeable of the security management system applications.
- C. Professional Services personnel shall be on-site and available to meet with Contractor's representatives for a period of not less than two consecutive days. On-site visit shall be scheduled at the convenience of the Contractor.

3.23 AS-BUILT DOCUMENTATION

- A. The Contractor shall furnish the Contractor two (2) CDs with complete as-built manuals and drawings in an indexed PDF file format. Drawings shall be a minimum of 11"x17" engineering format. These manuals shall contain:
 - 1. System Operating Instructions
 - 2. System Functional Block Diagram(s)
 - 3. System Schematic Diagram(s)
 - 4. System Wiring Diagrams
 - 5. As-Built Drawings of Entire System including Equipment Rack Elevations

6. Component Technical Operation Manuals
 7. Component Service Manuals
 8. Software Operating Manuals
 9. Port and Switch Labeling
 10. Final Endurance Test Report
- B. Maintenance Manual: The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
- C. The contractor shall provide a new network map indicating all new buildings included in this scope of work. Network map shall include equipment information, IP addresses, VLAN information, etc. Network map shall be prepared utilizing a computer drafting program such as AutoCAD or Visio, and shall be presented in electronic format.

3.24 WARRANTY

- A. If any defects are found within the three (3) year full warranty period, the defective system component shall be replaced at no extra cost to the Contractor for part or labor. Provide a statement of this warranty with the O&M Manuals.
- B. During the warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. Resolve any previous outstanding problems.
- C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- D. The Contractor shall be responsible to provide service during normal working hours on a normal business day within (4) hours after notification by the Contractor for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system components operation, or the loss of the main switch or other dead-end equipment which renders the entire system beyond 50% inactive or un-usable. Provide an on-site authorized factory technician within 24 hours if required.
- E. If equipment cannot be repaired within 24 hours of service visit, Contractor shall supply “loaner” equipment to the Contractor at no charge.

3.25 CERTIFICATION

- 3.26 Upon completion of the testing, the manufacturer or representative shall issue to the Contractor a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

END OF SECTION 281300

(This page intentionally left blank)

SECTION 28 13 53—IP NETWORK COMPATIBLE INTERCOM (IX SYSTEM)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. IP Video Intercom. (Aiphone IS Series)

1.2 RELATED SECTIONS

- A. Section 27 15 13 – Copper Horizontal Cabling
- B. Section 28 13 00 – Access Control

1.3 REFERENCES

- A. American National Standards Institute (ANSI/TIA/EIA) 568 - Commercial Building Telecommunications Cabling Standard.
- B. International Organization for Standards (ISO) 9001:2000 - Quality Management Systems - Requirements.

1.4 SYSTEM DESCRIPTION

- A. IP Network Compatible Video Intercom System: A network-based communication and security system featuring video entry security, internal communication, emergency stations, and paging. All units and app in the systems shall be able to unlock doors remotely on a network, assist onsite visitors from an offsite location, broadcast emergency announcements, and communicate using a PoE network.
 1. Power Source: Power over Ethernet (802.3af).
 2. Network Interface: 10 BASE-T / 100 BASE-TX Ethernet (RJ-45).
 3. Network Protocols: IPv4, IPv6, TCP, UDP, SIP, HTTP, HTTPS, MJPEG, RTSP, RTP, RTCP, IGMP, MLD, SMTP, DHCP, NTP, DNS.
 4. Bandwidth Usage:
 - a. G.711: 64Kbps x 2 per video call.
 - b. 64Kbps per monitor.
 - c. H.264: 24Kbps ~ 2,048Kbps.
 5. Communication: Hands-free (VOX), push-to-talk (simplex), or handset (full-duplex).
 6. Video Display: 7 inch color LCD.
 7. Camera: Type:
 - a. 1/3 inch color CMOS. 1.23 Megapixels.
 - b. View Area at 0 degree camera angle mounted at 4 feet 11 inches (1500 mm) AFF: 2 feet 3 inches (700 mm) vertical x 3 feet 9 inch (1150 mm) horizontal at 19 inches (500 mm).
 8. Video Stream: ONVIF Profile S.
 9. Door Release: Programmable Form C dry contact, 24V AC/ DC, 500mA (use RY-24L for larger contact rating, which requires 24V DC power supply) or use RY-IP44 with 4 multipurpose relays.
 10. Wire Type: CAT-5e or CAT-6.
 11. Distance:

- a. Any station to Network Node: 330 feet (100 meters).

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- C. Shop Drawings: Submit the following:
 1. Wiring Diagrams: Indicate wiring for each item of equipment and interconnections between items of equipment.
 2. Include manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
- D. Installation and Operation Manuals:
 1. Submit manufacturer's installation and operation manual, including operation instructions and component wiring diagrams.
 2. Provide detailed information required for Owner to properly operate equipment.
- E. Warranty: Submit manufacturer's standard warranty.
- F. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- G. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001:2015 certified company.
- B. Installer Qualifications: Factory trained and experienced with system installations of scope and size required for the Project.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 1. Finish areas designated by Architect.
 2. Do not proceed with remaining work until workmanship is approved by Architect.
 3. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
- C. Handling: Protect materials during handling and installation to prevent damage.

1.8 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.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Aiphone IP Video Intercom System: IX Series Intercom System as manufactured by Aiphone Corporation.
- B. Equals by Commend or N2

2.2 SYSTEM DESIGN

- A. Master Station(s): Provide 3 master stations.
- B. Audio Video Door Stations:
 - 1. Model IX-DV (Video Door Station - Surface Mount - Hands Free): Provide per drawings.
- C. Provide Selective Door/Gate Release.
- D. Provide Audio/video streaming via ONVIF Profile S.
- E. Provide ONVIF Profile S camera input (max 500).
- F. Provide Overhead paging.
- G. Provide Contact input at door station.

2.3 FUNCTIONAL COMPONENTS:

- A. Functional Components: As indicated on the drawings or as required to complete system.
 - 1. Video Master Station Series IX-MV7:
 - a. Model IX-MV7-B (Master Station - Black, Hands Free).
 - b. An IP addressable video master station with a 7 inch color LCD monitor. It can be wall or desk mounted (desk stand included). The IX-MV7 offers handset (duplex) and hands-free (VOX/PTT) communication and call up to 500 other IX stations. It connects directly to a network using CAT-5e/6 cable. This station requires a 802.3af compliant Power-over-Ethernet network.
 - 2. Substation Series IX-RS:
 - a. Model IX-RS-B (Black Handset Substation)
 - 3. IXW-MA IP Programmable Relay Adaptor: Multi-purpose adaptor - PoE - screen only.
 - 4. RY-IP44 IP Programmable Relay Adaptor:
 - a. 4 contact inputs and 4 relay outputs (compatible with the IX Series, IS-IP Series, and IPW-1A only).
 - 5. 2-Wire Network Adapter Model IX-1AS:
 - a. One 2-wire input with 2 built-in contact outputs; door release and camera call-up. Powered via PoE, Compatible with Aiphone's LE and NE series audio door

- or substations for connection to Video Master Station Model IX-MV7 over a network.
6. Wire Network Adapter Model IX-10AS (Ten IX-1AS adaptors in a rack mounted enclosure):
 - a. Ten 2-wire inputs with ten, 2 built-in contact outputs; door release and camera call-up. Powered via PoE, Compatible with Aiphone LE and NE series audio door or substations for connection to Video Master Station Model IX-MV7 over a network.
 7. Network Paging Adapter Model IX-PA:
 - a. Address book that supports up to 50 stations and can be connected to 3rd party devices. Can be accessed by an IX-MV7 master station or an instance of the IX Mobile App to allow messages to be broadcast through the IX-PA 600u or 8u output. A 3rd party device can be connected to the audio input to send messages to the paging adaptor address book.
 8. 30 Degree Angle Box Model KAW-D 30:
 - a. Designed for use with one gang mountable video door stations.
 9. Electric Door Strike Model EL-12S:
 - a. The door strike is designed for wood framed wooden doors. The unit operates on 12~16 V AC.
 10. Stainless Steel Enclosure Model SBX-ISDVF:
 - a. 18-Guage Stainless Steel Surface Mount Box for IS-SS/IS-DVF/IS-IPDVF/IX-DF(SS)/IX-DF-HID/RP10 designed for surface mounting door stations.
 - b. Size: 10-7/16 inches x 5-15/16 inches x 3-5/16 inches (top); 2-5/16 inches (bottom) (265 mm x 151 mm x 84 mm (top); 59 mm (bottom).
 - c. Weather resistant.
 - d. Vandal-resistant.
 - e. Inside space for cabling.
 - f. Mounts to flat wall surface.
 - g. Opening at bottom for drainage.
 11. Stainless Steel Enclosure Model SBX-IDVFRA:
 - a. 18-Guage Stainless Steel Surface Mount Box for IS-DVF-(2)RA, IX-DF-2RA, IX-SS-(2)RA.
 - b. Size: 11-11/16 inches x 7 inches x 3-5/16 inches (top); 2-5/16 inches (bottom) (297 mm x 178 mm x 84 mm (top); 59 mm (bottom).
 - c. Weather resistant.
 - d. Vandal-resistant.
 - e. Inside space for cabling.
 - f. Mounts to flat wall surface.
 - g. Opening at bottom for drainage.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive integrated security and communication system.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

- A. Verify the following compliance before starting installation.
 - 1. The unit turns inoperative during power failure.
 - 2. Keep the intercom wires at least 1 foot (30 cm) away from strong electrical wiring (AC 100-240 V) including, in particular, wiring for inverter electrical appliances. Noise and malfunction could result.
 - 3. If a strong light shines on the main unit screen, the picture may turn white or only silhouettes will be visible.
 - 4. Other manufacturer's devices (such as sensor, detectors, door releases) used with this system, comply with the manufacturer's installation requirements.
 - 5. The LCD panel is manufactured with very high precision techniques, inevitably will have a very small portion of its picture elements always lit or not lit at all. This is not considered a unit malfunction. Please be aware of this in advance.

3.3 INSTALLATION

- A. Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

3.4 SET-UP AND ADJUSTING

- A. Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION AND TRAINING

- A. Demonstration:
 - 1. Demonstrate that integrated security and communication system functions properly.
 - 2. Perform demonstration at final system inspection by qualified representative of manufacturer.
- B. Instruction and Training:
 - 1. Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
 - 2. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
 - 3. Provide instruction and training by qualified representative of manufacturer.

3.6 PROTECTION

- A. Protect installed integrated security and communication system from damage during construction.

END OF SECTION

(This page intentionally left blank)

SECTION 282100 - VIDEO SURVEILLANCE CAMERAS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. These Specifications contained herein describe specific functional requirements of the Video Surveillance Cameras. It is not the intent of these specifications to detail and describe the exact performance of the cameras. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.
- B. Interior Camera System - System consists of multiple IP based cameras with specified housings, mounting, lenses, features, etc. throughout the building interior as indicated on the drawings and as specified herein.
- C. Exterior Camera System - System consists of multiple IP based cameras with specified housings, mounting, lenses, local power supplies, features, etc. around the perimeter of the building and throughout the project site as indicated on the drawings and as specified herein.

1.3 QUALITY ASSURANCE

- A. National Fire Protection Association.
- B. National Electric Code.
- C. American with Disabilities Act.
- D. Underwriter's Laboratory.
- E. FCC Part 15 – Subpart B Class A.
- F. NEMA Type 4AX.
- G. NEMA Type 1.
- H. NTSC/EIA.
- I. ISO 14001
- J. ISO/IEC 14496-2 MPEG-4, MPEG-H Part 2.

- K. H.264, H.265.
- L. FCC CFR 47 Part 15 Class A – Telecommunications – Radio Frequency Devices – Digital Device Emission
- M. UL 60950-1 Information Technology Equipment – Safety.
- N. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and 11th Edition (or later).
- O. BICSI Telecommunications Distribution Methods Manual (TDMM) 13th Edition or later.
- P. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75 mile radius now rendering satisfactory service.
- Q. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and /or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.
- R. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.
- S. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.4 DEFINITIONS

- A. Industry standard words and phrases are used throughout the Drawings and Specifications, except:
 - 1. Words which have well-known technical or trade meanings are used in accordance with such recognized meanings.
 - 2. Whenever the following listed words and phrases are used, they shall be mutually understood to have the following respective meanings:
- B. The words “as indicated.” means: as shown on the Drawings, and in accordance with the Specifications.
- C. The words “as required.” means: as required to provide a complete and satisfactory Work in full conformance with the Drawings and Specifications.
- D. The word “New” means: new Work to be provided by Contractor.
- E. The word “Provide” means: furnish, install, connect, test and make ready for use.

- F. The words “Relocate existing” means: remove existing item from present location. Reinstall, re-connect, and test existing item and make ready for use at new location as shown on the Drawings.
- G. The words “Remove existing “means: remove existing item and return item to Owner.
- H. The word “Replace” means: remove existing item and return item to Owner. Provide new item as indicated.
- I. The word “Work”: The Work is the completed construction required by the Drawings and Specifications, and includes all labor necessary to produce such construction, and all materials and equipment incorporated or to be incorporated in such construction.
- J. The word “Furnish” means: supply item as specified. Item to be installed by others.

1.5 QUALITY ASSURANCE

- A. National Fire Protection Association.
- B. National Electric Code.
- C. American with Disabilities Act.
- D. Underwriter’s Laboratory.
- E. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and Tenth Edition (or later).
- F. BICSI Telecommunications Distribution Methods Manual (TDMM).
- G. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75mile radius now rendering satisfactory service.
- H. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and /or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.
- I. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years’ experience in the manufacture of progressive products specified.
- J. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.6 CONTRACTOR QUALIFICATIONS

- A. Qualifications of Contractor

1. Contractor shall be an installation and service contractor regularly engaged in the sale, installation, maintenance and service of access control systems.
2. Contractor shall have three years' experience with the installation, start-up and programming of systems of a similar size and complexity to the one proposed.
3. Contractor shall be a factory authorized dealer of the system proposed for at least two years.
4. Contractor shall provide factory certified technicians to perform the installation of all intelligent controller components in this project. Evidence of the certification shall be in writing from the manufacturer and shall be on the technician's person at all times while on site.

B. Supervision of Work

1. Contractor shall employ a competent Foreman to be in responsible charge of the Work. Foreman shall be on the project site daily during the execution of the Work.
2. Contractor's Foreman shall be a regular employee, principle, or officer of Contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.

C. Qualifications of Technicians

1. All electronic systems Work shall be performed by electronic technicians thoroughly trained in the installation and service of specialty low-voltage electronic systems.
2. Electrician electrical workers may be used to install conduit, raceways, wiring, and the like, provided that final termination, hook-up, programming, and testing is performed by a qualified electronic technician, and that all such Work is supervised by the Contractor's Foreman.
3. All incidental Work, such as cutting and patching, lock hardware installation, painting, carpentry, and the like, shall be accomplished by skilled craftsperson regularly engaged in such type of work. All such Work shall comply with the highest standards applicable to that respective industry or craft.
4. All 120 VAC power wiring and connections are to be performed by a qualified Electrician, licensed to perform such Work in the Owner.

D. Subcontractors

1. Definition: A Subcontractor is a person or entity who has a direct contract with the Contractor to perform any of the Work at the site.
2. Use of any Subcontractor is subject to the approval of Owner. The Contractor shall identify all Subcontractors on the Bid Form. The Contractor shall make no substitution for any Subcontractor previously selected without approval from Owner.
3. Contractor's Foreman shall be on the project site daily during all periods when Subcontractors are performing any of the Work. Contractor's Foreman shall be in responsible charge of all Work, including any Work being performed by Subcontractors.
4. By an appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by the terms of the Drawings and Specifications, and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these documents, assumes toward Owner.

E. Supervision and Construction Procedures

1. The Contractor shall supervise and direct the Work, using his best skill and attention. Contractor is solely responsible for all construction means, methods, and techniques.
2. The Contractor shall employ a competent foreman who shall be in attendance at the project site during the progress of the Work. The foreman shall represent the Contractor and all communications given to the foreman shall be as binding as if given to the Contractor.

F. Regulatory Requirements

1. All Work is to conform to all building, fire, and electrical codes and ordinances applicable in the Owner. In case of conflict between the Drawings/Specifications and codes, the codes shall govern. Notify Owner Project Manager of any such conflicts.
2. Contractor shall secure and pay for all licenses, permits, plan reviews, engineering certifications, and inspections required by regulatory agencies. Contractor shall prepare, at Contractor's expense, any documents, including drawings that may be required by regulatory agencies.

G. Permits

1. The Contractor shall make application for and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

H. The Project Drawings represent the level of system design to be provided by Owner. Contractor shall provide all additional system design work required, including:

1. Conduit layout and sizing.
2. Wire and cable layout and sizing.
3. Point-to-point wiring and equipment hook-up information.
4. Equipment mounting details.
5. Design of equipment cabinets.
6. Other detailed design work required.

B. Contractor's design shall conform to all applicable codes and ordinances. All electrical design, including the sizing and placement of conduit, raceways and conductors, shall be in accordance with NFPA 70: National Electrical Code, current version, unless local codes establish more stringent requirements.

I. Contractor's design work is subject to review and approval by Owner's Project Manager.

J. Contractor's design shall also include:

1. The addition of all wire, cable, conduit, connectors and junction boxes required for system operation.
2. The installation of conduit between the control components and all equipment at each door, as necessary.
3. Completed "as-built" documentation of all security systems, including documentation of existing equipment, wiring, conduits, and raceways.
4. Other Work as defined within the Project Drawings and Specifications.

- K. The contractor/subcontractor is required to answer all warranty and Service calls within 4 hours of the initial customer contact and provide an authorized technician onsite within 24 hours.
 - 1. Proper identification is required and must be visible while onsite for warranty/service calls. Notification of completion must be provided to authorized personnel onsite before departing facility.
 - 2. Consult and coordinate with all trades providing adjoining work and make an Adjustment or relocation necessary to accommodate other equipment or to maintain proper function of existing equipment without claims for additional payment.

- L. These Specifications contained herein describe specific functional requirements of the SMS as required by the owner. It is the intent of these specifications to detail and describe the exact performance of the system. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

1.7 WARRANTY

- A. Provide a three (3) year full warranty of the system, including equipment, wiring and software against defects in material and workmanship from the date of system completion and acceptance. If any defects are found within the warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor.

- B. During the first year's warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:
 - 1. Visual checks and operational test of the multiplexer, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.
 - 2. Correct all diagnosed problems.
 - 3. Resolve any previous outstanding problems.

- C. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

- D. Contractor shall provide a parts and labor guarantee on all Work. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

- E. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by Owner, or acts of god.

- F. Contractor shall promptly respond to Owner's requests for service during the guarantee period. Contractor shall provide repair service as soon as reasonably possible upon request from Owner, but in no case shall service response exceed 8 hours from time of request.

- G. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- H. The Contractor shall be responsible to provide service during normal working hours within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system component operation, or the loss of the video switcher or other head-end equipment. Provide an on-site authorized factory technician within 24 hours if required.
- I. If equipment cannot be repaired within 24 hours of service visit, Contractor shall provide “loaner” equipment to the Owner at no charge.

1.8 SUBMITTALS

- A. Product Data: Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.
- B. Procedures
 - 1. Provide submittals to Owner’s Project Manager.
 - 2. Submit electronic copy of each submittal.
- C. Shop Drawings
 - 1. General Shop Drawings for the project as described elsewhere.
 - 2. Provide other Shop Drawings only if specifically requested by Owner’s Project Manager.
- D. Manufacturers Installation and Programming Instructions
 - 1. Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.
- E. Project Record Drawings
 - 1. Definition: Project Record Drawings are drawings that completely record and document all aspects and features of the Work. (Also known as “as-built” drawings.)
 - 2. The purpose of Project Record Drawings is to provide factual information regarding all aspects of the Work, to enable future service, modifications, and additions to the Work.
 - 3. Project Record Drawings are an important element of this Work. Contractor shall accurately maintain Project Record Drawings throughout the course of this project. Project Record Drawings shall include documentation of all Work, including the documentation of existing equipment, wiring, conduits, and raceways that are to be reused in the Work.
 - 4. Owner Project Manager shall furnish Contractor with two (2) sets of site plans for Contractor’s use in preparing Project Record Drawings. One set shall be used as a working set, the other shall be used to prepare the final record set.
 - 5. Contractor shall maintain the working set of Project Record Drawings at the project site throughout the course of the Work. The working set shall be updated on a daily basis as the Work progresses.
 - 6. Project Record Drawings shall accurately show the physical placement of the following:

- a. Equipment and devices.
 - b. Conduit and raceways.
 - c. Junction and pull box locations.
 - d. End-of-line resistor locations.
 - e. Interfaces to external equipment.
 - f. Connections to power and telephone circuits.
- F. Project Record Drawings shall show the physical placement of each device and conduit or aerial center line, to be accurate to within one foot (1') of the nearest landmark. Where the site plan furnished by Owner's Project Manager conflicts with actual conditions, Contractor shall amend site plan as required. Indicate exact description of conduit runs (above ground, two-foot trench, along outside wall of building, etc.).
- G. Project Record Drawings shall show wire and cable runs, zone numbers, tamper circuit configuration, panel/circuit breaker numbers from which equipment is powered, and splice points. Such information may be shown on the site plans.
- H. Project Record Drawings shall be available for inspection by Owner's Project Manager on a daily basis. Incomplete or inaccurate Project Record Drawings may be cause for delay of Contractor's payment.
- I. Upon completion of Work, and prior to Final Acceptance, Contractor shall prepare and submit to Owner's Project Manager a final record set of Project Record Drawings. This set shall consist of all data transferred from the working set, supplemented by Riser Diagrams and other information. The final record set of Project Record Drawings shall be drafted by a skilled draftsman, under the supervision of Contractor. All final Project Record Drawings shall be provided to Owner.
- J. System Documentation
1. Definition: System Documentation is a complete collection of all installation, programming, operation, and maintenance manuals and work sheets relating to the equipment provided as part of the Work.
 2. Contractor shall maintain a file of System Documentation at the project site throughout the course of the Work. Such file shall be updated with new information as equipment is received and installed. System Documentation shall be available for inspection by Owner Project Manager on a daily basis.
 3. Upon completion of Work, and prior to final Acceptance, Contractor shall prepare and submit to Owner's Project Manager electronic sets of System Documentation.
- K. Closeout Submittals
1. Provide a set of as-built drawings and manuals to the Owner's Project Manager
 - g. As-Built Drawings

- h. Mounting Details
 - i. Product Data
 - j. Installation Manuals
 - k. Operating Manuals
 - l. Maintenance/Service Manuals
2. Provide the Owner's Project Manager- with all programming sheets, keys to the equipment cabinets, as-built drawings, operating manuals, maintenance/repair manuals, spare fuses, all programming sheets and keys to the equipment cabinets, tools for tamper-resistant enclosures and tools for manual resetting devices.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Security of Contractor's Tools and Equipment: Owner is not responsible for the care, storage or security of any of the Contractor's tools or equipment.

1.10 PROJECT/SITE CONDITIONS

A. Environmental Conditions

- 1. Power: Electrical power will be supplied by Owner to the extent that the usage is compatible with available facilities in the vicinity of the work.
- 2. Telephone: Contractor may use a telephone designated by Owner for local and toll-free calls. The costs of long distance calls are the responsibility of the Contractor and shall not be charged to Owner.
- 3. Rest room Facilities: Contractor may use existing Rest room facilities designated by Owner.
- 4. Parking: Owner reserves the right to limit or restrict Contractor parking based upon the daily requirements of the other contractors on site.
- 5. Dust Control: Make provisions to control all dust, dirt, and foreign material caused by the performance of the Work.
- 6. Use of explosive type fastening equipment is prohibited.
- 7. Notify Owner immediately of any damage or possible damage to any other equipment.

B. Clean-Up

- 1. Contractor shall clean-up, on a daily basis as the Work progresses, all dirt, dust and debris caused by Contractor's operations. Clean-up shall be completed by the end of each workday to the satisfaction of Owner's on-site representative.
- 2. In the event that Contractor fails to clean-up, Owner may elect to have clean-up performed by others, with the costs of such clean-up being charged to the Contractor.

C. Construction Aids

- 1. Definition: Construction Aids are facilities and equipment required by personnel to facilitate the execution of the Work. Construction Aids include scaffolds, staging,

ladders, platforms, hoists, cranes, lifts, trenchers, core drillers, protective equipment, and other such facilities and equipment.

2. Contractor shall provide all Construction Aids required in the execution of the Work. Construction Aids that are the property of Owner or other contractors shall not be used without permission.
3. Storage of Construction Aids shall be coordinated with Owner's on-site representative.

D. Safety

1. The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work.
2. Contractor shall comply with all local, state, and federal regulations and laws for the safety of the work place.

E. Accident Reports

1. Serious or fatal accidents shall be reported immediately by telephone or radio to the Owner's Project Manager.

F. Existing Conditions

1. Owner does not warrant the condition of any portion of the existing wiring, conduit or raceway systems. Prior to submitting his proposal, Contractor shall examine all existing conditions and determine to what extent the existing wiring, conduit, and raceway systems may be reused.
2. Contractor's proposal price shall include the cost of replacing existing wiring, conduit, and raceways as required.

1.11 SEQUENCING

A. Description

1. This implementation plan describes the general approach that shall be followed in order to minimize the time for the access control systems to be operational.

B. Approach

1. Contractor shall plan and schedule all work in such a sequence as to minimize the time before the system is operational. The following is a suggested work sequence:
 - a. Order all equipment needed and notify any subcontractors to schedule their participation.
 - b. Perform all system layout work.
 - c. Insure there are an adequate number of power receptacles available to operate all security equipment and coordinate with Owner as to where power is available.
 - d. Provide shop drawings to verify location of all equipment, conduit runs, power connections, etc. Submit shop drawings to Owner Project Manager.

- e. Coordinate with Owner to provide space in each building's Communications Room for mounting of processors.
- f. Provide training on how to fill out the programming sheets for access levels.
- g. Prepare and pre-test all equipment to the greatest extent possible.
- h. Install all equipment.
- i. Provide training on the programming other various options.
- j. Test and inspect all systems.
- k. Perform all other Work as required.
- l. Perform the Acceptance Test.
- m. Provide training.
- n. Provide as-built drawings.

1.12 SCHEDULING

- A. The Contractor, within five (5) days after being awarded the contract, shall prepare and submit for Owner's information, an estimated progress schedule for the Work. The progress schedule shall be related to the entire project, and shall indicate start and completion dates.

1.13 SYSTEM STARTUP

- A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

1.14 OWNER'S INSTRUCTIONS

- A. Coordination with Owner
 - 1. Contractor shall closely schedule and coordinate his activities with designated Owner representatives.
 - 2. Contractor shall provide Owner's Project Manager with a work plan on a weekly basis. Such work plan will describe locations of intended activities, types of activities, and potential conflicts to facility operations.
- B. Owner's Right to Carry Out The Work
 - 1. If the Contractor defaults or neglects to carry out the Work in accordance with the Project Drawings and Specifications and fails within seven days after receipt of written notice from Owner to commence and continue correction of such default or neglect with diligence and promptness, Owner may, after seven days following receipt of an additional

written notice and without prejudice to any other remedy Owner may have, make good such deficiencies. In such case, an appropriate Change Order shall be issued deducting from the payments then or thereafter due the Contractor the cost of correcting such deficiencies.

- C. Minor Changes in The Work
 - 1. Owner shall have the authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time and not inconsistent with the intent of the Project Drawing and Specifications. Such changes shall be provided by written order.

1.15 COMMISSIONING

- A. Manufacturer shall provide the opportunity to assist Contractor with commissioning.
- B. After all Work is completed, and prior to requesting the Acceptance test, Contractor shall conduct a final inspection, and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.
- C. Contractor shall submit a request for the Acceptance test in writing to the Owner Project Manager, no less than fourteen days prior to the requested test date. The request for Acceptance test shall be accompanied by a certification from Contractor that all Work is complete and has been pre-tested, and that all corrections have been made.
- D. During Acceptance test, Contractor shall demonstrate all equipment and system features to Owner. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by Owner.
- E. Any portions of the Work found to be deficient or not in compliance with the Project Drawing and Specifications will be rejected. Owner Project Manager will prepare a list of any such deficiencies observed during the Acceptance test. Contractor shall promptly correct all deficiencies. Upon correction of deficiencies, Contractor shall submit a request in writing to Owner Project Manager for another Acceptance Test.
- F. If, at the conclusion of the Acceptance Test, all Work is found to be acceptable and in compliance with the Project Drawings and Specifications, Owner Project Manager will issue a letter of Acceptance to Contractor and Owner.

1.16 MAINTENANCE

- A. Provide full procedures for all database back-ups.
- B. Provide full procedures for server/workstation hard drive maintenance, such as defrag, etc.
 - 1. Provide full procedures for maintaining physical and software firewalls.
 - 2. Provide full procedures for upgrading software.
- C. Provide full procedures for testing battery condition on all field panels for adequate back-up time.

- D. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

1.17 MANUFACTURERS

A. Qualification of the Manufacturer:

1. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 5 years and who shall be able to refer to similar installations now rendering satisfactory service.
2. Perform all work under the onsite supervision of a factory authorized, trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer's and owner approval. A CSR of the installing contractor or manufacturer shall train the owner's personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.
3. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and/or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.
4. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.
5. Manufacturer shall have local sales and technical support available. During the installation process, manufacturer shall be actively involved to assist with the installation. Upon completion of the installation, manufacturer shall provide an on-site review of the installation and provide the end-user training on an "as needed" basis.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

- A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.
- B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.
- C. This specification is intended to establish a carefully planned minimum level of quality and performance for all components and will be rigorously enforced by Owner. Acceptable manufacturers of components described herein.

- D. Products not listed as equals shall be submitted to BCL through the appropriate channels prior to the final RFI submission date.

2.2 MANUFACTURERS

- A. Basis of Design is Axis with equals by Panasonic or Hanwha.
- B. Must be compatible with Access Control Management System and Intrusion Detection system. Equipment supplier shall have a service organization that can respond to emergency service calls within 8 hours.
- C. All material and/or equipment necessary for proper operation of the system, not specified or described herein, shall be deemed part of these specifications.

2.3 GENERAL

- A. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
- B. All systems and components shall have been thoroughly tested and proven in actual use.
- C. All systems and components shall be provided with the availability of a toll-free (U.S. and Canada), 24-hour technical assistance program (TAP) from the manufacturer. The TAP shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.
- D. Cameras shall be IP-based and comply with established network and video standards.
- E. Cameras shall be powered by the switch utilizing the network cable.
- F. Cameras shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
- G. Cameras shall support secure boot.

2.4 VIDEO SURVEILLANCE SCHEDULE

- A. Camera types listed below describing various resolutions, form-factor and features shall be supplied by a single camera manufacturer video surveillance system.

2.5 4K OUTDOOR RUGGIDIZED CAMERA (EXTERIOR OF BUILDING)

- A. The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
- B. The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.

- C. The camera shall provide a removable IR-cut filter, providing day/night functionality.
- D. The camera shall be equipped with a varifocal lens with P-iris.
- E. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
- F. The camera shall be manufactured with an IP52-rated, IK08 impact-resistant, polycarbonate casing.
- G. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
- H. The camera shall provide options for clear and smoked lower dome.
- I. Illumination
 - 1. 0.19 lux F1.7 (color)
 - 2. 0.04 lux F1.7 (B/W)
 - 3. 0 lux with IR illumination on
- J. Resolution
 - 1. The camera shall be designed to provide video streams in (3840x2160) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.
 - 2. The camera shall provide up to 8 individually cropped out view areas.
 - 3. The camera shall support video resolutions including:
 - a. 3840x2160
 - b. 1920x1080 (HDTV 1080p)
 - c. 1280x720 (HDTV 720p)
 - 4. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).
- K. Encoding
 - 1. The camera shall support the following video encoding algorithms:
 - a. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second in all resolutions.
 - b. Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - c. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - d. Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second.
 - e. Support H.264 with automatic scene adaptive bitrate control in up to 25/30 frames per second.
 - 2. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
 - 3. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate speaks the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
 - 4. The camera shall provide configurable compression levels.
 - 5. Support standard baseline profile H.264 with motion estimation.

6. Support motion estimation in H.264/MPEG-4 Part 10/AVC.
 7. The camera shall for its H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- L. Transmission
1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)
 2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- M. Image
1. The camera shall incorporate Automatic and Manual White Balance.
 2. The camera shall incorporate an electronic shutter operating in the range of
 3. 1/62500 s to 2 s.
 4. The camera shall incorporate Wide Dynamic Range - Forensic Capture functionality providing up to 120 dB dynamic range.
 5. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
 6. The camera shall incorporate a function for optimization of low light behavior.
 7. The camera shall allow for rotation of the image in steps of 90°.
- N. IR Illumination
1. The camera shall be equipped with built-in IR LEDs
 2. The IR LEDs shall have a range of up to 30 m (100 ft)
 3. The IR LEDs shall emit light with a wavelength of 850 nm
- O. User Interface
1. Web server
 - a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
 2. Language Specification
 - a. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
 3. IP addresses
 - a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c. The camera shall provide support for both IPv4 and IPv6.

- P. PTZ functionality
 - 1. Provide Digital PTZ functionality.
 - 2. Provide preset position functionality

- Q. Event functionality
 - 1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Live Stream Accessed
 - c. Camera tampering
 - d. Manual Trigger/Virtual Inputs
 - e. PTZ functionality
 - f. Embedded third party applications
 - g. Edge storage disruption detection
 - 2. Response to triggers shall include:
 - a. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - b. Send images, using FTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d. Send SNMP trap message
 - e. Activating embedded illumination/IR LED
 - f. Recording to local storage and/or network attached storage
 - g. PTZ control functionality
 - 3. The camera shall provide memory for pre & post alarm recordings.

- R. Edge storage
 - 1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras SD-card slot
 - b. Network attached storage, located on the local network
 - 2. The camera shall be able to detect and notify Edge storage disruptions.

- S. Protocol
 - 1. The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour
 - 2. The SMTP implementation shall include support for SMTP authentication.

- T. Text overlay
 - 1. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - 2. Provide the ability to apply privacy masks to the image.
 - 3. Allow for the overlay of a graphical image, such as a logotype, into the image.

- U. Security
 - 1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 - 2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 - 3. The camera shall support IEEE 802.1X authentication.

4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
 5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.
- V. API support
1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
 2. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
 3. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
 4. For ONVIF profile specifications, see www.onvif.org/
- W. Embedded applications
1. The camera shall provide a platform allowing the upload of third party applications into the camera.
- X. Installation and maintenance
1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
 7. The camera shall provide Remote zoom and Remote focus functionality.
 8. Camera firmware shall be provided free of charge for the lifetime of the camera.
- Y. Access log
1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 2. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- Z. Camera diagnostics
1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 3. The camera shall send a notification when the unit has re-booted and all services are initialized.

- AA. Hardware interfaces
 - 1. Network interface
 - a. The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Fast Ethernet-port, using a standard RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 - 2. Enclosure
 - a. Be manufactured with an IP52-rated, IK08 impact-resistant, polycarbonate casing.
 - b. Be fitted with a dehumidifying membrane.
 - c. Provide encapsulated electronics and captive screws.

- BB. Power
 - 1. Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3
 - a. Max: 11.5 W
 - b. Typical: 8.6 W

- CC. Environmental
 - 1. Operate in a temperature range of 0 °C to 50 °C (32 °F to 122 °F).
 - 2. Operate in a humidity range of 10–85% RH (non-condensing).

- 2.6 5 MP VANDAL-RESISTANT MINI DOME FULL HIGH DEFINITION (FHD) NETWORK CAMERA (HALLWAYS AND CORRIDORS)
 - A. The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
 - B. The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.
 - C. The camera shall provide a removable IR-cut filter, providing day/night functionality.
 - D. The camera shall be equipped with a varifocal lens with P-iris.
 - E. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
 - F. The camera shall be manufactured with an IP52-rated, IK10 impact-resistant casing with polycarbonate hard coated dome.
 - G. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
 - H. The camera shall provide options for clear and smoked lower dome
 - I. Illumination
 - 1. 5MP 25/30 fps with WDR:
 - a. Color: 0.12 lux at 50 IRE, F1.5
 - b. B/W: 0.02 lux at 50 IRE, F1.5
 - c. 0 lux with IR illumination on
 - 2. 4MP 50/60 fps:
 - a. Color: 0.24 lux at 50 IRE, F1.5
 - b. B/W; 0.04 lux at 50 IRE, F1.5

- c. 0 lux with IR illumination on
- J. Resolution
- 1. The camera shall be designed to provide at least two video streams in 5 MP (3072x1728) at up to 30 frames per second (60 Hz mode) or 25 frames per second (50 Hz mode) using H.264 or Motion JPEG.
 - 2. The camera shall be designed to provide at least two video streams in 4 MP (2240x1680) at up to 60 frames per second (60 Hz mode) or 50 frames per second (50 Hz mode) using H.264 or Motion JPEG.
 - 3. The camera shall support video resolutions including:
 - a. 3072x1728
 - b. 2240x1680
 - c. 1920x1080 (HDTV 1080p)
 - d. 1280x720 (HDTV 720p)
- K. The camera shall provide up to 8 individually cropped out view areas.
- L. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).
- M. Encoding
- 1. The camera shall support the following video encoding algorithms:
 - 2. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second (3072x1728).
 - 3. Motion JPEG encoding in a selectable range from 1 up to 50/60 frames per second (2240x1680).
 - 4. Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second (3072x1728).
 - 5. Baseline Profile H.264 encoding with motion estimation in up to 50/60 frames per second (2240x1680).
 - 6. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second (3072x1728).
 - 7. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 50/60 frames per second (2240x1680).
 - 8. Support High Profile H.264 encoding with motion estimation up to 25/30 frames per second (3072x1728).
 - 9. Support High Profile H.264 encoding with motion estimation up to 50/60 frames per second (2240x1680).
 - 10. Support H.264 with automatic scene adaptive bitrate control.
 - 11. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
 - 12. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
 - 13. The camera shall provide configurable compression levels.
 - 14. The camera shall support standard baseline profile H.264 with motion estimation.
 - 15. The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
 - 16. The camera shall for its H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.

- N. Transmission
 - 1. The camera shall allow for video to be transported over:
 - 2. HTTP (Unicast)
 - 3. HTTPS (Unicast)
 - 4. RTP (Unicast & Multicast)
 - 5. RTP over RTSP (Unicast)
 - 6. RTP over RTSP over HTTP (Unicast)
 - 7. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.

- O. Image
 - 1. The camera shall incorporate Automatic and Manual White Balance.
 - 2. The camera shall incorporate an electronic shutter operating in the range of
 - 3. 1/71500 s to 2 s.
 - 4. The camera shall incorporate Wide Dynamic Range - Forensic Capture functionality providing up to 120 dB dynamic range.
 - 5. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
 - 6. The camera shall incorporate a function for optimization of low light behavior.
 - 7. The camera shall allow for rotation of the image in steps of 90°.
 - 8. The camera shall incorporate a function for Electronic Image Stabilization (EIS) for real-time image stabilization.
 - 9. The camera shall incorporate a function to manually correct barrel distortion, by using a slider to correct distortion in the image.

- P. Audio
 - 1. The camera shall support two-way full duplex audio:
 - 2. Input sources
 - a. External microphone
 - b. External line device
 - 3. Output sources
 - a. External line device

- Q. Encoding
 - 1. The camera shall support:
 - a. AAC LC 8/16/32/48 kHz
 - b. G.711 ADPCM 8kHz
 - c. G.726 ADPCM 8kHz
 - d. Opus 8/16/48 kHz

- R. IR Illumination
 - 1. The camera shall be equipped with built-in IR LEDs.
 - 2. The IR LEDs shall have a range of up to 40 m (130 ft)
 - 3. The IR LEDs shall emit light with a wavelength of 850 nm.

- S. User Interface
 - 1. Web server

- a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
 2. Language Specification
 - a. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
- T. IP addresses
1. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 2. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 3. The camera shall provide support for both IPv4 and IPv6.
- U. PTZ functionality
1. Provide Digital PTZ functionality
 2. Provide preset positions functionality
 3. Provide optical zoom
- V. Event functionality
1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Audio Detection
 - c. Live Stream Accessed
 - d. Camera tampering
 - e. Manual Trigger/Virtual Inputs
 - f. PTZ functionality
 - g. External input
 - h. Embedded third party applications
 - i. Edge storage disruption detection
 2. Response to triggers shall include:
 - a. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - b. Send images, using FTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d. Send SNMP trap message
 - e. Recording to local storage and/or network attached storage
 - f. Activating external output
 - g. Play audio clip
 - h. PTZ control functionality
 - i. WDR mode
 3. The camera shall provide memory for pre & post alarm recordings.
- W. Edge storage
1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras microSD-card slot
 - b. Network attached storage, located on the local network
 2. The camera shall incorporate encryption functionality for the SD card.

3. The camera shall be able to detect and notify Edge storage disruptions.
- X. Protocol
1. The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour, LLDP
 2. The SMTP implementation shall include support for SMTP authentication.
- Y. Text overlay
1. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 2. Provide the ability to apply privacy masks to the image.
 3. Allow for the overlay of a graphical image, such as a logotype, into the image.
- Z. Security
1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 3. The camera shall support IEEE 802.1X authentication.
 4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
 5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.
- AA. API support
1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
 2. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
 3. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
 4. For ONVIF profile specifications, see www.onvif.org/
- BB. Embedded applications
1. The camera shall provide a platform allowing the upload of third party applications into the camera.
- CC. Installation and maintenance
1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.

5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
7. The camera shall provide remote zoom and remote focus functionality.
8. The camera shall provide autorotation functionality.
9. The camera shall provide a software controlled function for power redundancy when both the RJ45 connector and the DC power connector are connected.

DD. Access log

1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
2. Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

EE. Camera diagnostics

1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
3. The camera shall send a notification when the unit has re-booted and all services are initialized.

FF. Hardware interfaces

1. Network interface
 - a. The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Fast Ethernet-port, using a standard RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
2. Inputs/Outputs
 - a. The camera shall be equipped with two configurable I/O ports, accessible via a removable terminal block. These inputs/outputs shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts. The output shall be able to provide 12 V DC, 50 mA.
3. Audio
 - a. The camera shall be equipped with one 3.5 mm jack for line/mic input and one 3.5 mm jack for line output.
4. Power
 - a. The camera shall be equipped with a removable terminal block providing connectivity for external power.

GG. Enclosure

1. Be manufactured with an IP52-rated, IK10 impact-resistant casing with polycarbonate hard coated dome.
2. Be fitted with a dehumidifying membrane.
3. Provide encapsulated electronics

HH. Power

1. Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3
2. Max: 12.9 W
3. Typical: 6.5 W
4. 8 – 28 V DC
5. Max: 14.5 W
6. 6.9 W

II. Environmental

1. Operate in a temperature range of -10 °C to 50 °C (14 °F to 122 °F).
2. Operate in a humidity range of 10–85% RH (non-condensing).

JJ. System Requirements and Network

1. The camera shall incorporate a built-in web server, such that the standard web browser Microsoft Windows Internet Explorer can be used to access the camera without need for special viewer software.
2. The following web browsers can also be used to access the camera with the plug-in free viewer: Firefox and Google Chrome. The plug-in free viewer enables the above browsers automatically when they are started. The plug-in free viewer display method will be selected automatically. ActiveX viewer can allow for H.264 (High/Main/Baseline Profile) video streams and JPEG format images on the Google Chrome.
3. The camera shall support the following network protocols: IPv4, IPv6, TCP, UDP, ARP, ICMP, IGMP*, HTTP, HTTPS, FTP (client only), SSL, SMTP, DHCP, DNS, NTP, RTP/RTCP, RTSP over TCP, RTSP over HTTP, and SNMP (v1, v2c, v3). Network security shall be via password (basic authentication) and IP filtering. *Source-Specific Multicast (SSM) shall be supported.
4. The camera shall have an FTP client capability which allows the following:
 - a. Transferring a JPEG image to a pre-specified FTP server when an alarm is triggered by either motion detection or camera tampering detection.
 - b. Periodically capturing a JPEG image and transferring it to the FTP server.
5. The camera shall support QoS technology using Differentiated Services Code Point (DSCP).
6. The camera shall be compliant with the Open Network Video Interface Forum Profile S (ONVIF Profile S) conformance.

KK. Interfaces:

1. The network interface shall be via an 8-pin RJ-45 connector, 10Base-T/100Base-TX Ethernet.
Both IPv6 and IPv4 are supported.
2. The camera shall have a 4-pin I/O interface located on the rear of the camera, that is accessible via a supplied cable.
There shall be an sensor input port, and an alarm/relay output port.
The alarm output port shall be the solid state relay output electrically isolated from the camera (semiconductor relay +/- 50 V, 0.4 A) .
3. The camera shall support 1 optically isolated sensor input.
The interface shall be via a supplied I/O 4-pin cable.
4. The camera shall have a built-in SD card slot for an on-board recording capability for movies and still pictures.
The maximum number of recording shall be up to 4,000.
The camera notify the specified SD card maintenance information.

SD card up to 256 GB shall be available.

(The maximum number of event recording in the SD card is 4000. It may not use the full capacity of the SD card, depending on the limitation set for the event recording.)

2.7 12 MP FIXED DOME WITH 180°/270°/360° PANORAMIC VIEW

- A. The camera shall operate on an open source and Linux-based platform and include a built-in web server.
- B. The camera shall be equipped with a progressive scan megapixel sensor.
- C. The camera shall provide a removable IR-cut filter, providing day/night functionality.
- D. The camera shall provide HDMI output to enable live streaming to an HDTV monitor.
- E. The camera shall be factory-focused, which removes the need for manual focusing.
- F. The camera shall be manufactured with a repaintable casing.
- G. The camera shall provide local video storage utilizing a microSD/microSDHC/microSDXC memory card expansion.
- H. The camera shall be manufactured with an IP66-, NEMA 250 4X-rated and IK-10 impact-resistant casing with polycarbonate and aluminum hard-coated dome.
- I. Illumination
 - 1. Color: 0.19 lux at 50 IRE F2.2
 - 2. B/W: 0.04 lux at 50 IRE F2.2
 - 3. 0 lux with IR illumination on
- J. Resolution
 - 1. The camera shall be designed to provide at multiple, individually configurable streams in H.264 and Motion JPEG.
 - 2. The camera shall support 360° overview, corridor and quad views. Up to four individually cropped out and de-warped view areas. The 360° overview can be streamed simultaneously with four view areas or one other de-warped view.
 - 3. The camera shall support video resolutions including:
 - a. Overview: 2992x2992 to 160x160
 - b. Quad view: 3584x2688 to 256x144
 - c. View area 1-4, 16:9: 2304x1296 to 256x144, 4:3: 2048x1536 to 320x240
 - d. Corridor: 2560x1920 to 256x144
 - 4. The camera shall provide both landscape format (4:3 and 16:9 aspect ratio) as well as corridor format (3:4 and 9:16 aspect ratio).
 - 5. The camera shall provide resolution up to 1920x1080 when connected via HDMI.
- K. Encoding
 - 1. The camera shall support the following video encoding algorithms:
 - a. Motion JPEG encoding with WDR in a selectable range from 1 up to 12.5/15 frames per second in 360° overview and de-warped views.

- b. Motion JPEG encoding without WDR in a selectable range from 1 up to 25/30 frames per second in 360° overview.
 - c. Baseline Profile H.264 encoding with motion estimation.
 - d. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC).
 - e. High Profile H.264 encoding with motion estimation.
 2. The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
 3. The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate speaks the camera shall support Maximum Bit Rate (MBR).
 4. The camera shall provide configurable compression levels.
 5. The camera shall support standard baseline profile H.264 with motion estimation.
 6. The camera shall support motion estimation in H.264/MPEG-4 Part 10/AVC.
 7. The camera shall for its H.264 implementation support scene adaptive bitrate control with automatic dynamic ROI to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements.
- L. Transmission
 1. The camera shall allow for video to be transported over:
 - a. HTTP (Unicast)
 - b. HTTPS (Unicast)
 - c. RTP (Unicast & Multicast)
 - d. RTP over RTSP (Unicast)
 - e. RTP over RTSP over HTTP (Unicast)
 - f. SRTP (Unicast & Multicast)
 2. The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
- M. Image
 1. The camera shall incorporate automatic and manual white balance.
 2. The camera shall incorporate an electronic shutter operating in the range of 1/22500 s to 2 s.
 3. The camera shall incorporate forensic wide dynamic range functionality, providing up to 120 dB dynamic range.
 4. The camera shall support manually defined values for:
 - a. Color level
 - b. Brightness
 - c. Sharpness
 - d. Contrast
 5. The camera shall allow for rotation of the image.
- N. IR Illumination
 1. The camera shall be equipped with built-in IR LEDs.
 2. The IR LEDs shall have a range of up to 15 m (50 ft)
 3. The IR LEDs shall emit light with a wavelength of 850 nm.
- O. User Interface
 1. Web server
 - a. The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.

- b. Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
 2. Language Specification
 - a. The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
 3. IP addresses
 - a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature.
 - c. The camera shall provide support for both IPv4 and IPv6.
- P. PTZ functionality
 1. Provide digital PTZ functionality of view areas.
 2. Provide preset positions functionality.
 3. Provide digital pan and tilt of corner, corridor and quad views.
 4. Provide a guard tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.
- Q. Event functionality
 1. The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a. Video Motion Detection
 - b. Camera tampering
 - c. Manual Trigger/Virtual Inputs
 - d. PTZ functionality
 - e. Embedded third party applications
 - f. Edge storage fail-over recording detection
 2. Response to triggers shall include event actions:
 - a. Send notification, using HTTP, HTTPS, TCP, SNMP trap or email
 - b. Send images, using FTP, SFTP, HTTP, HTTPS, network share or email
 - c. Send video clip, using FTP, SFTP, HTTP, HTTPS, network share or email
 - d. Send SNMP trap message
 - e. Recording to local storage and/or network attached storage
 - f. Activate external output
 - g. PTZ control functionality
 - h. WDR mode
 - i. Day and night mode
 3. The camera shall provide memory for pre & post alarm recordings.
- R. Edge storage
 1. The camera shall support continuous and event controlled recording to:
 - a. Local memory added to the cameras microSD-card slot
 - b. Network attached storage, located on the local network
 2. The camera shall incorporate encryption functionality for the SD card.
 3. The camera shall be able to detect and notify edge storage disruptions.
- S. Protocol
 1. The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMP v1/v2c/v3

- (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SRTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, LLDP, HDMI 1.4.
2. The SMTP implementation shall include support for SMTP authentication.
- T. Text overlay
1. Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 2. Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds.
 3. Provide the ability to manually set up and configure privacy masks to the image.
 4. Allow for the overlay of a graphical image, such as a logotype, into the image.
- U. Security
1. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
 2. The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
 3. The camera shall support IEEE 802.1X authentication.
 4. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
 5. The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.
- V. API support
1. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
 2. The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.
 3. The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.
 4. For ONVIF profile specifications, see www.onvif.org/
- W. Embedded applications
1. The camera shall provide a platform allowing the upload of third party applications into the camera.
- X. Installation and maintenance
1. The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 2. The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 3. The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 4. The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 5. The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 6. The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.

- Y. Access log
 - 1. The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 - 2. The camera shall provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.

- Z. Camera diagnostics
 - 1. The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 - 2. The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 - 3. The camera shall send a notification when the unit has re-booted and all services are initialized.

- AA. Hardware interfaces
 - 1. Network interface
 - a. The camera shall be equipped with one 10BASE-T/100BASE-TX Fast Ethernet-port using a RJ45 connector, and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 - 2. Inputs/Outputs
 - a. The camera shall be equipped with one supervised (alarm) input and one digital output, accessible via a removable terminal block. This input shall be configurable to respond to normally open (NO) or normally closed (NC) dry contacts. The output shall be able to provide 12 V DC, 25 mA.
 - 3. Video
 - a. The camera shall be equipped with HDMI Type D for video and audio output.

- BB. Enclosure
 - 1. Be manufactured with an IP66, NEMA 4X and IK10 impact-resistant casing in polycarbonate and aluminum.
 - 2. Be fitted with a dehumidifying membrane.

- CC. Power
 - 1. The camera shall provide power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3
 - 2. Max: 12.95 W
 - 3. Typical: 7.8 W

- DD. Environmental
 - 1. Operate in a temperature range of -40 °C to 50 °C (-40 °F to 122 °F)
 - 2. Operate in a maximum temperature (intermittent) of 55 °C (131 °F)
 - 3. Operate in a humidity range of 10–100% RH (condensing).

2.8 INTELLIGENT VIDEO ANALYTICS

- A. The camera shall have a unique conventional intelligent video analytics named Distributed Enhanced Processing Architecture Advanced (DEPA Advanced) to trigger an alarm based on user-defined rules.
- B. The camera shall incorporate a built-in unique Intelligent Motion Detection (IMD) capability. To minimize false triggers, this Intelligent Motion Detection shall compare the current image with prior 15 frames within the camera. This algorithm shall allow the camera to discriminate against some environmental noise such as shaking leaves or Auto Gain Control maximum rate noise.
- C. The camera shall have a camera tampering detection function that alerts the operator if the camera is tampered with. Tampering can include spraying of the camera lens, covering it with a cloth, or changing of the mounting direction.
- D. The camera shall have the following scene analytics, all of which can be set from the camera setup menu:
 - 1. Intrusion: When a moving object enters the designated area, an alarm is triggered.
 - 2. Passing: A passage line is determined, and when a moving object passes the set line, an alarm is triggered.

2.9 MOUNTING

- A. Surface – Wall. Unit shall mount on surface of wall to either a recessed electrical outlet box or directly on the wall surface as indicated on the drawings.
- B. Surface - Ceiling. Unit shall mount on surface of ceiling to either an electrical outlet box or directly on the ceiling surface as indicated on the drawings.
- C. Recessed – Ceiling. Unit shall mount recessed in an accessible ceiling via the use of ceiling grid support hardware or shall be recessed directly into a fixed ceiling system with appropriate hardware.

PART 3 - EXECUTION

3.1 CONTRACTOR/OWNER COMMUNICATIONS

- A. Contractor shall obtain the following programming information from the Owner:
 - 1. The labeling scheme for the cameras
 - a. Ex: (Building Name-CC-Camera #-Brief Location) Sunbeam-CC-001-RM150EXT
 - 2. The IP address range to be used for cameras
 - 3. Specific users/passwords to be used when setting up the system for administration/administrators
 - 4. Schedules to be created/maintained for motion detection and/or camera recording

5. Whether or not exterior cameras shall be surge protected at the camera in the interior building, or in a rack mounted surge protection device for multiple cameras in each TR tied to the grounding bar.

3.2 GENERAL INSTALLATION

- A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.
- B. Refer to plans for locations and quantities of equipment. Equipment locations shown on plans will be required to be field coordinated to ensure proper system operation. The contractor shall provide adequate costs in the bid to locate interior cameras within 10' in any direction of the location indicated on the bid drawings. Exact location of each camera shall be coordinated with the owner in the field prior to installation. This coordination shall include a site survey with the owner in which the use of a field of view comparator is employed.
- C. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system. Camera placement shall be coordinated with glass and exterior exposures to reduce or eliminate the requirement for severe back light compensation.
- D. Perform all work under the on-site supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer's and owner approval. A CSR of the installing contractor or manufacturer shall train the owner's personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.
- E. Camera Mounts: The Contractor shall install the camera mounts as specified by the manufacturer and as shown; provide mounting hardware sized appropriately to secure the mount, camera and housing, provide electrical and signal transmission cabling to the mount location as specified.
- F. Cameras: The Contractor shall install the cameras with power and signal lines to the camera; aim camera to give field of view as needed to cover the alarm zone and synchronize all cameras so the picture does not roll on the monitor when cameras are selected.
 1. Provide a change of all camera lenses up/down/size and re-aiming of each camera as directed by the Owner.
- G. Delivery of all loose equipment which is to be turned over to owner shall be carefully coordinated and scheduled with owner prior to shipment

3.3 CYBER SECURITY PROTECTION

- A. All cameras shall have the latest firmware installed.
- B. Reset to factory default settings

- C. Set the root password
 - 1. Make sure to use a strong password and keep it protected. On a multi-camera installation, the cameras can have the same password or unique passwords. Using the same password simplifies management but increases the risk if one camera's security is compromised.
 - 2. When setting the initial password, the password is sent in clear text over the network. If there is a risk of network sniffing, first set up a secure an encrypted HTTPS connection before resetting the passwords.
 - 3. Use a password with at least 8 characters, preferably using a password generator.
- D. Set user permissions
- E. Configure basic network settings Set time and date
- F. Disable audio
- G. Enable encryption
 - 1. Access the camera using HTTPS, which encrypts the traffic between the client and the camera. All camera administrative tasks should go through HTTPS. Video streamed over RTP/RTSP is still unencrypted. If the video stream contains sensitive data, tunnel RTP/RTSP over HTTPS. This is controlled by (and depends on) the video client/VMS capabilities.
 - 2. A self-signed certificate is adequate for providing encryption, but the web browser will warn that the certificate cannot be validated. A CA-signed certificate is needed for the client to authenticate that it is accessing the correct camera.
 - 3. Enable HTTPS users with administration rights should encrypt traffic between the clients and the camera. This requires that the client supports HTTPS.
- H. Create a backup admin account
 - 1. Create a backup administrator account with a different password than the primary administrator account.
- I. Create video client account
 - 1. A client or a Video Management System (VMS) should normally use the operator group with restricted administrator privileges. Video systems and clients should not use the administrator account. In most cases the operator group is sufficient. However, the VMS may use services that require administrator rights.
- J. Disable AVHS
 - 1. If the camera is not connected to a hosted video service, disable AVHS.
- K. Disable discovery services
 - 1. Discovery protocols are support services that make it easier to find the cameras on the network. After deployment, you should stop the cameras from announcing their presence on the network by disabling the discovery protocol.
- L. Configure advanced network settings
 - 1. Select Use the following DNS server address and specify the following:
 - 2. Enter the domain(s) to search for the host name used by the product. Multiple domains can be separated by semicolons. The host name is always the first part of a fully qualified domain name, for example, myserver is the host name in the fully qualified domain name myserver.mycompany.com where mycompany.com is the domain name.

3. Enter the IP addresses of the primary and secondary DNS servers. The secondary DNS server is optional and is used if the primary is unavailable.
 - M. Disable SOCKS
 1. If the network is not using SOCKS, disable it in the network camera as well.
 - N. Disable QoS
 1. If Quality of Services is not being used, QoS should be disabled.
 - O. Disable always multicast video
 1. To prevent the camera from multicasting video by default, disable multicast video streaming. The camera can still multicast video upon request.
 - P. Disable SSH
 - Q. Set IP address filter
 1. video clients access live and recorded video only through the VMS, they should not be allowed to access any video directly through the cameras.
 2. Enabling IP filtering for authorized clients will prevent the camera from responding to network traffic from any other clients. Make sure to add all authorized clients (VMS server and administrative clients) to the white list.
 - R. Access to IEEE 802.1x network
 1. To be accepted in a network protected by IEEE 802.1x, the cameras need to have appropriate certificates and settings.
 - S. Configure SNMP monitoring
 - T. Remote system log
- 3.4 WIRING INSTALLATION
- A. CCTV wiring shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all Local, State and National codes. This contract shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.
 - B. Provide firestop material and seal all cable penetrations in the building.
 - C. All wiring between devices shall be run open wired above accessible ceilings. Where existing cable management systems are in place and there is adequate capacity to install the CCTV wiring, the contractor may utilize these pathways providing they have coordinated with all other wiring contractor on site. Where multiple runs are required all cables shall be bundled with approved cable ties on four foot centers.
 - D. Where pathways do not exist for SMS wiring, this contract shall be responsible for providing all required cable management systems such as J-hooks to support communications cabling to meet building codes and manufacturer's recommendations.

- E. Cables shall not be laid upon ceilings or supported in a manner that would violate any codes or standards.
- F. All cabling installed in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.
- G. All control and signal cable shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

3.5 TELECOMMUNICATIONS ROOMS

- A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.
- B. Coordinate lay-out of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.
- C. Coordinate lay-out of telecom rooms with electrical plans and locations of electrical outlets.
- D. Lay-out of telecommunications equipment cabinets and racks shall provide a minimum of 36" aisle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.
- E. Coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as UPS units may have special mounting requirements that need additional coordination.

3.6 GROUNDING

- A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.
- B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.
- C. The Division 16 Contractor has provided 120V branch circuitry for use by the CCTV system contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the CCTV system equipment. In no case shall the CCTV system installation compromise the integrity of the Building Electrical Grounding System.

3.7 PROGRAMMING

- A. It is the Contractor's responsibility to program the system in this section according to the Owner's wishes. This involves camera labeling, camera operation sequences, camera and recorder schedules, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.
- B. Each building shall have the following minimum programming:
 - 1. Camera labels programmed in NVR.
 - 2. Camera record rates based upon TOD schedules, alarm events, motion events.
 - 3. Camera motion detection recording based upon TOD schedules. Motion detection scene masking.
 - 4. PTZ cameras – Home position, tours, alarm pre-sets.
- C. Additional programming at each building shall include set-up of graphical floor plans with interactive camera icons for all cameras local to that building. Owner NOC shall include set-up of graphical floor plans with interactive camera icons for all sites.
- D. Set-up of passwords and a minimum of four (4) user access levels including assignment of specific privileges for each user access level.

3.8 IDENTIFICATION/LABELING

- A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.
- B. The contractor shall be responsible for generating and programming the labeling for camera information within the recorder software.
- C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.9 TESTS

- A. System Startup
 - 1. The Contractor shall not apply power to the CCTV system until the following items have been completed:
 - a. CCTV system equipment items and circuitry have been set up in accordance with manufacturer's instructions.

- b. A visual inspection of the CCTV system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
 - c. System wiring has been tested and verified as correctly connected as indicated.
 - d. All system grounding and transient protection systems have been verified as properly installed and connected as indicated.
 - e. Power supplies to be connected to the CCTV system have been verified as the correct voltage, phasing, and frequency as indicated.
2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work/equipment.

3.10 SITE TESTING

- A. General: The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification. Original copies of all data produced during performance verification shall be turned over to the Owner at the conclusion of testing prior to final approval.
 1. Contractor's Field Testing: The Contractor shall calibrate and test all equipment, verify operation, place the integrated system in service, and test the integrated system. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure. In addition, the Contractor shall make a master video tape recording showing typical day and night views of each camera in the system and shall deliver the tape with the report. Note any objects in the field of view that might produce high-lights that could cause camera blinding. Note any objects in the field of view or anomalies which may cause blind spots. Note if a camera cannot be aimed to cover the zone. Note night assessment capabilities and whether lights or vehicle headlights cause blooming or picture degradation. If any of the above conditions or other conditions exist that cause picture degradation or interfere with the camera field of view, the Contractor shall inform the Architect. The tape shall be recorded using the video recorder installed as part of the CCTV system. The Contractor shall provide the Owner with the original tape as part of the documentation of the system and shall submit a letter certifying that the CCTV system is ready for performance verification testing. The field testing shall as a minimum include:
 - a. Verification that the video transmission system and any signal or control cabling have been installed, tested, and approved.
 - b. Verification that the multiplexer is fully functional and that the multiplexer has been programmed as needed for the site configuration.
 - c. Verification that all video sources and video outputs provide a full bandwidth signal that complies with EIA 170 at all video inputs.
 - d. Verification that all video signals are terminated properly.
 - e. Verification that all cameras are synchronized and that the picture does not roll when cameras are switched.

2. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.
3. Performance Verification Test: The Contractor shall demonstrate that the completed CCTV system complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test as specified, shall not be started until receipt by the Contractor of written permission from the Owner, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. The Owner may terminate testing at any time when the system fails to perform as specified.

3.11 TRAINING REQUIREMENTS

- A. Provide the owner with a minimum of 24 hours of training designed to make all users familiar with the operation of the system.
 1. The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the CCTV system as specified. The training shall be oriented to the specific system being installed under this contract. Training manuals shall be delivered for each trainee with two additional manuals delivered for archiving at the project site. The Contractor is responsible for furnishing all audio-visual equipment and all other training materials and supplies. A training day is 8 hours of instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the facility. Approval of the planned training schedule shall be obtained from the Owner at least 14 days prior to the training.
 2. The course shall be taught at the project site for one full day during or after the Contractor's field testing. No part of the training given during this course will be counted toward completion of the performance verification test. The course shall consist of instruction, hands-on training, instruction on the specific hardware configuration of the installed system, and specific instructions for operating the installed system. The course shall demonstrate system start up, system operation, system shutdown, system recovery after a failure, the specific hardware configuration, and operation of the system and its software. The students should have no unanswered questions regarding operation of the installed CCTV system. The Contractor shall prepare and insert additional training material in the training manuals when the need for additional material becomes apparent during instruction. The course shall include:
 - a. General: CCTV hardware, installed system architecture and configuration.
 - b. Functional operation of the installed system and software.
 - c. Operator commands.
 - d. Fault diagnostics and correction.
 - e. General system maintenance.

- f. Replacement of failed components and integration of replacement components into the operating CCTV system.
- 3. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.
 - B. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.
 - C. Demonstrate adjustment, operation and maintenance of the system including each component and control.
 - D. This training period shall be scheduled with the Owner after the successful completion of the system.

3.12 AS BUILT DOCUMENTATION

- A. Copies of all approved shop drawings with the Engineer's stamp.
- B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of owner's manuals must contain the proper software viewers for each document type.
 - a. Interior Camera assembly including housing and lens
 - b. Exterior Camera Assembly including housing and lens.
 - c. Each type of camera power supply
 - d. Camera recorder
 - e. Racks/Cabinets
 - f. System Software.
- C. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.
- D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.
- E. Rack elevations for all systems with rack mounted equipment.
- F. System Operating Instructions: Provide a clear and concise description of preparation which gives, in detail, the information required to properly operate the equipment and system.
- G. Provide statement of warranty.

3.13 WARRANTY

- A. This Contractor shall warrant all workmanship, equipment and material provided under this contract for a period of three (3) years from the date of approval of certificate of contract completion by the Owner. If any defects are found within the warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor. Provide statement of warranty with the O&M manuals.
- B. During the first year's warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:
 - a. Visual checks and operational test of the multiplexer, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.
 - b. Correct all diagnosed problems.
 - c. Resolve any previous outstanding problems.
- C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- D. The Contractor shall be responsible to provide service during normal working hours within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system component operation, or the loss of the video switcher or other head-end equipment. Provide an on-site authorized factory technician within 24 hours if required.
- E. If equipment cannot be repaired within 24 hours of service visit, Contractor shall provide "loaner" equipment to the Owner at no charge.

3.14 CERTIFICATION

- A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification

END OF SECTION 282100

SECTION 282300 - VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. These Specifications contained herein describe specific functional requirements of the CCTV system. It is not the intent of these specifications to detail and describe the exact performance of the system. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.
- B. Video Recording - Equipment and software to receive, store and archive the network video from all cameras as indicated on the drawings and as specified hereinfor **30 DAYS AT 7-10FPS (RECORDING RATE SHALL BE CONFIRMED WITH OWNER PRIOR TO SIZING THE NVR)**
- C. Video Management - Equipment and software to process video from all cameras and provide control/distribution as required for storage, archive, preview, and live monitoring of all video files and streams.
- D. Video Clients – Equipment including software and workstations to provide direct, real- time, GUI based access to live and recorded video.
- E. Video Monitoring – Equipment including decoders, workstations, transmission, and displays to provide real-time access to live and processed video as indicated on the drawings and as specified herein.
- F. Network Electronics – Provided under section 272100.
- G. Network Camera Cabling – Provided under section 271513
- H. Floor standing enclosed rack with locking front and rear doors to house the head end equipment. Rack shall be located per plans and as coordinated with other contractors.
- I. Integrated Video Surveillance System

1.3 QUALITY ASSURANCE

- A. National Fire Protection Association.

- B. National Electric Code.
- C. American with Disabilities Act.
- D. Underwriter’s Laboratory.
- E. FCC Class B.
- F. NEMA Type 4AX.
- G. NEMA Type 1.
- H. NTSC/EIA.
- I. ISO/IEC 14496-2 MPEG-4, MPEG-H Part 2.
- J. H.264, H.265.
- K. FCC CFR 47 Part 15 Class A – Telecommunications – Radio Frequency Devices – Digital Device Emission
- L. UL 60950-1 Information Technology Equipment – Safety.
- M. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and 11th Edition (or later).
- N. BICSI Telecommunications Distribution Methods Manual (TDMM) 13th Edition or later.
- O. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75 mile radius now rendering satisfactory service.
- P. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and /or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.
- Q. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years’ experience in the manufacture of progressive products specified.
- R. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.
- S. Licensing shall be required for the VMS software. The licensing shall include:
 - 1. A software serial number shall be associated with the software and will support the pre-defined license configuration for the VMS model number. At any time, additional add-on features and SSA can be purchased for the VMS software license. Some features are natively supported while others may require installation of version-compatible driver software to support the optional add-on licensed feature. VMS shall allow ability to

promote multiple standalone VMS sites to Satellite Application Server hosts for an Enterprise deployment if a VMS Master Application Server host exists at the site. VMS shall support ability to easily consolidate and manage a pool of licenses centrally for multiple Recorders. This shall provide maximum flexibility for on premise license management with the ability to move licenses between one or more recorders.

2. Metered number of licensed clients, agents, and/or web clients shall be easily increased, and the license version can easily be updated. The online registration shall auto-generate the updated license for the applicable server and email the file.
3. Number of centralized IP cameras, Video Analytics, Facial Recognition, Facial Verification and/or License Plate Recognition licenses can be easily increased, and the license version can easily be updated. The online registration shall enable transferring of individual recorder licenses to consolidate them into a single pool of licenses managed and it will auto-generate and email the updated license file.
4. SSA expiration warning message shall be notified in reports and displayed in the License Manager. In addition, the associated recorders will take on the same SSA date as their assigned Centralized Application Server.
5. The detailed license status shall be easily accessible and clearly stated in the VMS software.
6. Major software releases for the VMS will require an updated compatible license file. An automated online registration shall be available from the manufacturer to support generation of new or update licenses upon demand, and delivered electronically via email.

1.4 DEFINITIONS

- A. Industry standard words and phrases are used throughout the Drawings and Specifications, except:
 1. Words which have well-known technical or trade meanings are used in accordance with such recognized meanings.
 2. Whenever the following listed words and phrases are used, they shall be mutually understood to have the following respective meanings:
- B. The words “as indicated.” means: as shown on the Drawings, and in accordance with the Specifications.
- C. The words “as required.” means: as required to provide a complete and satisfactory Work in full conformance with the Drawings and Specifications.
- D. The word “New” means: new Work to be provided by Contractor.
- E. The word “Provide” means: furnish, install, connect, test and make ready for use.
- F. The words “Relocate existing” means: remove existing item from present location. Reinstall, re-connect, and test existing item and make ready for use at new location as shown on the Drawings.
- G. The words “Remove existing “means: remove existing item and return item to Owner.

- H. The word “Replace” means: remove existing item and return item to Owner. Provide new item as indicated.
- I. The word “Work”: The Work is the completed construction required by the Drawings and Specifications, and includes all labor necessary to produce such construction, and all materials and equipment incorporated or to be incorporated in such construction.
- J. The word “Furnish” means: supply item as specified. Item to be installed by others.

1.5 QUALIFICATIONS

- A. Manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, material and services specified for this project for commercial, military or industrial use.
- B. Qualifications of Contractor
 - 1. Contractor shall be an installation and service contractor regularly engaged in the sale, installation, maintenance and service of Video Management systems.
 - 2. Contractor shall have three years’ experience with the installation, start-up and programming of systems of a similar size and complexity to the one proposed.
 - 3. Contractor shall be a factory authorized dealer of the system proposed for at least two years.
 - 4. Contractor shall provide factory certified technicians to perform the installation of all intelligent controller components in this project. Evidence of the certification shall be in writing from the manufacturer and shall be on the technician’s person at all times while on site.
- C. Supervision of Work
 - 1. Contractor shall employ a competent Foreman to be in responsible charge of the Work. Foreman shall be on the project site daily during the execution of the Work.
 - 2. Contractor's Foreman shall be a regular employee, principle, or officer of Contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.
- D. Qualifications of Technicians
 - 1. All electronic systems Work shall be performed by electronic technicians thoroughly trained in the installation and service of specialty low-voltage electronic systems.
 - 2. Electrician electrical workers may be used to install conduit, raceways, wiring, and the like, provided that final termination, hook-up, programming, and testing is performed by a qualified electronic technician, and that all such Work is supervised by the Contractor's Foreman.
 - 3. All incidental Work, such as cutting and patching, lock hardware installation, painting, carpentry, and the like, shall be accomplished by skilled craftsperson regularly engaged in such type of work. All such Work shall comply with the highest standards applicable to that respective industry or craft.
 - 4. All 120 VAC power wiring and connections are to be performed by a qualified Electrician, licensed to perform such Work in the Owner.

E. Subcontractors

1. Definition: A Subcontractor is a person or entity who has a direct contract with the Contractor to perform any of the Work at the site.
2. Use of any Subcontractor is subject to the approval of Owner. The Contractor shall identify all Subcontractors on the Bid Form. The Contractor shall make no substitution for any Subcontractor previously selected without approval from Owner.
3. Contractor's Foreman shall be on the project site daily during all periods when Subcontractors are performing any of the Work. Contractor's Foreman shall be in responsible charge of all Work, including any Work being performed by Subcontractors.
4. By an appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by the terms of the Drawings and Specifications, and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these documents, assumes toward Owner.

F. Supervision and Construction Procedures

1. The Contractor shall supervise and direct the Work, using his best skill and attention. Contractor is solely responsible for all construction means, methods, and techniques.
2. The Contractor shall employ a competent foreman who shall be in attendance at the project site during the progress of the Work. The foreman shall represent the Contractor and all communications given to the foreman shall be as binding as if given to the Contractor.

G. Regulatory Requirements

1. All Work is to conform to all building, fire, and electrical codes and ordinances applicable in the Owner. In case of conflict between the Drawings/Specifications and codes, the codes shall govern. Notify Owner Project Manager of any such conflicts.
2. Contractor shall secure and pay for all licenses, permits, plan reviews, engineering certifications, and inspections required by regulatory agencies. Contractor shall prepare, at Contractor's expense, any documents, including drawings that may be required by regulatory agencies.

H. Permits

1. The Contractor shall make application for and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

I. The Project Drawings represent the level of system design to be provided by Owner. Contractor shall provide all additional system design work required, including:

1. Conduit layout and sizing.
2. Wire and cable layout and sizing.
3. Point-to-point wiring and equipment hook-up information.
4. Equipment mounting details.
5. Design of equipment cabinets.
6. Other detailed design work required.

- J. Contractor's design shall conform to all applicable codes and ordinances. All electrical design, including the sizing and placement of conduit, raceways and conductors, shall be in accordance with NFPA 70: National Electrical Code, current version, unless local codes establish more stringent requirements.
- K. Contractor's design work is subject to review and approval by Owner's Project Manager.
- L. Contractor's design shall also include:
 - 1. The addition of all wire, cable, conduit, connectors and junction boxes required for system operation.
 - 2. The installation of conduit between the control components and all equipment at each door, as necessary.
 - 3. Completed "as-built" documentation of all security systems, including documentation of existing equipment, wiring, conduits, and raceways.
 - 4. Other Work as defined within the Project Drawings and Specifications.
- M. The contractor/subcontractor is required to answer all warranty and Service calls within 4 hours of the initial customer contact and provide an authorized technician onsite within 24 hours.
 - 1. Proper identification is required and must be visible while onsite for warranty/service calls. Notification of completion must be provided to authorized personnel onsite before departing facility.
 - 2. Consult and coordinate with all trades providing adjoining work and make an Adjustment or relocation necessary to accommodate other equipment or to maintain proper function of existing equipment without claims for additional payment.
- N. These Specifications contained herein describe specific functional requirements of the SMS as required by the owner. It is the intent of these specifications to detail and describe the exact performance of the system. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

1.6 WARRANTY

- A. Provide a one (1) year full warranty of the system, including equipment, wiring and software against defects in material and workmanship from the date of system completion and acceptance. If any defects are found within the warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor.
- B. During the first year's warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:
 - 1. Visual checks and operational test of the multiplexer, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.
 - 2. Correct all diagnosed problems.
 - 3. Resolve any previous outstanding problems.

- C. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.
- D. Contractor shall provide a parts and labor guarantee on all Work. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.
- E. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by Owner, or acts of god.
- F. Contractor shall promptly respond to Owner's requests for service during the guarantee period. Contractor shall provide repair service as soon as reasonably possible upon request from Owner, but in no case shall service response exceed 8 hours from time of request.
- G. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- H. The Contractor shall be responsible to provide service during normal working hours within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system component operation, or the loss of the video switcher or other head-end equipment. Provide an on-site authorized factory technician within 24 hours if required.
- I. If equipment cannot be repaired within 24 hours of service visit, Contractor shall provide "loaner" equipment to the Owner at no charge.
- J. Software:
 - 1. Manufacturer's software warranty must be described in the manufacturer's EULA for the product.
 - 2. Provide free access to any software service updates or hot fixes released due to a material defect or error in the product.
 - 3. Provide new device driver packs, multiple times per year, to extend support for additional devices without the need for a new version of the product.
 - 4. Provide free access to self-paced interactive e-training.
 - 5. Software Updates and Upgrades:
 - a. Make software upgrades available for a period of one year from activation of the software license. Coverage options shall include:
 - 1) Free access to any new product versions for the purchased VMS software product.
 - 2) 100% credit on owners current VMS software products when upgrading to a more advanced VMS product.
 - 3) Case Management online tool for submitting and tracking technical cases.
 - 4) Direct Access to technical support via e-mail and phone.
 - 5) Prioritized handling of support phone call response times based upon criticality of issue, for questions submitted by email or that cannot be answered in initial phone call.
 - 6) Additional years of software upgrades available for purchase separately.

1.7 SUBMITTALS

- A. Product Data: Complete product data and technical specification data sheets that include manufacturer's data for all material and equipment.
- B. Procedures
 - 1. Provide submittals to Owner's Project Manager.
 - 2. Submit electronic copy of each submittal.
- C. Shop Drawings
 - 1. Shop Drawings and Schematics: Shall depict the VMS in final proposed "as built" configuration. The following must be provided:
 - 2. Connection diagrams for interfacing equipment.
 - 3. List of connected equipment.
 - 4. Locations for all major equipment components to be installed under this specification.
- D. Manufacturers Installation and Programming Instructions
 - 1. Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.
- E. Project Record Drawings
 - 1. Definition: Project Record Drawings are drawings that completely record and document all aspects and features of the Work. (Also known as "as-built" drawings.)
 - 2. The purpose of Project Record Drawings is to provide information regarding all aspects of the Work, to enable future service, modifications, and additions to the Work.
 - 3. Project Record Drawings are an important element of this Work. Contractor shall accurately maintain Project Record Drawings throughout the course of this project. Project Record Drawings shall include documentation of all Work, including the documentation of existing equipment, wiring, conduits, and raceways that are to be reused in the Work.
 - 4. Owner Project Manager shall furnish Contractor with two (2) sets of site plans for Contractor's use in preparing Project Record Drawings. One set shall be used as a working set, the other shall be used to prepare the final record set.
 - 5. Contractor shall maintain the working set of Project Record Drawings at the project site throughout the course of the Work. The working set shall be updated daily as the Work progresses.
 - 6. Project Record Drawings shall accurately show the physical placement of the following:
 - a. Equipment and devices.
 - b. Conduit and raceways.
 - c. Junction and pull box locations.
 - d. End-of-line resistor locations.
 - e. Interfaces to external equipment.
 - f. Connections to power and telephone circuits.
- F. Project Record Drawings shall show the physical placement of each device and conduit or aerial center line, to be accurate to within one foot (1') of the nearest landmark. Where the site plan furnished by Owner's Project Manager conflicts with actual conditions, Contractor shall amend

site plan as required. Indicate exact description of conduit runs (above ground, two-foot trench, along outside wall of building, etc.).

- G. Project Record Drawings shall show wire and cable runs, zone numbers, tamper circuit configuration, panel/circuit breaker numbers from which equipment is powered, and splice points. Such information may be shown on the site plans.
- H. Upon completion of Work, and prior to Final Acceptance, Contractor shall prepare and submit to Owner's Project Manager a final record set of Project Record Drawings. This set shall consist of all data transferred from the working set, supplemented by Riser Diagrams and other information. The final record set of Project Record Drawings shall be drafted by a skilled draftsman, under the supervision of Contractor. All final Project Record Drawings shall be provided to Owner.
- I. System Documentation
 - 1. Definition: System Documentation is a complete collection of all installation, programming, operation, and maintenance manuals and work sheets relating to the equipment provided as part of the Work.
 - 2. Contractor shall maintain a file of System Documentation at the project site throughout the course of the Work. Such file shall be updated with new information as equipment is received and installed. System Documentation shall be available for inspection by Owner Project Manager daily.
 - 3. Upon completion of Work, and prior to final Acceptance, Contractor shall prepare and submit to Owner's Project Manager electronic sets of System Documentation.
- J. Closeout Submittals
 - 1. Provide a set of as-built drawings and manuals to the Owner's Project Manager
 - a. As-Built Drawings
 - b. Mounting Details
 - c. Product Data
 - d. Installation Manuals
 - e. Operating Manuals
 - f. Maintenance/Service Manuals
 - 2. Provide the Owner's Project Manager- with all programming sheets, keys to the equipment cabinets, as-built drawings, operating manuals, maintenance/repair manuals, spare fuses, all programming sheets and keys to the equipment cabinets, tools for tamper-resistant enclosures and tools for manual resetting devices.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver software installation packages via download directly from manufacturer's web site
- B. Software installation packages must be digitally signed by the manufacturer.
- C. Security of Contractor's Tools and Equipment: Owner is not responsible for the care, storage or security of any of the Contractor's tools or equipment.

- D. Deliver materials in manufacturer's original, unopened, undamaged containers with original identification labels.
- E. Protect stored materials from environmental and temperature conditions following the manufacturer's instructions.
- F. Handle and operate products and systems according to the manufacturer's instructions.

1.9 PROJECT/SITE CONDITIONS

A. Environmental Conditions

- 1. Power: Electrical power will be supplied by Owner to the extent that the usage is compatible with available facilities near the work.
- 2. Dust Control: Make provisions to control all dust, dirt, and foreign material caused by the performance of the Work.
- 3. Use of explosive type fastening equipment is prohibited.
- 4. Notify Owner immediately of any damage or possible damage to any other equipment.

B. Clean-Up

- 1. Contractor shall clean-up, daily as the Work progresses, all dirt, dust and debris caused by Contractor's operations. Clean-up shall be completed by the end of each workday to the satisfaction of Owner's on-site representative.
- 2. If Contractor fails to clean-up, Owner may elect to have clean-up performed by others, with the costs of such clean-up being charged to the Contractor.

C. Construction Aids

- 1. Definition: Construction Aids are facilities and equipment required by personnel to facilitate the execution of the Work. Construction Aids include scaffolds, staging, ladders, platforms, hoists, cranes, lifts, trenchers, core drillers, protective equipment, and other such facilities and equipment.
- 2. Contractor shall provide all Construction Aids required in the execution of the Work. Construction Aids that are the property of Owner or other contractors shall not be used without permission.
- 3. Storage of Construction Aids shall be coordinated with Owner's on-site representative.

D. Safety

- 1. The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs about the Work.
- 2. Contractor shall comply with all local, state, and federal regulations and laws for the safety of the workplace.

E. Existing Conditions

- 1. Owner does not warrant the condition of any portion of the existing wiring, conduit or raceway systems. Prior to submitting his proposal, Contractor shall examine all existing

conditions and determine to what extent the existing wiring, conduit, and raceway systems may be reused.

2. Contractor's proposal price shall include the cost of replacing existing wiring, conduit, and raceways as required.

1.10 SYSTEM STARTUP

- A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

1.11 OWNER'S INSTRUCTIONS

A. Coordination with Owner

1. Contractor shall closely schedule and coordinate his activities with designated Owner representatives.
2. Contractor shall provide Owner's Project Manager with a work plan on a weekly basis. Such work plan will describe locations of intended activities, types of activities, and potential conflicts to facility operations.

B. Owner's Right to Carry Out the Work

1. If the Contractor defaults or neglects to carry out the Work in accordance with the Project Drawings and Specifications and fails within seven days after receipt of written notice from Owner to commence and continue correction of such default or neglect with diligence and promptness, Owner may, after seven days following receipt of an additional written notice and without prejudice to any other remedy Owner may have, make good such deficiencies. In such case, an appropriate Change Order shall be issued deducting from the payments then or thereafter due the Contractor the cost of correcting such deficiencies.

C. Minor Changes in The Work

1. Owner shall have the authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time and not inconsistent with the intent of the Project Drawing and Specifications. Such changes shall be provided by written order.

1.12 COMMISSIONING

- A. Manufacturer shall provide the opportunity to assist Contractor with commissioning.
- B. After all Work is completed, and prior to requesting the Acceptance test, Contractor shall conduct a final inspection, and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.
- C. Contractor shall submit a request for the Acceptance test in writing to the Owner Project Manager, no less than fourteen days prior to the requested test date. The request for Acceptance

test shall be accompanied by a certification from Contractor that all Work is complete and has been pre-tested, and that all corrections have been made.

- D. During Acceptance test, Contractor shall demonstrate all equipment and system features to Owner. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by Owner.
- E. Any portions of the Work found to be deficient or not in compliance with the Project Drawing and Specifications will be rejected. Owner Project Manager will prepare a list of any such deficiencies observed during the Acceptance test. Contractor shall promptly correct all deficiencies. Upon correction of deficiencies, Contractor shall submit a request in writing to Owner Project Manager for another Acceptance Test.
- F. If, at the conclusion of the Acceptance Test, all Work is found to be acceptable and in compliance with the Project Drawings and Specifications, Owner Project Manager will issue a letter of Acceptance to Contractor and Owner.

1.13 MAINTENANCE

- A. Provide full procedures for all database back-ups.
- B. Provide full procedures for server/workstation hard drive maintenance, such as defrag, etc.
- C. Provide full procedures for maintaining physical and software firewalls.
- D. Provide full procedures for upgrading software.
- E. Provide full procedures for testing battery condition on all field panels for adequate back-up time.
- F. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

PART 2 - PRODUCTS

2.1 QUALIFICATION OF THE MANUFACTURER:

- A. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 10 years and who shall be able to refer to similar installations now rendering satisfactory service.
- B. Perform all work under the onsite supervision of a factory authorized, trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer's and owner approval. A CSR of the installing contractor or manufacturer shall train the owner's personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.

- C. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and/or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.
- D. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.

2.2 PRODUCT EQUIVALENCY

- A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.
- B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.
- C. Must be compatible with Video Management System and Intrusion Detection system. Equipment supplier shall have a service organization that can respond to emergency service calls within 8 hours.
- D. This specification is intended to establish a carefully planned minimum level of quality and performance for all components and will be rigorously enforced by Owner. Acceptable manufacturers of components described herein are:

2.3 MANUFACTURERS

- A. Milestone or equals by Exaq or AMAG
- B. All material and/or equipment necessary for proper operation of the system, not specified or described herein, shall be deemed part of these specifications.

2.4 VIDEO MANAGEMENT SOFTWARE GENERAL

- A. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
- B. All systems and components shall have been thoroughly tested and proven in actual use.
- C. All systems and components shall be provided with the availability of a toll-free (U.S. and Canada), 24-hour technical assistance program from the manufacturer. The technical assistance program shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.

- D. GDPR-Ready Certification: The VMS must have a GDPR-ready seal from EuroPriSe.
 - 1. The vendor shall provide comprehensive guides and templates to aid in configuring a GDPR compliant system.

- E. System Architecture: The VMS shall consist of:
 - 1. Servers: One or more VMS servers.
 - a. Physical or virtualized Windows servers.
 - b. Virtualized Windows servers, using:
 - 1) Microsoft Hyper-V.
 - 2) VMWare.
 - 2. UPS provided to physical servers, network infrastructure and devices such as cameras.

- F. Server Software Components: One or more software components, or software components made by others as noted, per VMS server.
 - 1. Management Server: Central service component of the VMS responsible for handling system configuration, distributing the configuration to other system components, such as Recording Server services, and for facilitating user authentication.
 - 2. Failover Management Server: Installation of the Management Server service in a Microsoft Windows Failover Cluster, or similar, which ensures that another server takes over the Management Server function, should the first server fail.
 - 3. Failover Management Server: Installation of the management server service in a Microsoft Windows Failover Cluster, or similar, which ensures that another server takes over the management server function, should the first server fail.
 - 4. Recording Server: Service responsible for communications, recording and event handling for all devices (cameras, video and audio encoders, I/O modules, metadata sources, etc.), including:
 - a. Retrieving video, audio, metadata and I/O event streams from devices.
 - b. Recording video, audio and metadata.
 - c. Providing access to live and recorded video, audio and metadata.
 - d. Transmit live audio from operator's microphone to one or more camera speakers or supported IP speakers.
 - e. Providing access to device status.
 - f. Triggering system and video events on device failures, events, etc.
 - g. Writes video streams, audio streams and their metadata to a high-performance media database.
 - h. Performing motion detection and generate smart search metadata.
 - i. Communicating with other Milestone products when using the Milestone Interconnect technology.

- G. Failover Recording Server: Implementation of Recording Server service designated to take over recording and other tasks should an active Recording Server fail.
 - 1. Failover Recording Server shall operate in two modes: cold-standby for monitoring multiple Recording Server services and hot-standby for monitoring a single Recording Server.

- H. Failover Recording Server: Implementation of recording server service designated to take over recording and other tasks should an active recording server fail.
 - 1. Failover recording server shall operate in two modes: cold-standby for monitoring multiple recording servers and hot-standby for monitoring a single recording server.

2. Both cold- and hot-standby mechanisms shall offer fully automatic and user transparent failover in the event of hardware or system failure, with automatic synchronization of video, audio and metadata at system recovery.
- I. Event Server: Service that handles various tasks related to events, alarms, maps and third-party integrations via the Software Development Kit.
- J. Failover Event Server: Implementation of Event Server service by installing Event Server in a Microsoft Windows Failover Cluster, to ensure that another server takes over should the first server fail.
- K. Log Server: Service that writes all system, audit and rule-triggered log messages to database.
- L. Service Channel: Service responsible for communicating the following:
 1. Service and configuration messages to the Client.
 2. Updates to a video wall monitor layout.
 3. Communicating that a specific Failover Recording Server is active.
- M. Mobile Server: Service responsible for hosting the Web Client and for providing access to the VMS for Web Client and Mobile client users.
- N. ONVIF Bridge: Optional server, including ONVIF Bridge service, RTSP Bridge service, and the ONVIF Bridge Manager, plus 64-bit plug-in for Management Client. This is to enable private-to-public video integration.
- O. DLNA Server: Service to enable display of live video on any DLNA compliant TV or displays without the need for additional equipment.
- P. Microsoft SQL Server: Microsoft database server service for the Management Server, Event Server and Log Server services.
- Q. Microsoft Active Directory (required for MFA): Active Directory is not required for single-site systems but is recommended for cyber security purposes.
- R. PC or Laptop Workstations: One or more PCs or laptops for client software applications intended to run on Windows-based PCs and laptops.
- S. Management Client: The administration interface for all parts of the VMS, designed to be run remotely from, for example, an administrator's computer.
- T. Client: Designed for day-to-day use by dedicated operators, to be run remotely on the operator's computer. Provides dedicated task-oriented tabs for Live Video, Video Playback, Search, plus dockable tabs for System Monitor and Alarm Monitor. Supports definable keyboard and joystick button shortcuts for frequently-used actions, including window or camera selection.
- U. Web Client: Browser-based application for the occasional or remote user that needs easy access to live video monitoring and audio listening with PTZ control including use of presets, and video and audio playback and export, with defined exports available for later usage or download.
- V. Tablets or Smartphones: One or more tablets or smartphones using Web Client or Mobile client.

- W. Mobile Client: Native mobile app for smartphone or tablet users, for easy access to live and playback of cameras, and to activate system events and outputs. Additionally, for use as a remote recording device by using the mobile device's built-in camera, whereby video from the device's camera is streamed back to the VMS and recorded like a standard camera.
- X. Video Walls: Optionally one or more video walls.
- Y. Wide-Area Surveillance System: Optionally one or more individual VMS products connected to gain central surveillance operation across geographically dispersed sites.
- Z. Networks:
 - 1. Multiple Network Segments: The VMS must support network segmentation into separate device, server and internet-connected networks.
 - 2. Device Network: Local network whose capacity and configuration are suitable for the level of video, audio and metadata data transmission established by the system design and its intended usage.
 - 3. Server Network: Local network whose capacity and configuration are suitable for the level of video data transmission, systems integration, and user operations established by the system design and its intended usage.
 - 4. Internet-Connected Network: Internet-connected network providing connection to remote VMS sites and private-to-public connection via ONVIF Bridge. This network is also used for remote user access via the Mobile Server.
- AA. Network Traversal:
 - 1. Enable software clients to access Recording Server services from outside a NAT firewall, using public addresses and port forwarding.
 - 2. Provide Remote Connect Services that enable secure remote connections to devices across different types of private and public networks.
- BB. Multi-System Architectures: Provide three architecture options for multi-site deployments:
 - 1. Distributed Recording Server Services: Intended for sites with stable network connections between the central site and any number of remote sites.
 - a. Management Server at central site is providing user authentication and authorization for all distributed Recording Server services.
 - b. Each site has at least one Recording Server.
 - 2. Merged Architecture: Intended for sites with stable network connections between all sites, establishes central management of, and central surveillance operations for, geographically dispersed sites via one or more levels of parent/child system connections. The merged architecture shall:
 - a. Management Server at parent site is providing user authentication for the full merged system and each child site Management Server is providing authorization.
 - b. Each site is equipped with one Management Server and at least one Recording Server.
 - c. Parent systems must be at least Corporate-level systems.
 - d. Child systems may be any number of Corporate or lower systems
 - e. Child Corporate systems function as autonomous sites even upon loss of network connectivity.
 - f. Make site details, including name, address, administrators and additional information, defined in the federated system available in the site navigation.

3. Interconnected Architecture: Suitable for providing central surveillance operations capabilities for a centrally Corporate-managed distributed system where some or all network connections between the local systems are unstable or intermittent. Capabilities shall include:
 - a. Management Server at central site is providing user authentication and authorization for all interconnected cameras.
 - b. Remote site is providing authentication and authorization to its cameras on central system access.
 - c. Central site is equipped with one Management Server and at least one Recording Server.
4. Site Independence: Remote sites using the interconnected systems functionality shall operate as a full and separate VMS and NVR systems.
5. Different Network Domains: All or some systems may run on different network domains.
6. Number of Remote Sites: Any number of remote sites, which may run any size and any number of separate supported VMS and NVR systems.
7. Upload Management: Provide for the transfer of recordings from remote sites to the central site. It shall be possible at the central site to automatically or manually request recordings from the remote site, which requests shall be queued for execution once the remote site is connected to the central site's network. Users may define time intervals and bandwidth caps for upload of video from a remote site.
8. Mobile and On-Premise VMS Support: Remote sites can be on-premise systems or mobile systems, for example busses, trains and ferries and should be resilient to intermittent connectivity to central site.
9. Status Detection: VMS proactive detection of errors and cost-efficient management of connected sites by propagation of system status events and embedded remote management of connected system.
10. Remote Management: VMS detection of system problems and remote management of interconnected sites.
11. Device Driver: Connect the high-end VMS with most other VMS and NVR versions made by the software manufacturer through a device driver-based interconnected systems functionality.
12. Central Video View and Playback: Live video and playback of video for cameras from the remote site shall be the same as for cameras connected directly to the central site.
13. Remote Camera Licenses: VMS shall require a dedicated camera license for each interconnected camera that is enabled on the central site.

2.5 SYSTEM DESIGN CRITERIA

- A. Scalability: Provide component-based system architecture to support scaling of VMS from small systems (up to 100 devices) to very large systems (several thousand devices) for single-site or multi-site deployment, whereby:
 1. For Small Systems: All software components can be installed on the same server if the server is able to handle the combined load.
 2. For Large Systems: Software components can be installed on separate dedicated servers to scale and distribute the load.
- B. Availability and High Performance: Provide the following capabilities to ensure high VMS availability and performance.
 1. Failover Recording Server: Provide hot and cold Failover Recording Server capabilities.

2. Management Server, Event Server, Log Server: Support Windows Server Failover Clustering, or similar.
 3. Failover Recording Server: Provide hot and cold failover recording server capabilities.
 4. Management Server, Event Server, Log Server: Support Windows Server Failover Clustering, or similar.
 5. Storage solution shall be configured with RAID10 for Live database and RAID5 or RAID6 for archive database.
- C. Operating Systems: Provide server and client software applications that are native 64 bit Microsoft Windows applications.
- D. Network Addressing: Support both IPv4 and IPv6 addressing.
- E. Video Standards: Provide simultaneous digital multi-channel live streaming and recording of video from IP cameras and IP video encoders without any software limitations on the number of cameras per Recording Server, with support for the following codecs and options:
1. Codecs:
 - a. H.264 and H.265
 - b. MPEG-4 and MPEG-4 ASP
 - c. MJPEG
 - d. MxPEG
 2. Options:
 - a. Toggling between recording key frames only or full video stream for MPEG-4, H.264 and H.265 video.
 - b. Adjustable GOP length for MPEG-4, H.264 and H.265 video.
 - c. Toggle between recording full framerate from the camera and any lower FPS for MJPEG video.
- F. Video De-Interlacing: Provide live video views with an adaptive de-interlacing option, to improve the quality of interlaced video, based on the actual video content received, for example, to smooth area of an image where object lines would otherwise appear as jagged lines.
- G. Multi-Live Video Streaming: Provide multiple streams for live viewing using any combination of supported standards, video resolutions and frame rates.
- H. Adaptive Streaming: Provide automatic selection between the live video streams configured for multi-live video streaming from the Recording Server to the Client or Video Wall depending on the requested resolution.
- I. Audio Standards: Provide simultaneous digital two-way audio streaming and recording of audio from IP speaker and IP microphone devices without any software limitations on the number of devices per Recording Server, with support for the following codecs and options:
1. Codecs:
 - a. AAC
 - b. G711
 - c. G726
 2. Options:
 - a. Playback of audio files on rule.
- J. DLNA Support: Provide the ability to easily display live video from the installed cameras directly onto any modern consumer-grade TV supporting DLNA functionality.

- K. Hardware Acceleration Client: Provide the following hardware acceleration capabilities to offload Client video processing from the computer CPU to dedicated hardware video processing capabilities:
 - 1. NVIDIA GPU: Automatically detect and use all available NVIDIA GPUs, for hardware accelerated decoding, color correction, and scaling.
 - 2. Intel Quick Sync: Automatically detect and use Intel Quick Sync Video GPU integrated into select Intel processors for hardware accelerated decoding, color correction, and scaling.
 - 3. Provide the ability to use both NVIDIA and Intel GPUs at the same time and automatically load balance the requests for optimal performance.
 - 4. Provide the ability to show which GPU is used to decode which stream.

- L. Hardware Acceleration Recording Server: Provide the following hardware acceleration capabilities to offload Recording Server video processing from the computer CPU to dedicated hardware video processing capabilities:
 - 1. NVIDIA GPU: Automatically detect and use all available NVIDIA GPUs, for hardware accelerated decoding to enable server-side motion detection.
 - 2. Intel Quick Sync: Automatically detect and use Intel Quick Sync Video GPU integrated into select Intel processors for hardware accelerated decoding to enable server-side motion detection.
 - 3. Provide the ability to use both NVIDIA and Intel GPUs at the same time and automatically load balance the requests for optimal performance.

- M. Hardware Acceleration Mobile Server: Provide the following hardware acceleration capabilities to offload Mobile Server video processing from the computer CPU to dedicated hardware video processing capabilities:
 - 1. NVIDIA GPU: Automatically detect and use all available NVIDIA GPUs, for hardware accelerated decoding to enable adaptive transcoding.
 - 2. Intel Quick Sync: Automatically detect and use Intel Quick Sync Video GPU integrated into select Intel processors for hardware accelerated decoding to enable adaptive transcoding.
 - 3. Provide the ability to use both NVIDIA and Intel GPUs at the same time and automatically load balance the requests for optimal performance.

- N. ONVIF Bridge Functionality: Provide access to live and recorded video, and the ability to control pan-tilt-zoom cameras in compliance with the relevant ONVIF Profile G and Profiles S standards.
 - 1. Camera-Independent Motion Detection: Provide real-time, camera-independent motion detection with:
 - a. Configurable Sensitivity: Configurable and automatic motion-detection sensitivity per camera
 - b. Searchable Metadata: Searchable motion detection metadata created during motion detection.
 - c. Exclusion Zones: Multiple motion exclusion zones definable per camera to keep irrelevant motion from triggering recording.

- O. PTZ Control Priorities:
 - 1. Provide 32,000 PTZ priority levels for control of rights between different operators and automatic scanning and patrolling schemes.

2. PTZ Scans and Patrols shall pause for higher-priority manual or event-based camera control, and resume after manual session timeout and completion of event camera control period.
- P. Configurable Pre-Buffering: Provide pre-buffering with variable buffer length, with the ability to place buffer on disk or in memory.
- Q. Device Video Quality Optimization: Provide video quality optimized per available bandwidth, device screen resolution, and camera view window sizes in these clients:
- R. Client Optimization:
1. Switch between all configured live video streams from the cameras to optimize bandwidth consumption and workstation performance.
 2. Optimize viewing performance for remote viewing according to the available bandwidth and view layouts, maximizing video stream quality per display capabilities of defined views.
- S. Web Client and Mobile Client Optimization: Optimize transcoding by capping video stream resolution and frame rate for transmission to Web Client and Mobile client.
- T. Multicasting: Provide optimization of network load in systems with many users viewing the same camera live, by sending one video stream per camera to multiple Client and Video Wall instances.
- U. Multiple Language Support: Provide support for multiple languages.
- V. Management Client Built-In Help: American English, Chinese (Simplified), French, German, Japanese, Korean and Portuguese (Brazil).
- W. True Multi-Window Support: Provide true multi-window support whereby secondary windows have full functionality and can be operated in independent mode or synchronized mode where they follow the control of the main window.
- X. SNMP Agent: Provide VMS functionality to act as SNMP agent that can generate an SNMP trap upon rule activation.
- Y. System Capacities: Provide the following maximum capacities, constrained only by the physical performance capabilities of installed server hardware and network infrastructure:
1. Unrestricted devices.
 2. Unrestricted client software users.
 3. Unrestricted mobile devices.
 4. Unrestricted client PCs or laptops.
 5. Unrestricted servers.
 6. Unrestricted video walls, with an unrestricted number and combination of display monitors.
 7. Unrestricted sites.
 8. Unrestricted system rules.
 9. Unrestricted time profiles.
 10. Unrestricted software client profiles.
 11. Unrestricted media storage.
 12. Recording rates of at least 30 FPS per camera, limited only by hardware capabilities.

2.6 SYSTEM SECURITY

- A. Control and Information Security: Provide the following data protection measures and user rights management capabilities in support of system confidentiality, integrity and availability:
1. Data in Transit:
 - a. HTTPS connections from devices to Recording Server that support HTTPS connections.
 - b. Encrypted communication between the Recording Server and services that retrieve streaming data.
 - c. Encrypted communication between the Management Server and the Recording Server.
 - d. HTTPS connections from Recording Server to VMS clients, SDK clients and services that support HTTPS connections.
 2. Data at Rest Integrity and Encryption: Provide encryption and digital signature settings per media storage container.
 - a. Two modes of video database encryption using 256-bit AES encryption:
 - 1) Light Encryption. Encrypts only the first part of the MJPEG or MPEG-4/H.264 video, audio and metadata, to use less processing power for encrypting the video. Video cannot be decoded without the information contained in the encrypted header.
 - 2) Strong Encryption. Encrypts all parts of the video, audio and metadata stored in the database.
 3. Digital sign media databases with SHA-2 algorithm to establish a means of detecting modification of stored video, audio and metadata.
 4. Off-Premises Live and Recorded Video in Transit: HTTPS connections must use trusted CA certificates and support HTTPS connections from:
 - a. Mobile Server to browser-based Web Client and Mobile client app.
 - b. ONVIF Bridge to remote public systems.
 5. Data Integrity of Exported Video:
 - a. Export video in format that can only be viewed in the Client Player.
 - b. Per-export password protection for playback.
 - c. 56-bit DES; 128, 192 and 256-bit AES encryption.
 - d. Digital sign exported media with SHA-2 algorithm to establish a means of detecting modification of exported video.
 - e. Include any digital signatures applied in the media database.
 - f. Client Player's Verify Signatures function to validate authenticity of exported video recording.
 - g. Option to prevent re-export of exported video.
 6. Digital Certificates: Use of customer-provided CA digital certificates for connections to the Mobile Server.
 7. Data Access Control: Provide:
 - a. User profiles restricting device access and video viewing, playback and export, including by day and time-of-day.
 - b. Timestamped audit log of who logged in, viewed live or recorded video, or exported video.
- B. User Authentication:
1. Log-in Options: Log-in authentication via:
 - a. Microsoft Active Directory.
 - b. Local Windows user accounts.

- c. Basic user system account (username and password credentials).
 - d. Dual authentication, a.k.a. two-person rule, requiring two verified persons to gain access.
 2. Auto-Log-In: Use of last used credentials for authentication, with Auto-log-in and auto-restore of camera views.
 3. Kerberos Authentication: Provide strong authentication via Kerberos support.
- C. User Rights Management: Provide common and central detailed management of user rights across all user and programmatic (SDK) interfaces, using roles, users, and user groups:
 1. Tiered User Rights: Assign partial management of permissions to system administrators using the Management Client.
 2. User Rights: Define roles, add and delete users, manage permissions for roles, user groups and users, generate user rights management reports. Tiered user management rights shall enable differentiated administrator rights per administrator role.
 3. User Rights Inheritance: Create sub-management domains where management of a specific set of devices can be assigned to a specific system administrator.
 4. Roles: Defining roles establishes permissions (also called “rights”) that determine which system features may be accessed by users and groups. Provide the following security settings for roles:
 - a. Role Info:
 - 1) General: Management Client profiles, evidence lock profiles, dual authorization rights, system log-in time profile.
 - 2) Applications: Login to Client, Web Client and Mobile client.
 - 3) Anonymous PTZ Sessions: Enabling anonymous user information for PTZ sessions.
 - b. Users and Groups: Users and groups can be assigned to multiple roles.
 - c. Overall System Permissions: Globally allow or deny permissions for servers, devices and functions (such as manage, read, edit and delete).
 - d. Specific System Permissions: Allow permissions for specific individual devices and functions:
 - e. Cameras: Visibility, live view (within time profile), playback (within time profile), search sequences, smart search, export, manual recording, bookmark functions, AUX commands, evidence lock functions.
 - f. Microphones and Speakers: Visibility, listen to live audio (within time profile), playback audio (within time profile), search sequences, export, manual recording, bookmark functions, evidence lock functions.
 - g. Inputs and Outputs: Visibility, activation.
 - h. PTZ Control: Manual control, activate PTZ presets, PTZ priority, manage PTZ presets and patrolling, reserve and release PTZ session.
 - i. Speech: Speak to speakers, speak priority.
 - j. Remote Recordings: Retrieve remote recordings.
 - k. Video Wall: Visibility, edit, delete, operate, playback.
 - l. External Events: Visibility, edit, delete, trigger.
 - m. View Groups: Visibility, edit, delete, operate.
 - n. Servers: Professional server access and authentication details, Milestone Federated Architecture site permissions.
 - o. Matrix: Visibility.
 - p. Alarms: Manage, view, disable alarms, receive notifications.
 - q. MIP: Milestone Integration Platform plug-in permissions.

- D. Client Authentication: Provide Management Server authentication and authorization of connecting clients and use a session-limited access token for controlling access to the Recording Server.
- E. System Hardening: System hardening guide that:
 - 1. Describes data security, network security and physical security measures and best practices for securing the installed VMS against cyber-attacks. This includes security considerations for the hardware and software of servers, clients and network device components of a video surveillance system.
 - 2. Incorporates standards-based and best-practice-based security and privacy controls and maps them to each hardening recommendation.

2.7 LOGGING

- A. Provide logging of errors, warnings, system information, user activity, and logs about rules to a centralized database with time, date, and other related information. Logs provide multi-system support and configurable logging limits.
 - 1. System Logs: Log all system related errors, warnings and system information, to be used for troubleshooting.
 - 2. Audit Logs: Log user activity in client applications including, but not limited to, user system access, configuration changes and operator actions.
 - 3. Rule-Triggered Logs: Log rules in which the system administrator has specified the “Make new log entry” action.
 - 4. Log Exporting: Logs can be exported as comma-separated-values (.csv) files.
 - 5. Log Filtering: Logs can be filtered based on time frame, source name, source type, user, user location, rule name, etc.
 - 6. Log-Related Options: Settings can be changed about:
 - a. Log retention time.
 - b. Which levels (error, warning, and system information) are logged.
 - c. Log security.

2.8 SYSTEM FUNCTIONALITY

- A. Configuration Management:
 - 1. Real-Time Configuration Change Application: Immediately apply authorized changes of system configuration data for all sites, including, but not limited to licenses, devices, rules, schedules, users, maps, alarms, recording, client views, including while recording is in operation.
 - 2. Configuration Data Caching for Continued Operation: Cached Recording Server configuration data shall ensure continuous operation of Recording Server during periods where the Management Server is inaccessible.
 - 3. Backup and Restore: Built-in backup and restore support for manual system backup of all configuration data, including but not limited to:
 - a. All system configuration data.
 - b. Full device configuration data.
 - c. Maps.
 - d. Alarm settings and definitions.
 - e. Software client views.
 - f. User-defined rules, events and dashboard customizations.

- g. Defined video bookmarks.
 - 4. Configuration Reporting: Provide complete or partial documentation of system configuration, including custom and site-specific free-text information, contractor's notes and option for logo inclusion.
- B. Customizable Built-in System Monitor:
- 1. System Dashboard: Dashboard display containing detailed and up-to-date information about current servers and cameras. Dashboard displays include the following items:
 - a. Server Tiles: Displays the status of individual or groups of servers via colored tiles.
 - b. Camera Tiles: Displays the status of the cameras via colored tiles.
 - c. Details on monitoring parameters are shown when a tile is selected.
 - d. Monitoring Parameters: Customizable Normal, Warning and Critical system monitor and event triggers for:
 - 1) General Server Information:
 - a) CPU usage.
 - b) Memory available.
 - 2) Recording Server Information:
 - a) CPU usage.
 - b) Memory available.
 - c) Free space.
 - d) Retention time.
 - 3) Camera Information:
 - a) Live FPS.
 - b) Recording FPS.
 - c) Used space.
 - 2. System Details: Detailed real-time display and reporting of system performance and conditions for:
 - a. General Server Information:
 - 1) CPU and memory usage.
 - b. Recording Server Information:
 - 1) CPU and memory usage.
 - 2) Pie-chart status information for the storage elements on each hard drive: video recordings and archives; other data, including video archives from other archive storage locations (such as network drives); free space, disk size.
 - 3) Network adaptor usage.
 - 4) Storage container usage.
 - 5) Camera information.
 - c. Camera Information: A table containing:
 - 1) General status.
 - 2) Recording status.
 - 3) Camera name.
 - 4) Storage container used.
 - 5) Used space.
 - 6) Live FPS.
 - 7) Recording FPS.
 - 8) Live video format.
 - 9) Recording video format.
 - 10) Media data received.
 - d. Historical Reporting: On-screen and PDF report of historical performance data going back 30 days.

3. Monitoring Multiple Servers and Federated Systems: Provide multiple dockable tabs in with system performance and use information for different servers and federated systems.
- C. Application Workspace Optimization:
1. Options for optimizing application workspaces in the Management Client software:
 - a. Application Layout: Rearranging layout via drag-and-drop.
 - b. Management Client Profiles:
 - 1) Centralized management of application options for optimization application for different user categories and skill levels.
 - 2) Ability to tailor the availability of main/sub functions for different user roles.
 2. Options for optimizing application workspaces in the Client software:
 - a. General: Control general look and feel and navigation properties, such as color mode, camera title bar, grid sizes.
 - b. Personal or Centrally Enforced: Optimization can either be made as individual personalization managed by each operator, or centrally enforced using profiles.
 - c. View Layouts: Availability of specific view layouts enforced using profiles.
 - d. Themes: User interface color schemes enabling user choice of dark or light themes.
 - e. Simple and Advanced Modes: Optional simplified user interface with toggling between “Simple” and “Advanced” mode.
 - f. Control Panes Availability: Control availability of control panes and functions in live and playback tabs, and in setup mode.
 - g. Timeline Information: Control information included in timeline in playback tab.
 - h. Export Behavior: Control behavior and availability of export function.
 - i. Keyboard and Joystick Setup: Setup of keyboard short cuts and joystick controls.
 - j. Alarm and Access Control Notifications: Control behavior of alarms and access control notifications.
 - k. Application Language: Control application language.
 - l. Advanced Application Settings: Control advanced application settings such as use of multicast, hardware acceleration, adaptive streaming, videos diagnostics overlay and time zone settings.
- D. Device Discovery and Management:
1. Add Hardware wizard to automatically discover and upon approval add devices to system using Universal Plug and Play (UPnP) discovery, IP network range scanning, or manual device detection.
 2. Replace Hardware wizard for swift replacement of malfunctioning devices with preservation of configuration settings and recordings, including those for attached cameras, microphones, speakers, inputs, outputs and metadata devices.
 3. Move Hardware wizard for moving devices and related devices from one Recording Server to another during runtime with no loss of settings, recordings, rules, permissions etc.
 4. User ability to enable and disable devices for purposes of maintenance or temporary deactivation.
 5. User ability to change the password of one or multiple devices based on a pre-configured time interval. Must be supported for ONVIF-compliant devices.
 6. For ONVIF Profile T & Q compliant devices. User ability to manage a VMS user account that communicates with a device. Add a user, list an existing user, and delete a user.
 7. For ONVIF Profile T & Q compliant devices. User ability to manage network configuration. Change IP address, subnet mask, and default gateway.

- E. Camera Image and Video Stream Management: Adjustment of per-camera and per-video stream settings, with each camera allowed one or more streams for live viewing and one stream for recording, including an optional per-camera or per-camera-group preview window:
1. Per Camera:
 - a. General Settings: Change all camera specific general settings such as brightness, color level, compression, maximum bit rate, resolution and image rotation.
 - b. Camera Video Stream Settings: Define as many different streams as specific camera support. Change individual stream settings such as FPS, resolution, image quality, video encoding format and resolution.
 2. Per Camera Group:
 - a. General Settings: Change all common camera specific general settings for the camera group such as brightness, color level, compression, maximum bit rate, resolution and image rotation.
 - b. Camera Video Stream Settings: Define as many different streams as specific camera support for the camera group. Change individual stream settings such as FPS, resolution, image quality, video encoding format and resolution.
 - c. One camera can be associated to multiple camera groups.
 3. Video Streams: Define one camera video stream used for recording and multiple cameras video streams to be used for live viewing.
 4. Recording: Manage recording functionality including:
 - a. Related device recording.
 - b. Manual recording timer.
 - c. Pre-buffer use.
 - d. Recording framerate.
 - e. Media storage assignment.
 - f. Automatic retrieval of edge recordings.
 5. Fisheye Lens Viewing: Capability for fisheye lens camera views provided through utilization of the panomorph lens technology.
 6. Motion Detection: Manage motion detection functionality including:
 - a. Motion sensitivity.
 - b. Processing all frames or keyframes only.
 - c. Generation of motion metadata for smart search.
 - d. Exclusion zones.
 7. Camera Events: Define which camera events will be forwarded to the VMS.
 8. Client Settings: Define client related functionality including:
 - a. Use multicast for live stream.
 - b. Related devices.
 - c. Keyboard shortcut.
 9. Privacy Masks: Permanent and liftable system-defined camera image privacy masks hide certain areas in the camera image for live view, recording, and video export.
 - a. Permanent Masks: Allow a system admin to mask areas in cameras at all times and for all users. Permanently masked areas cannot be revealed once recorded.
 - b. Liftable Masks: Allows a system admin to establish default mask areas in cameras at all times and for all users, but with the option to sufficiently privileged operators to temporarily remove the masks for authorized users if needed – such as during investigation.
 - c. Masking Level: When establishing a privacy mask, system admins may select a mask level on a scale between ‘light blur’ to ‘solid grey’.

- F. PTZ Camera Control: Camera-based and system-based PTZ camera control including the following capabilities.
 - 1. Camera PTZ preset positions: Camera-based PTZ presets may be imported from the camera and renamed for use in system-based manual and automatic PTZ control.
 - 2. Automated Use of PTZ Presets: Scheduled and event-based rules capability to move PTZ cameras to pre-set positions.
 - 3. System-Based PTZ Preset Positions: System-based PTZ presets are definable for use in system-based manual and automatic PTZ control.
 - 4. PTZ Patrolling: Multiple per-camera PTZ patrolling schemes may be defined with the following options:
 - a. Adjustable wait times between preset position changes.
 - b. Disabling of motion detection to avoid false detection alarms.
 - c. Multiple patrolling schedules per camera per day, with different schedule for days, nights and weekends.

2.9 EVENT AND ALARM MANAGEMENT

- A. Rules Engine: Provide rules for automating of different aspects of the system, including camera control, system behavior and external devices, based on events or time profiles, or a combination of events and time profiles.
 - 1. Trigger Events: Provide a Microsoft-Outlook-style configuration dialog where pre-defined and custom-defined events are used in rules to trigger actions.
 - a. Event Categories: Organize events into the following categories:
 - 1) Hardware: Physical hardware devices connected to the system.
 - 2) Devices: Certain functions and states of devices available via connected hardware devices.
 - 3) External: Relating to VMS integrations.
 - 4) Recording Server: Archiving, failover and database functions.
 - 5) Analytics: From integrated analytics applications and systems.
 - 6) User-Defined: Custom-configured events enabling users to manually trigger actions and events in the system.
 - 2. Start Actions: Triggering events may initiate a wide set of system actions, including, but not limited to:
 - a. Control start and stop of recording, including scheduled and event-based recording.
 - b. Change camera stream properties.
 - c. Change of video wall content and layout.
 - d. PTZ camera preset positions and patrols.
 - e. Event-based notifications, including email notifications to single or multiple recipients with optional attachment of a camera still image or AVI video clip.
 - f. External system interactions.
 - g. Bookmark creation.
 - h. Play pre-recorded audio.
 - i. Retrieve video and audio from edge storage devices and video from interconnected systems.
 - j. Single rule allows for executing multiple system actions.
 - k. Rule actions shall be triggered by event, time interval or a combination of event and time.
 - l. Rules shall be optionally stopped by event or after a specified time.
 - m. Unrestricted number of rules.

- B. Time Profiles: Provide the following time profile functionality for use with profiles, rules and triggers:
1. Dynamic day-length time profile that follows daylight changes over a year including Daylight Savings Time for a given location defined by a GPS position.
 2. Time profiles contain one, or more, single or recurring periods of time.
 3. A single time period may span one or more days, defined by a starting date and time and an ending date and time.
 4. A recurring period is defined as a time range with recurrence pattern and range:
 - a. Time range is a starting and ending time within a day.
 - b. Recurrence pattern may be Daily, Weekly, Monthly or Yearly.
 - c. Recurrent range is a starting and ending date, or a starting date with a duration in days.
 5. Unrestricted number of time profiles.
- C. Single-Point Event/Alarm Management: Provide central management of all internal system alarms and external security alarms. Events are pre-defined or user-specified incidents on the VMS that can be set up to trigger an alarm, including analytics events and manual control actions. Event and alarm management capabilities shall include but not be limited to:
1. Alarm Data Settings:
 - a. Customizable alarm priorities, statuses and categories to enable alignment of the alarm handling workflow with existing workflows and security systems.
 - b. Optional sound notifications for different alarm priorities for notification of new incoming alarms.
 - c. Manage which alarm priorities trigger desktop notifications for alarms.
 - d. Manage which alarm data are shown in the Alarm Manager, including but not limited to:
 - 1) ID.
 - 2) Image.
 - 3) Location.
 - 4) Message.
 - 5) Owner.
 - 6) Priority Level.
 - 7) Source.
 - 8) State Level.
 - 9) State Name.
 - 10) Time.
 - e. Optional Reasons for Closing to be chosen when an alarm is closed.
 - f. Add audio files in wav-format to be used as alarm notification sounds.
 - g. Manage how long alarms instances are kept in the system before being automatically deleted.
 2. Alarm Configuration:
 - a. User-definable alarm descriptions and work instructions.
 - b. Select triggering event and source.
 - c. Alarm time profiles specifying that response actions must take place within the specified time profile.
 - d. Select start and stop events specifying that response actions must take place within the specified event window.
 - e. Select a user defined event to be triggered if an alarm is not acknowledged within a defined time limit.

- f. Association of alarms with one or more cameras, with automatic display of camera video in the alarm preview window, with a minimum of 15 cameras showing simultaneously in the alarm preview window.
 - g. Association of alarms to maps.
 - h. Association of initial alarm owner (individual user or group) and priority.
 - i. Association of alarm category.
 - j. Select user defined event to be triggered by the alarm.
 - k. Enable or disable desktop notifications for alarms.
3. Alarm Manager:
- a. Alarm list with extensive sorting and filtering capabilities.
 - b. Instant preview of recorded video from primary and related cameras, at the time of the incident.
 - c. Thumbnail image from primary camera, at the time of the incident.
 - d. Alarm disabling option shall enable users to suppress alarms from a given device for a specified time period.
 - e. Common alarm list for all interconnected systems and cameras.
 - f. Common alarm list for all sites in a Federated Architecture.
 - g. Alarm handling reports providing information about alarm inflow and alarm handling performance.
4. Alarm Handling:
- a. Instant preview live video of primary camera.
 - b. Instant preview of recorded video from primary and related cameras, at the time of the incident.
 - c. Option to select any related cameras to be displayed in the live and playback view items.
 - d. Present the alarm work instructions.
 - e. Change priority and status of the alarm.
 - f. Alarm escalation with option to forward alarms to operators with appropriate skills to handle specific types of alarms.
 - g. Present time logged alarm activities.
 - h. Add time logged comments to the alarm incident.
 - i. Desktop notifications shall allow immediate access to alarm handling.
5. Map Integration:
- a. Present incident location automatically on map.
 - b. Tight integration with the map function allowing operators to indicate and acknowledge active alarms via map.
 - c. All other map functionality must be available when viewing maps in the Alarm Manager.
6. Web Client: Provide the following alarm list, alarm handling and investigation functionality:
- a. Alarm List:
 - 1) Alarm list with filtering capabilities:
 - a) All or personal alarms.
 - b) All or specific alarm states.
 - c) All or specific alarm priorities.
 - 2) Thumbnail image from primary camera, at the time of the incident.
 - 3) Click to handle alarm.
 - b. Alarm Handling:

- 1) Instant preview of recorded video from primary and related cameras, at the time of the incident. Available incoming audio for cameras that have related microphones.
 - 2) Present the alarm work instructions.
 - 3) Change priority and status of the alarm.
 - 4) Alarm escalation with option to forward alarms to operators with appropriate skills to handle specific types of alarms.
7. Mobile Client: Provide the following alarm notification, alarm list, alarm handling and investigation functionality:
- a. Alarm Notification: Receive alarm notifications using Push Notifications. Notifications include access to:
 - 1) Video.
 - 2) Alarm information.
 - 3) Work instructions.
 - b. Alarm List:
 - 1) Alarm list with filtering capabilities:
 - a) All or personal alarms.
 - b) All or specific alarm states.
 - c) All or specific alarm priorities.
 - 2) Thumbnail image from primary camera, at the time of the incident.
 - 3) Click to handle alarm.
 - c. Alarm Handling:
 - 1) Instant preview of recorded video from primary and related cameras, at the time of the incident.
 - 2) Present the alarm work instructions.
 - 3) Change priority and status of the alarm.
 - 4) Alarm escalation with option to forward alarms to operators with appropriate skills to handle specific types of alarms.

2.10 VIDEO PROCESSING AND VIEWING

- A. Multiple Monitor Support: Support multiple monitors where each monitor shall show multiple floating or full-screen windows for display of views or individual view items.
- B. View Window Aspect Ratios: Support multiple views optimized for 4:3 and 16:9 display settings in both landscape and portrait orientations.
- C. Private or Shared Views: Private views can only be access by the user who created them. Views may be shared generally and available to all roles or restricted to specific roles. Viewing of a content item in a shared view is subject to the viewer's permissions relating to the content item.
- D. View Groups: View groups facilitate view navigation and simplify searching across multiple views by narrowing search scope.
- E. View Layout Persistence: Same view layout in both live and playback modes.
- F. View Arrange and Restore: Support simple drag-and-drop re-arrangement of cameras in views for optimized monitoring of incidents, including replacement of individual cameras with different cameras, with single-click restore of original view layout.

- G. View Creation: Views that display up to 100 view items including cameras, web pages, still images, text and interactive items. View capabilities include, but are not limited to:
1. Camera View Item: Live and recorded camera video displayed in resizable view windows, utilized in several workspaces within the application. Each camera view item contains the following:
 - a. Video Status Indicator: A round dot indicating one of four states:
 - 1) Green: A connection to the camera is established.
 - 2) Red: Video from the camera is being recorded.
 - 3) Yellow: Playing back recorded video.
 - 4) Gray: The video has not changed for more than two seconds.
 - b. Motion Indicator: An icon of a moving person that appears only when motion is detected since it was last cleared.
 - c. Bounding-Box Display: Display of metadata bounding boxes as provided by supported cameras and integrated analytics in live and playback views.
 - d. Update on motion only: Optimizes CPU use by allowing motion detection to control whether the image should be decoded and displayed.
 - e. PTZ Camera View Item: PTZ camera view item can be configured to provide virtual joystick camera control and PTZ navigation overlay buttons on the video image.
 - f. Overlay Buttons: Used to add manually controlled speakers, events, outputs, PTZ cameras and to start/stop recording.
 2. Camera Navigator: User-defined views of specific sets of cameras in relation to each other, for example, according to floor plan, to enable visually tracking people and objects as they move from one camera's field of view to another. Camera Navigator function provides an add-on to the Map with no special configuration needed.
 3. Carousel: Allow a specific view item to automatically sequence rotate through pre-defined set of cameras that are not necessarily present in the view at the same time. Operators may select default or custom display times for each camera, and they are able to manually switch to the next or previous camera in the carousel list.
 4. Hotspot: Global hotspot function shall allow users to work in detail with any camera selected from any view. Local hotspot function shall allow users to work in detail with a camera selected from the same view.
 5. HTML Page: Show interactive HTML page.
 6. Image: Show a still image.
 7. Matrix: Shows live video from multiple cameras in any view layout with customizable rotation paths, remotely controlled by the computers sending matrix remote commands.
 8. Navigable Map Pages: Static or active map pages may be used to provide a good overview of premises, and for switching between different views, such as map page displaying a floor plan.
 9. Text: Add text.
 10. Video Wall: Display video wall control providing the following functionality:
 - a. Show monitor layout of currently selected video wall.
 - b. Drag-and-drop views to any monitor.
 - c. Drag-and-drop cameras to any view item location in any monitor.
 - d. Change video wall via dropdown.
 - e. Activate video wall preset via dropdown.
 11. 3rd party plug-ins: Add 3rd party plug-ins to extend the behavior of Client.
- H. Live Video: Views provide camera live viewing capabilities including, but not limited to:
1. Live Viewing: View live video of camera view items on the Live tab.
 2. Manual PTZ Control: Manual PTZ control options:

- a. Video overlaid PTZ control.
 - b. Joystick.
 - c. Virtual joystick function.
 - d. PTZ point-and-click control.
 - e. Reserve and release PTZ control.
 - f. PTZ preset positions.
 - g. Overlay buttons to activate PTZ preset positions.
 - h. PTZ zoom to a defined rectangle.
 - i. Start, stop, and pause patrolling.
 - j. View who have PTZ control and time to automatic release, including anonymous users.
3. Stream Selection: Change to any defined live video stream.
 - a. Manual selection of defined live video stream.
 - b. Adaptive Streaming: Automatic selection of defined live video streams with the best match to the requested resolution.
 4. Send Video to Destination: Option to send current camera to the following destinations:
 - a. View item in an existing window.
 - b. New floating window.
 - c. View item in any defined video wall.
 5. Digital Zoom: Magnification of video to facilitate detail viewing.
 6. Bookmarks: Create quick or detailed bookmarks, to facilitate incident review and documentation.
 - a. System generated headline for quick bookmark.
 - b. Optional headline and description information for detailed bookmark.
 7. Independent Video Playback:
 - a. Playback of video in multiple camera view items, each on its own independent timeline.
 - b. Option to initiate playback mode and synchronizing playback timeline with current time in independent playback.
 8. Instant Change of Camera: Drag-and-drop placement of a different camera in a camera view item, instantly changes the content to video from the new camera, according to the camera view item's current timeline position.
 9. Smart Map: Enable quick navigation to smart map, showing the geographic location of the camera, even camera located on a specific level inside a multistory building.
 10. Centralized Search: Initiate Centralized Search for the camera in a new window.
 11. Manual Recording: Start and stop manual recording with automatic stop of recording after a configurable number of minutes.
- I. Video Playback: Views provide additional camera playback capabilities including, but not limited to:
1. Playback: Time synchronized play back video of camera view items on the Playback tab.
 2. Navigation: Advanced video navigation includes:
 - a. Forward and backwards playback at different speeds:
 - 1) Playback Speeds: ¼x, ½x, 1x, 2x, 4x, 8x, 16x.
 - 2) Instant Realtime Speed: Toggle 1x playback speed or selected playback speed.
 - b. Forward and backwards frame-by-frame.
 - c. Skip to next or previous recorded sequence.
 - d. Skip to beginning or end of recordings.
 - e. Jump to date/time.

3. Timeline: An overview of recorded sequences and bookmarks via integrated video timeline with time navigation and playback controls, including the following functionality:
 - a. Timeline Video Playback: Video from multiple camera view items integrated to a common video timeline, with common timeline control from any of the integrated camera view item.
 - b. Single and Consolidated Timeline: Two timelines with the first showing overview of selected camera view item and second showing a consolidated overview of all camera view items in the view.
 - c. Timeline Period: Select which period timeline covers.
 - 1) 5, 10, 20 minutes.
 - 2) 1, 2, 4, 8, 12, 16, 20 hours.
 - 3) 1, 2, 4 days.
 - 4) 1, 2, 4 weeks.
 - d. Recorded Sequences Overview: Recorded sequences of video and audio are shown in the timeline. The timeline displaying light-red to indicate recording, red for motion, light-green for incoming audio, and green for outgoing audio. If there are additional sources of data available, these are displayed as other colors.
 - e. Bookmarks Overview: Bookmarks are shown in the timeline with instant preview of the recorded video.
 - f. Integrated Time Interval Selection: Integrated function to select a time interval for export, evidence lock or video and audio retrieval from edge storage devices and interconnected systems.
 - 1) Visual selection on timeline.
 - 2) Select start and end date/time.
 - 3) Loop selected period on playback.
 - g. Multi-Window Timeline: Ability to use one timeline to control playback of cameras in multiple view windows.
4. Recording Search: Search listing of camera sequences or bookmarks.
 - a. Preview: Search results may be previewed.
 - b. Print: Print of still image from the selected video clip may be initiated.
 - c. Export: Export of selected video clips may be initiated, reducing time needed to prepare forensic video material.
- J. Send View Item to Video Wall: Option to send current view item content to any defined video wall.
 1. Map: Send map to video wall with the current geographic location, zoom level, and layers.
- K. Two-Way Audio: Audio from cameras with built-in or attached microphones can be configured for listening. Camera built-in or attached speakers can be configured for use to talk to individuals near speakers. Additional capabilities include:
 1. Broadcast: Broad announcements can be made by selecting the All Speakers option when talking.
 2. Lock to Selected Audio Devices: Enables continued use of microphones and speakers from selected cameras, while viewing video from a different set of cameras. This enables, for example, informing an individual at risk about the safety status of nearby areas.
 3. Level Meter: Level meter indicates the volume of the speaking operator's voice, to indicate whether the operator is at a correct distance from the microphone.
- L. Centralized Search: Provides search categories and filters to allow users to find recording sequences, bookmarks, recordings with motion, alarms, events, vehicle license plates and data

from third-party systems, with the ability to preview video and take direct action, e.g. by exporting the search results or sending the search results to PDF. The search results shall be presented instantly as thumbnail images:

1. Sequence Search: Search in recording sequences on one or more cameras.
2. Motion Search: Search for sequences with motion, or Smart Search for motion in selected areas on one or more cameras.
3. Bookmark Search: Search for bookmark headlines or descriptions.
4. Alarms and Events Search: Search for alarms and events, with the ability to apply filters to refine the search results.
5. Vehicle license plate search: Search for license plates, with the ability to apply filters to refine the search results.
6. Third-party Systems Search: Search for metadata from integrated third-party systems.
7. Save Search: The ability to save searches for reuse:
 - a. Save searches.
 - b. Search for and open saved searches.
 - c. Edit saved searches.
 - d. Delete saved searches.
8. Navigation: Ability to jump to search results through a clickable timeline, or the ability to scroll through the search results.
9. Preview: Selected sequence previews with auto play and direct export support.

M. Video Export and Documentation: Client options for video export and documentation include, but are not limited to:

1. Snapshot: Produce instant visual documentation of a camera by saving the camera image to a file.
2. Print: Produce instant visual documentation of a camera by sending it directly to a printer.
3. Storyboarding: The storyboarding function makes it possible to include video sequences from different or overlapping time intervals from different cameras in the one and the same export.
4. Export Format: including the standalone Client — Player application for simple instant viewing by authorities.
5. Export Preview: Review video just prior to export, with looped playback option.
6. Export Other Formats: Create evidence material in media player format (AVI files), MKV format, or still image format (JPEG images).
7. Re-Export: Re-Export allows an authorized individual to export a digitally signed selection from the original video exported. Option to disable re-export, during initial export to softwareformat, prevents undesirable re-distribution of sensitive video recordings.
8. Bulk Export: In a single step, export in multiple formats to multiple destinations, including direct export to optical media, to ensure consistency across exported video sequences in various formats, and reduce human error possibilities.
9. Export of Comments: Two video formats support inclusion of comments in exported video:
 - a. Include general and/or camera-specific comments to a video export file.
 - b. Media Player Format: Include comments as pre/post slides.
10. Video Incident Report Printing: Utilize still images rather than clips to print incident reports including images, surveillance details and free-text user comments.

2.11 MAPS

- A. Maps: Provide multi-layered physical overview of surveillance video coverage, with interactive access to and control of the VMS and related devices, including the following elements:
1. Map Images: Illustrated maps or photographs. Supported image file formats are: BMP, GIF, JPEG, JPG, PNG, TIF, TIFF, and WMP.
 2. Camera Icons: Indicate camera locations on the map. Fixed camera icons show camera view as colored angle radiating from the camera. PTZ camera icons show preset camera views as colored angles radiating from the camera.
 - a. Live Preview: Hover mouse pointer over camera icon to display a live preview in a resizable window.
 - b. PTZ Preset Navigation: Click on PTZ preset view zone moves camera to the preset position.
 3. Microphone Icons: Microphone icons show microphone locations on the map.
 - a. Live Listening: Place mouse over microphone icon; press and hold left mouse button to listen to incoming audio from microphone.
 4. Speaker Icons: Indicate speaker locations on the map.
 - a. Live Speaking: Place mouse over speaker icon; press and hold left mouse button to talk through speaker.
 5. Control Icons: Icons to use for control of objects such as doors, gates, and lights.
 6. Hot Zones: Hot zones to provide vertical navigation through a hierarchy of maps by clicking on a hot zone.
 7. Map Overview Window: Navigable overview of map hierarchy set up in Client.
 8. Video Wall Integration: Drag-and-drop integration of maps with video wall.
 9. Map Image Updates: When map images are replaced by an updated version of the map image of the same scale, map icons and other elements are kept in their original locations.
 10. Map Display Information: Information display options include but are not limited to:
 - a. Real-time status monitoring indication from all system components including cameras, I/O devices and system servers.
 - b. Graphical visualization of the system status through color coding.
 - c. Hierarchical propagation of status indications to higher ordered maps.
 - d. Different levels of status indications available (alarm, warning and errors).
 - e. System performance data for cameras and servers including camera resolution, FPS, network use and disk space.
 - f. Ability to suppress status indications (such as alarms and operational status) for a given device.
 - g. Editable device names in map and map-specific names and references assignable to devices in Map, subject to user permissions.
- B. Smart Maps: Provide a geographic information system to accurately reflect geography in the real world, enabling video view and cameras access at multiple locations around the world in a geographically correct way. Differentiate from Maps, which utilize a different map for each location, by providing the complete picture in a single view, with seamless drilldown across different map layers. Include the following capabilities:
1. GIS Map Services: Supported services shall include Bing, Google and OpenStreetMap map services. Geo-referenced GIS Maps, such as shapefiles, and geo-referenced CAD drawings and building maps with multiple floor levels, such as dwg and dxf files, are supported.
 - a. Offline OpenStreetMap Map Service: Support the use of owner-provided OpenStreetMap server for offline use.

2. Default World Map: Standard world geographic background containing geo-reference data but not containing geographic reference features such as county boundaries, and cities.
3. Map Layers: Map data layers whose display may be toggled on and off, including but not limited to: Camera name and field of view, quick links, street names, and building and business names.
4. Camera Selection: Capabilities include:
 - a. Instant one-click camera preview in floating view of up to 25 cameras.
 - b. Easy multi-camera selection within camera preview.
 - c. Easy drag-and-drop and point-and-click definition of: cameras, camera field of view. Changing cameras placement, direction and field of view automatically update camera position information.
 - d. Selection of 10 different camera icons.
 - e. Depiction of camera field of view on map.
5. Camera Aggregation: Camera object aggregation that preserves the overview when multiple cameras are closely located.
6. Device Naming: Administrators may name edit devices in a map and assign map-specific names and references to devices in a map.
7. Navigation: Easy drag-and-drop and point-and-click definition of:
 - a. Location Links: Location links shall enable quick navigation across different sites and locations.
 - b. Quick Links: Quick links shall enable drilldown to existing classic Client maps.
 - c. Building Navigation: Navigation between different floors in buildings with multiple levels, where only camera related to the specific floor level are presented.

2.12 MEDIA STORAGE MANAGEMENT

- A. Provide multiple media storage containers definable with the following characteristics:
 1. Container: Each container consists of a live database and optionally one or more archive databases, with container-specific archiving and grooming schemes and retention times. Archive database can reside on the same disk as the live database or on secondary disks or network drives.
 2. Capacity: Maximum recording capacity shall be limited only by available disk space or configured container storage limit.
 3. Device Assignment: Recording of each device is assigned to a specific storage container. The assigned storage container for a device or group of devices may be changed from one container to another.
 4. Archiving: Recorded video data may be automatically moved from a container's live database storage to its archived storage. Archived data is still online and available to client software.
 5. Grooming: Video data grooming possibility to enable reduction of video recording data size by reducing the frame rate of the video data when archiving.
 6. Maximum Recording Times: Maximum recording times may be set for manual recordings, with VMS deleting older video to free up storage for newer video.
- B. Edge Video Storage: Provide utilization of camera-based storage including the following capabilities:
 1. Video and Audio Retrieval: Retrieving video and audio recordings across low-bandwidth connections based on time profiles, events or manual requests.

2. Video and Audio Consolidation: Consolidating video and audio from multiple storage mechanisms:
 - a. Seamless merging of video and audio stored centrally in media database, and video and audio retrieved from associated camera edge storage, or from an interconnected system.
 - b. Optionally consolidate pre-event images recorded locally in camera or video encoder.
 3. Scalable Video Quality Recording (SVQR): Capability to record high quality video using edge storage and record low quality video centrally, to minimize network bandwidth utilization, using the capabilities described above. High quality video can be retrieved when needed, on an event-driven, scheduled or manual basis.
- C. Evidence Lock: Provide capabilities for assuring the availability of recorded video selected for evidentiary use, including:
1. Extension of Video Retention: Manual extension of video retention time for a selected set of cameras, and its related devices, in a given time interval, where the operator selects an extended retention time from a pre-defined set of retention time options.
 2. Video Sequence Metadata: Users may add headline and comments information to locked video sequences to enhance their manageability.
 3. Management of Locked Video Sequences: Search, filter and listing functions including editing comments, modifying extended retention time and removing an evidence lock.
 4. Locked Video Export: Locked video may be exported through a single step operation.

2.13 MOBILE SERVER

- A. User Authentication: Facilitate the following methods of user authentication:
1. Basic Authentication: Basic user VMS account.
 2. Windows Authentication: Via Active Directory or local Windows user account. Possible to use current Windows user to facilitate single sign-on.
 3. Two-Step Verification: In addition to login capabilities, provide two-step authentication via a verification code transmitted to the user's registered email address, with a five-minute timeout for verification code expiration, and a user login block for exceeding the maximum number of failed code entry attempts, which defaults to three but may be adjusted.
- B. Dynamic Bandwidth Optimization: Optimize camera video stream from server to client to make optimum use of bandwidth.
- C. Smart Connect: Easy configuration of internet access to the Mobile Server by automatic configuration of firewalls and internet routers via UPnP, with verification of configuration and operation of internet connection, with option to email connection details to Mobile client users. Includes automatic Mobile Server on LAN via UPnP.

2.14 WEB CLIENT

- A. Provide the following browser-based capabilities:
1. User Authentication:
 - a. Require only username and password.
 - b. Support two-step verification.
 - c. User authentication and authorization is handled by Mobile Server.

2. Inherit System Views: Automatically obtain the user's private and shared views configuration from the system.
3. All-Camera View: Automatically generate a view for all cameras when no views are set up.
4. Two-Way Audio: Audio from cameras with built-in or attached microphones can be configured for listening. Camera built-in or attached speakers can be configured for use to talk to individuals near speakers. Audio playback shall be available for investigations, video exports and alarms. Additional capabilities include:
 - a. Broadcast: Broad announcements can be made by selecting a microphone icon on the view level when talking.
 - b. Use the Push-to-talk (PTT) Feature: Communicate via the VMS system, through a PC microphone and while watching live video from one camera, with people near a video camera with audio equipment. Push-to-talk (PTT) is also available in Actions.
5. Live Video Monitoring: View live video with PTZ control including use of presets, video playback, and triggering of camera-related outputs and events from within the camera's view.
6. Search: Search function to find cameras, types of camera, cameras with related microphones, cameras with related speakers and camera views.
7. Video Export: Provide video export, with the option to preview and store exported video on the server, and make it available for later usage or download, for example, when a higher-bandwidth connection is in use.
8. Still Image Export: Provide camera view JPEG image export.
9. Investigations: Ability to export the recordings, download and share them with authorities at a later stage:
 - a. Create AVI, MKV or database export files.
 - b. Option to include audio in the export package.
 - c. Export on the server to avoid moving large video files back and forth.
 - d. Store video recordings for a period that is longer than the retention time.
 - e. Play back the recordings even if the recordings have already been deleted from the media database.
 - f. Only download needed files or save them for downloading when on a faster connection.
 - g. Preview exports on the server without downloading them.

B. Secure Connection: Connect to Mobile Server through trusted CA certificates for HTTPS encryption.

1. Supported Browsers:
 - a. Microsoft Internet Explorer
 - b. Microsoft Edge
 - c. Safari
 - d. Google Chrome
 - e. Mozilla Firefox
2. Browser Plug-Ins or Extensions: No plug-ins or extensions to be installed.

2.15 MOBILE CLIENT

A. Provide the following native-app mobile client capabilities:

1. User Authentication:
 - a. Require only username and password.

- b. Support two-step verification.
 - c. User authentication and authorization is handled by Mobile Server.
 2. Multiple Server Profiles: Select between multiple server profiles to facilitate easily switching between sites or different connection addresses.
 3. Inherit System Views: Automatically obtain the user's private and shared views from the system to be use as camera lists.
 4. All-Camera View: Automatically generate a view for all cameras when no views are set up.
 5. Two-Way Audio: Audio from cameras with built-in or attached microphones can be configured for listening. Camera built-in or attached speakers can be configured for use to talk to individuals near speakers. Audio playback shall be available for investigations and alarms. Additional capabilities include:
 - a. Use the Push-to-talk (PTT) Feature: Communicate via the VMS system, through the microphone of the mobile device and while watching live video from one camera, with people near a video camera with audio equipment. Push-to-talk (PTT) is also available in access control.
 6. Full-Screen View: Display cameras in full screen to take better advantage of the mobile device's screen, with camera view navigation in full screen by swiping left or right.
 7. Pinch-To-Zoom: Digital pinch-to-zoom shall enable mobile users to enlarge a part of the image for closer review and conduct detailed investigation of video.
 8. Picture-In-Picture: Provide the following functionality for Picture-In-Picture:
 - a. Display a live picture-in-picture frame of the same camera when in playback mode.
 - b. The picture-in-picture shall be movable by dragging.
 - c. Double-tapping and will return to live view.
 - d. Hide live picture-in-picture frame.
 9. Search: Search function to find cameras, types of camera, cameras with related microphones, cameras with related speakers, and camera views.
 10. Mobile Video Push: Provide Mobile client capability for mobile device users to use their mobile device cameras as cameras in the VMS, including the following characteristics:
 - a. No Mobile Setup: No mobile device setup shall be required for mobile video push. Provide central server-side configuration.
 - b. Metadata Support: Mobile users shall be able to include metadata in the video submitted.
 - c. Audio: Mobile users shall be able to include audio in the video submitted.
 11. Investigation: Provide access to investigations created in the Web Client.
 12. Secure Connection: Connect to Mobile server through trusted CA certificates for HTTPS encryption.
 13. Supported Mobile Operating Systems:
 - a. Android
 - b. iOS

2.16 SDK-BASED INTEGRATION

- A. Provide an SDK for integration with third-party systems including, but not limited to:
 1. Seamless integration of video analytics algorithms and other third-party applications.
 2. Support for displaying MIP SDK plug-in items on smart map.
 3. Functionality for external applications to make changes to the system's configuration.

4. Compatibility with systems which integrate video surveillance with automatic teller machines (ATM), point-of-sale (POS) and enterprise resource planning (ERP) systems for managing loss prevention and fraud.
5. Compatibility with LPR for automatic reading and tracking of vehicle license plates.
6. Event integration via a simple message-based socket communication interface enabling external applications to trigger events in the VMS.
7. Functionality for external applications to trigger user-defined events in the VMS.

B. Implement the SDK via integration with client and server

2.17 COMPUTER EQUIPMENT

A. Computer Requirements: Consult with VMS manufacturer to determine current computer requirements appropriate for system design, intended use and desired level of performance. Optimize server computer count, and server application distribution across servers, to account for likely system expansion. The following are minimum requirements.

1. Computer Running Management Server and Service Channel:
 - a. CPU: Intel® Core™ i3 or better.
 - b. RAM: 8 GB or more.
 - c. Network: Ethernet 100 Mbit or better.
 - d. Graphics Adapter: Onboard GFX, AGP or PCI-Express, minimum 1024×768, 16-bit color or better.
 - e. Hard Disk Space: 50 GB free or more (depends on number of servers, devices, rules, and logging settings).
 - f. Operating System:
 - 1) For Individual Servers:
 - a) Microsoft Windows
2. To Run Clustering/Failover Management Server:
 - a. Microsoft Windows Server
3. Software:
 - a. Microsoft .NET 3.5 SP1 and .NET 4.7 Framework.
 - b. 300 Cameras or less: SQL Server Express Edition.
 - c. For larger systems or to support frequent database backups, run a licensed version of Microsoft SQL Server on its own server.
4. Computer Running Microsoft SQL Server (if not running Microsoft SQL Server Express Edition on Management Server computer):
 - a. CPU: Intel® Core™ i3 or better.
 - b. RAM: 8 GB or more.
 - c. Network: Ethernet 100 Mbit or better.
 - d. Graphics Adapter: Onboard GFX, AGP or PCI-Express, minimum 1024×768, 16-bit color or better.
 - e. Hard Disk Space: 100 GB free or more (depends on number of servers, devices, rules, and logging settings).
 - f. Operating System:
 - 1) Microsoft Windows Server
 - g. Software:
 - 1) Microsoft .NET 4.7 Framework.
 - 2) Microsoft SQL Server:

5. Computer Running Recording Server, Failover Recording Server, Failover Recording Server, Event Server or Log Server:
 - a. CPU: Intel® Core™ i3 or better.
 - b. RAM: 8 GB or more.
 - c. Network: Ethernet 100 Mbit or better.
 - d. Graphics Adapter: Onboard GFX, AGP or PCI-Express, minimum 1024×768, 16-bit color or better.
 - e. Hard Disk Space: 10 GB free or more (depends on number of devices and recording settings).
 - f. Operating System:
 - 1) For Individual Servers:
 - a) Microsoft Windows
 - 2) Software: Microsoft .NET 4.7 Framework.
 - g. Computer Running Management Client:
 - 1) CPU: Intel® Core™ i3 or better.
 - 2) RAM: 4 GB or more.
 - 3) Network: Ethernet 100 Mbit or better.
 - 4) Graphics Adapter: Onboard GFX, AGP or PCI-Express, minimum 1024×768, 16-bit color or better.
 - 5) Hard Disk Space: 1 GB free or more.
 - 6) Operating System:
 - a) Microsoft Windows
 - h. Software:
 - 1) Microsoft .NET 4.7 Framework.
 - 2) DirectX 11 or newer.
6. Computer Running Client or Accessing Remote Client:
 - a. CPU: Intel® Core™ i3 or better.
 - b. RAM: 1 GB or more.
 - c. Network: Ethernet 100 Mbit or better.
 - d. Graphics Adapter: Onboard GFX, AGP or PCI-Express, minimum 1024×768, 16-bit color or better.
 - e. Hard Disk Space: 500 MB free or more.
 - f. Operating System:
 - 1) Microsoft Windows
 - g. Software:
 - 1) Microsoft .NET 4.7 Framework.
 - 2) DirectX 11.0 or newer.

2.18 LICENSING

- A. License Activation: VMS shall offer easy-to-use automatic or manual online activation via the Internet and alternatively, offline activation via email and web for closed surveillance networks.
- B. Server Base License:
 1. Require one mandatory server base license for installing the product.
 2. Server base license shall permit the following deployments within the legal entity purchasing the base license:
 - a. Unrestricted number of Management Server services.
 - b. Unrestricted number of Recording Server services.

- c. Unrestricted number of Client, Web Client and Mobile client applications.
- C. Video Wall License:
 - 1. Video wall license shall permit connection of an unrestricted number of video wall instances (including physical displays) and camera feeds.
- D. Hardware Device License:
 - 1. Require one license per hardware IP address to connect:
 - a. Cameras.
 - b. Audio devices.
 - c. Video encoders.
 - d. Other devices.
 - 2. Support an unlimited number of hardware device licenses.
- E. Licensing of Interconnect:
 - 1. Require one Interconnect device license per camera in an interconnected site that is enabled in the central system.
 - 2. Interconnect license shall be tied to the parent system showing the interconnected devices.
- F. Licensing of Merged Architecture:
 - 1. The use of Merged Architecture is free and not subject to licensing. This implies that unrestricted sites and licensed cameras can be included in the federated hierarchy, without the need for additional or special licenses.
- G. License Overview Information: License overview shall include add-on products.
- H. License Administration: Provide expanded license information for multi-site installations where both the total used licenses for the common base license is presented along with the license use in the specific site.
- I. Changes Without Activation: A “Changes without activation” function shall allow additions and replacements of limited number of devices without requiring license device activation or reactivation.

2.19 REMOTE VIDEO DISPLAYS

- A. Widescreen, flat panel, HDTV supporting 1366x768 video resolution
 - 1. Display Formats: 120Hz, HDTV, 16:9 and scaled (480i, 480p, 720p, 1080i), WXGA 1280X768
 - 2. A/V inputs – HDMI, USB 2.0
 - 3. Greater than 160 deg viewing angle.
 - 4. All functions shall be IR remote controllable.
- B. Mount
 - 1. Wall mounts shall be supplied for displays. Provide all required supporting hardware as required by field conditions. Wall mounts shall be articulating arm mount.
 - 2. Mounts shall be wall mounts. Coordinate location and elevation with Architectural elevations and room furnishings.

3. Mounts shall be as manufactured by Peerless, Draper, Chief.

2.20 RACKS/CABINETS

- A. Units to be installed in server cabinet supplied under section 271100.

2.21 CABLING

- A. Refer to 271513 Copper communications Horizontal Cabling

2.22 NETWORK ELECTRONICS

- A. Refer to 272100 Network Electronics

2.23 CABLE MANAGEMENT SYSTEM

- A. Provide pre-manufactured cable supports. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48".
- B. Cable management devices must be sized to accommodate 100% spare capacity of the final installed cable base.
- C. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.
- D. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.
- E. Bridle rings shall not be acceptable.
- F. Manufactured by Caddy, or B-Line.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Submission of a proposal confirms that the contract documents and site conditions are accepted without qualifications unless exceptions are specifically noted.

- B. The site shall be visited on a regular basis to appraise ongoing progress of other trades and contractors, make allowances for all ongoing work, and coordinate the requirements of this contract in a timely manner.
- C. The systems must be inspected before installation and shall be free of any cosmetic defects or damage.

3.2 PREPARATION

- A. Prior to installation, the VMS system and network shall be configured and tested to meet the specified requirements in accordance with the manufacturer's instructions.

3.3 GENERAL INSTALLATION

- A. In order to ensure a complete, functional VMS, for bidding purposes, where information is not available from the Owner upon request, the worst-case condition shall be assumed.
- B. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.
- C. Refer to plans for locations and quantities of equipment. Equipment locations shown on plans will be required to be field coordinated to ensure proper system operation. The contractor shall provide adequate costs in the bid to locate interior cameras within 10' in any direction of the location indicated on the bid drawings. Exact location of each camera shall be coordinated with the owner in the field prior to installation. This coordination shall include a site survey with the owner in which the use of a field of view comparator is employed.
- D. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system. Camera placement shall be coordinated with glass and exterior exposures to reduce or eliminate the requirement for sever back light compensation.
- E. Perform all work under the on-site supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer's and owner approval. A CSR of the installing contractor or manufacturer shall train the owner's personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.
- F. Camera Mounts: The Contractor shall install the camera mounts as specified by the manufacturer and as shown; provide mounting hardware sized appropriately to secure the mount, camera and housing, provide electrical and signal transmission cabling to the mount location as specified.
- G. Cameras: The Contractor shall install the cameras with power and signal lines to the camera; aim camera to give field of view as needed to cover the alarm zone and synchronize all cameras so the picture does not roll on the monitor when cameras are selected.

1. Provide a change of all camera lenses up/down/size and re-aiming of each camera as directed by the Owner.
- H. Monitors: The Contractor shall install the monitors as shown and specified; connect all signal inputs and outputs as shown and specified; terminate video input signals as required; and connect the monitor to AC power.
- I. Video Recording Equipment: The Contractor shall install the video recording equipment as shown and as specified by the manufacturer; connect video signal inputs and outputs as shown and specified; connect alarm signal inputs and outputs as shown and specified; and connect video recording equipment to AC power.
- J. Delivery of all loose equipment which is to be turned over to owner shall be carefully coordinated and scheduled with owner prior to shipment

3.4 WIRING INSTALLATION

- A. CCTV wiring shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all Local, State and National codes. This contract shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.
- B. Provide firestop material and seal all cable penetrations in the building.
- C. All wiring between devices shall be run open wired above accessible ceilings. Where existing cable management systems are in place and there is adequate capacity to install the CCTV wiring, the contractor may utilize these pathways providing they have coordinated with all other wiring contractor on site. Where multiple runs are required all cables shall be bundled with approved cable ties on four foot centers.
- D. Where pathways do not exist for SMS wiring, this contract shall be responsible for providing all required cable management systems such as J-hooks to support communications cabling to meet building codes and manufacturer's recommendations.
- E. Cables shall not be laid upon ceilings or supported in a manner that would violate any codes or standards.
- F. All cabling installed in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.
- G. All control and signal cable shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

3.5 TELECOMMUNICATIONS ROOMS

- A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination

drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

- B. Coordinate lay-out of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.
- C. Coordinate lay-out of telecom rooms with electrical plans and locations of electrical outlets.
- D. Lay-out of telecommunications equipment cabinets and racks shall provide a minimum of 36” aisle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.
- E. Coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as UPS units may have special mounting requirements that need additional coordination.

3.6 GROUNDING

- A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.
- B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.
- C. The Division 16 Contractor has provided 120V branch circuitry for use by the CCTV system contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the CCTV system equipment. In no case shall the CCTV system installation compromise the integrity of the Building Electrical Grounding System.

3.7 PROGRAMMING

- A. It is the Contractor’s responsibility to program the system in this section according to the Owner’s wishes. This involves camera labeling, camera operation sequences, camera and recorder schedules, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.
- B. Each building shall have the following minimum programming:
 - 1. Camera labels programmed in each DVR.
 - 2. Camera record rates based upon TOD schedules, alarm events, motion events.
 - 3. Camera motion detection recording based upon TOD schedules. Motion detection scene masking.
 - 4. PTZ cameras – Home position, tours, alarm pre-sets.

- C. Additional programming at each building shall include set-up of graphical floor plans with interactive camera icons for all cameras local to that building. Owner NOC shall include set-up of graphical floor plans with interactive camera icons for all sites.
- D. Set-up of passwords and a minimum of four (4) user access levels including assignment of specific privileges for each user access level.

3.2 IDENTIFICATION/LABELING

- E. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.
- F. The contractor shall be responsible for generating and programming the labeling for camera information within the recorder software.
- G. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.3 TESTS

H. System Startup

1. The Contractor shall not apply power to the CCTV system until the following items have been completed:
 - a. CCTV system equipment items and circuitry have been set up in accordance with manufacturer's instructions.
 - b. A visual inspection of the CCTV system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
 - c. System wiring has been tested and verified as correctly connected as indicated.
 - d. All system grounding and transient protection systems have been verified as properly installed and connected as indicated.
 - e. Power supplies to be connected to the CCTV system have been verified as the correct voltage, phasing, and frequency as indicated.
2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work/equipment.

3.8 SITE TESTING

- A. General: The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification. Original copies of all data produced during performance verification shall be turned over to the Owner at the conclusion of testing prior to final approval.
 1. Contractor's Field Testing: The Contractor shall calibrate and test all equipment, verify operation, place the integrated system in service, and test the integrated system. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete

system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure. In addition, the Contractor shall make a master video tape recording showing typical day and night views of each camera in the system and shall deliver the tape with the report. Note any objects in the field of view that might produce highlights that could cause camera blinding. Note any objects in the field of view or anomalies which may cause blind spots. Note if a camera cannot be aimed to cover the zone. Note night assessment capabilities and whether lights or vehicle headlights cause blooming or picture degradation. If any of the above conditions or other conditions exist that cause picture degradation or interfere with the camera field of view, the Contractor shall inform the Architect. The tape shall be recorded using the video recorder installed as part of the CCTV system. The Contractor shall provide the Owner with the original tape as part of the documentation of the system and shall submit a letter certifying that the CCTV system is ready for performance verification testing. The field testing shall as a minimum include:

- a. Verification that the video transmission system and any signal or control cabling have been installed, tested, and approved.
 - b. Verification that the multiplexer is fully functional and that the multiplexer has been programmed as needed for the site configuration.
 - c. Verification that all video sources and video outputs provide a full bandwidth signal that complies with EIA 170 at all video inputs.
 - d. Verification that all video signals are terminated properly.
 - e. Verification that all cameras are synchronized and that the picture does not roll when cameras are switched.
2. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.
 3. Performance Verification Test: The Contractor shall demonstrate that the completed CCTV system complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test as specified, shall not be started until receipt by the Contractor of written permission from the Owner, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. The Owner may terminate testing at any time when the system fails to perform as specified.

3.4 TRAINING REQUIREMENTS

- B. Provide the owner with a minimum of 24 hours of training designed to make all users familiar with the operation of the system.
 1. The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the CCTV system as specified. The training shall be oriented to the specific system being installed under this contract. Training manuals shall be delivered for each trainee with two additional manuals delivered for archiving at the project site. The Contractor is responsible for furnishing all audio-visual equipment and all other training materials and supplies. A training day is 8 hours of instruction,

- including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the facility. Approval of the planned training schedule shall be obtained from the Owner at least 14 days prior to the training.
2. The course shall be taught at the project site for one full day during or after the Contractor's field testing. No part of the training given during this course will be counted toward completion of the performance verification test. The course shall consist of instruction, hands-on training, instruction on the specific hardware configuration of the installed system, and specific instructions for operating the installed system. The course shall demonstrate system start up, system operation, system shutdown, system recovery after a failure, the specific hardware configuration, and operation of the system and its software. The students should have no unanswered questions regarding operation of the installed CCTV system. The Contractor shall prepare and insert additional training material in the training manuals when the need for additional material becomes apparent during instruction. The course shall include:
 - a. General CCTV hardware, installed system architecture and configuration.
 - b. Functional operation of the installed system and software.
 - c. Operator commands.
 - d. Fault diagnostics and correction.
 - e. General system maintenance.
 - f. Replacement of failed components and integration of replacement components into the operating CCTV system.
- C. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.
1. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.
 2. Demonstrate adjustment, operation and maintenance of the system including each component and control.
 3. This training period shall be scheduled with the Owner after the successful completion of the system.
- ### 3.9 AS BUILT DOCUMENTATION
- A. Copies of all approved shop drawings with the Engineer's stamp.
 - B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of owner's manuals must contain the proper software viewers for each document type.
 1. Interior Camera assembly including housing and lens
 2. Exterior Camera Assembly including housing and lens.
 3. Each type of camera power supply
 4. Camera recorder
 5. Racks/Cabinets
 6. System Software.

- C. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.
- D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.
- E. Rack elevations for all systems with rack mounted equipment.
- F. System Operating Instructions: Provide a clear and concise description of preparation which gives, in detail, the information required to properly operate the equipment and system.
- G. Provide statement of warranty.

3.10 WARRANTY

- A. This Contractor shall warrant all workmanship, equipment and material provided under this contract for a period of one (1) year from the date of approval of certificate of contract completion by the Owner. If any defects are found within the warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor. Provide statement of warranty with the O&M manuals.
- B. During the first year's warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:
 - 1. Visual checks and operational test of the multiplexer, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.
 - 2. Correct all diagnosed problems.
 - 3. Resolve any previous outstanding problems.
- C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.
- D. The Contractor shall be responsible to provide service during normal working hours within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25% or more of system component operation, or the loss of the video switcher or other head-end equipment. Provide an on-site authorized factory technician within 24 hours if required.
- E. If equipment cannot be repaired within 24 hours of service visit, Contractor shall provide "loaner" equipment to the Owner at no charge.

3.11 CERTIFICATION

- A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all

components are properly installed and free of defects, and that the system is in compliance with this specification.

END OF SECTION 282300

(This page intentionally left blank)

DIVISION

31

EARTHWORK

(This page intentionally left blank)

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Removing existing vegetation.
 - 2. Temporary erosion- and sedimentation-control measures.
- B. Related Sections:
 - 1. Division 01 Section "Execution" for field engineering and surveying.
 - 2. See SWPPP drawings for Temporary Erosion Controls.
 - 3. Section 312000 Earth Moving.

1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- D. Utility Protection Zone: Area designated over existing utility areas.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. ODOT Construction and Material Specifications; January 1, 2010

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, and pavements.
2. Excavating and backfilling for buildings and structures.
3. Subbase and Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also, for temporary site fencing if not in another Section.
2. Division 03 Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
3. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
4. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

- D. Borrow Soil: Satisfactory soil imported from off-site or from elsewhere on-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer placed between subbase course and concrete slabs-on-grade.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.
- I. 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.
- J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk, or aggregate layer placed between the subgrade and drainage course for concrete slabs-on-grade.
- K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 - 1. Geotextiles.
- B. Samples for Verification: For the following products, in sizes indicated below:
 - 1. Geotextile: 12 by 12 inches.

1.5 EXISTING CONDITIONS

- A. An aggregate building pad area was previously prepared for this site.

1. The perimeter of this pad and grades are shown on Existing Site Conditions drawing.
2. This building pad was constructed in July 2019 with engineered fill borrowed from the site and compacted to the compaction specifications included below.
3. This pad was topped with 4 inches of compacted Item 304 stone aggregate and placed in a crown cross section with a 2% slope from the center to outside perimeter.
4. This existing pad perimeter exceeds the footprint of the building proposed in this contract as shown on Sheet SP1: Location of Existing Gravel Base Inset.

1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
 1. Do not close or obstruct streets, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.
- C. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures are in place.
- D. Do not commence earth moving operations until plant-protection measures specified in Division 01 Section "Temporary Tree and Plant Protection" are in place.
- E. The following practices are prohibited within protection zones:
 1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Erection of sheds or structures.
 4. Impoundment of water.
 5. Excavation or other digging unless otherwise indicated.
 6. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- F. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- B. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- C. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve, ODOT Item 304.
- D. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve, ODOT Item 304.
- E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- G. Drainage Course: Washed crushed stone or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 8; with 100 percent passing a 1/2-inch sieve and 0 to 5 percent passing a No. 16 sieve. Rounded river gravel shall not be used.
- H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- I. Sand: ASTM C 33; fine aggregate.
- J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

2.3 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 1. Survivability: Class 2; AASHTO M 288.
 2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
 3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
 4. Tear Strength: 56 lbf; ASTM D 4533.
 5. Puncture Strength: 56 lbf; ASTM D 4833.
 6. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.

7. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
 2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
 3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
 4. Tear Strength: 90 lbf; ASTM D 4533.
 5. Puncture Strength: 90 lbf; ASTM D 4833.
 6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
 7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
 8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.4 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

- B. Protect and maintain erosion and sedimentation controls during earth moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.
- D. Herbicide Treatment:
 - 1. Apply herbicide according to manufacturer's recommended rates and written application instructions.
 - 2. Apply to dry, prepared existing aggregate subbase in the area of the building proposed in this contract.

3.2 EXISTING BUILDING PAD MATERIAL

- A. Excess ODOT Item 304 material from the top 4 inches of the existing building pad area may be used as subbase in other paved areas.
- B. Reused aggregate material must be approved by the construction testing lab.

3.3 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6 inches beneath bottom of concrete slabs-on-grade.
 - f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.
- B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.
 - 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

- a. Intermittent drilling, ram hammering, or ripping of material not classified as rock excavation is earth excavation.
2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6 inches beneath bottom of concrete slabs-on-grade.
 - f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.4 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
- B. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- C. BUILDING PAD EXCAVATIONS:
 1. See EXISTING CONDITIONS, Paragraph 1.5 above and EXISTING BUILDING PAD MATERIAL Paragraph 3.2 above.
 2. Regrade the existing stone aggregate material in the area of the new building pad to a level condition meeting compaction specifications.
 3. Apply herbicide according to manufacturer's recommended rates and written application instructions to the regraded subgrade in the new building pad area.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit or as indicated.
- C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
 - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect, Owner's Representative, or Soils Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. ODOT Item 204, Subgrade Compaction.
 - 1. For all paved areas, subsequent to site clearing and prior to any fill or aggregate placement, all exposed surfaces should be proof rolled with an approved loaded, tandem axle truck to evaluate for soil stability and to verify that a relatively unyielding surface is achieved. Soft or loose soils, if encountered, should be disked, dried and recompacted or undercut and replaced with compacted engineered fill or otherwise as directed by the soils engineer at no additional cost to the Owner.
 - 2. In the event that excessive rutting or deflections occur during proof rolling operations, yielding soils should be addressed as noted in the site geotechnical report or as directed by the soils engineer at no additional cost to the Owner.
 - 3. All areas to receive pavement shall be compacted as noted in ODOT Item 204. Soils Engineer shall require proof rolling of subgrade prior to installation of base material. Proof rolling shall consist of driving over the subgrade with a loaded tandem dump truck as directed by the Soils Engineer until no deflection or tire indentation in the subgrade is present. All proof rolling procedures and any necessary corrective measures will be the complete responsibility of the Contractor.
 - 4. Payment for item 204 subgrade compaction for all operations described above shall be included in the lump sum bid price and shall include all labor, material and equipment required to complete this item of work.
- D. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 20 tons to identify soft pockets and areas of excess yielding. Proof rolling at asphalt pavement subgrades shall meet the requirements of ODOT Item 204.06. Do not proof-roll wet or saturated subgrades.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.9 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, damp proofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting 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.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."
- D. Backfill voids with satisfactory soil while removing shoring and bracing.
- E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

- H. Bedding course and Backfill for all metallic piping shall be natural washed stone material. Crushed limestone material is not permitted due to potential adverse reactions with the piping.

3.11 FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.
 - 3. Under steps and ramps, use engineered fill.
 - 4. Under building slabs, use subbase material, ODOT Item 304.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.12 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 (Standard Proctor):
 - 1. Building Slab:
 - a. Compact top 12 inches of subgrade and each 8 inch layer of backfill or fill material to 100 percent Standard Proctor maximum dry density. Compaction shall comply with ODOT Item 204 and per Geotechnical Report
 - b. The aggregate base should comply with the gradation requirements of ODOT Item 304 dense-graded aggregate. It should be compacted to 100 percent of the maximum dry density as determined by ASTM D698 (standard Proctor).
 - 2. Pavements:

- a. Compact top 12 inches of subgrade and each 8-inch layer of backfill or fill material to 98 percent Standard Proctor maximum dry density. Compaction shall comply with ODOT Item 204 and per Geotechnical Report.
- b. The aggregate base should comply with the gradation requirements of ODOT Item 304 dense-graded aggregate. It should be compacted to 98 percent of the maximum dry density as determined by ASTM D698 (standard Proctor).
3. Foundations: Compact top 12 inches of subgrade and each 8 inch layer of backfill or fill material to 100 percent Standard Proctor maximum dry density
4. Lawn and Unpaved Areas: Compact top 6 inches of subgrade and each 8-inch layer of backfill or fill material to 95 percent Standard Proctor maximum dry density.
5. Walkways: Compact top 6 inches of subgrade and each 8 inch layer of backfill or fill material to 98 percent Standard Proctor maximum dry density.
6. Underground Utilities: Provide the preceding requirements for the respective utility location(s).
7. Utility Piping and conduits:
 - a. Bedding shall begin by placing 4 to 6 inch bedding of the approved backfill material and compacting to 90 percent of the Modified Proctor maximum dry density. The width of the bedding shall be the diameter of the pipe plus 2 feet.
 - b. Haunching shall consist of placing the approved backfill material to the spring line of the pipe and compacting to 90 percent of the Modified Proctor maximum dry density. This lift shall not exceed 9 inches loose. The pipe bedding and flow line shall not be disturbed as a result of the haunching operation.
 - c. Initial backfill shall consist of placing the approved backfill material to the top of the pipe and compacting to 90 percent off the Modified Proctor maximum dry density. This lift shall not exceed 9 inches loose. Crushed or buckled pipe as a result of the backfilling operations will be removed and replaced with no additional payment.
 - d. Initial backfill shall continue in 6 inch lifts with the approval backfill material to a depth of 12 inches above the pipe
8. Finish backfilling of the trench shall consist of placing the approved backfill or material from the trench excavation in 6 inch lifts to the grade of the trench. Finish backfilling within paved areas shall continue to the base of the compacted aggregate with the approved backfill material.

3.14 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Turf or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1 inch.
 3. Pavements: Plus or minus 1/2 inch.

- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.15 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and slabs as follows:
 - 1. Place subbase course to compacted thickness as indicated. Compacted thickness shall be 4" minimum if thickness is not indicated.
 - 2. Compact subbase course at optimum moisture content, to not less than 95% of maximum dry unit weight according to ASTM D 1557.
 - 3. Place base course material over subbase course for construction drive and asphalt pavement patch areas.
 - 4. Shape subbase course and base course to required crown elevations and cross-slope grades.
 - 5. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
 - 6. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 7. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
- C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.16 SUBBASE UNDER CONCRETE SLABS-ON-GRADE

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under cast-in-place concrete slabs-on-grade (building platform) as follows:
 - 1. Place subbase course to compacted thickness as indicated. Compacted thickness shall be 4" minimum if thickness is not indicated.
 - 2. Compact subbase course at optimum moisture content, to not less than 95% of maximum dry unit weight according to ASTM D 1557.
 - 3. Consolidate using roller or vibratory compactor until it will remain stable under construction traffic. Wheels of construction vehicles shall not penetrate the drainage course more than 1/2" when driven across the surface.

3.17 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 - 2. Determine that fill material and maximum lift thickness comply with requirements.
 - 3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
 - 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained at no additional cost to the Owner.

3.18 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
 1. Remove waste materials, including trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

1.5 SUBMITTALS

- A. Existing Conditions: Documentation of existing conditions, adjoining construction, and previous site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or videotape.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify OUPS for area where Project is located before site clearing.
- C. Do not commence site-clearing operations until temporary erosion and sedimentation control and plant-protection measures are in place.
- D. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Erection of sheds or structures.
 - 4. Impoundment of water.
 - 5. Excavation or other digging unless otherwise indicated.
 - 6. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- E. Topsoil Replacement: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify vegetation to remain.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Maintain existing SWPPP improvements installed previously.
- B. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to SWPPP Drawings and requirements of authorities having jurisdiction.
- C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- D. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- E. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

- A. Interrupting Existing Utilities: Do not interrupt existing 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 Architect not less than two days in advance of proposed utility interruptions.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions to permit installation of new construction.
 - 1. Remove roots with a backhoe or other means of removing roots in the building pad area.

3.5 STRIPPING

- A. Site topsoil was stripped in an early site project and is stockpiled in two locations.

1. Maintain stockpile during construction to eliminate erosion and keep vegetative cover to reasonable height or not more than 36" high.
- B. Remove subsoil and non-soil materials in areas necessary for acceptable construction subbase in building and paved areas.

3.6 SITE IMPROVEMENTS

- A. Remove existing above and below-grade improvements as indicated and necessary to facilitate new construction.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove unsuitable and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

DIVISION

32

**EXTERIOR
IMPROVEMENTS**

(This page intentionally left blank)

SECTION 321216 - ASPHALT PAVING

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. Hot-mix asphalt patching.
- 2. Hot-mix asphalt paving.

- B. Related Sections:

- 1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
- 2. Division 32 Section Pavement Markings
- 3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

- C. ODOT SPECIFICATIONS:

- 1. Hot-mix asphalt patching.
- 2. All ODOT Construction and Material Specifications shall apply to this project except for ODOT Item 401.20 asphalt binder price adjustment. All asphalt delivered shall be accompanied with a load ticket as per Item 401.21. Asphaltic concrete bid items are not eligible for any asphalt binder price adjustment.

1.3 DEFINITION

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B. Samples: For each paving fabric, 12 by 12 inches minimum.
- C. Material Certificates: For each paving material, from manufacturer.
- D. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable standards of ODOT for asphalt paving work.
- C. Preinstallation Conference: Conduct conference at regular project meeting.
 - a. Review condition of subgrade and preparatory work.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Tack Coat: Minimum surface temperature of 60 deg F.
 - 2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone or crushed gravel.
- C. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone or gravel.
 - 1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.
- B. Asphalt Cement: ASTM D 3381 for viscosity-graded material.

- C. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- D. Water: Potable.
- E. Undersealing Asphalt: ASTM D 3141, pumping consistency.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.
- C. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications. Use if required by unforeseen conditions.
- D. Joint Sealant: ASTM D 6690 or AASHTO M 324, Type I, hot-applied, single-component, polymer-modified bituminous sealant.
- E. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N; colors complying with FS TT-P-1952.
 - 1. Color: White (automobiles); Yellow (busses).
- F. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes meeting ODOT specifications designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Base Course: ODOT Item 448 Type 2.
 - 3. Surface Course: ODOT Item 448 Type 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.
- D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.3 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
 - 1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.4 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
 1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.01 to 0.15 gal./sq. yd.
 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 PAVING GEOTEXTILE INSTALLATION

- A. Use of an approved geotextile shall be determined by the soils engineer.
- B. Apply asphalt binder uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd..
- C. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches and transverse joints 6 inches.
 1. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

3.6 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt 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 number of lifts and thicknesses indicated.
 2. Place hot-mix asphalt surface course in single lift.
 3. Spread mix at minimum temperature of 250 deg 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 in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.7 JOINTS

- A. Construct joints to ensure a 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 to joints.
 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.8 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.

- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.9 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
 - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
 - 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.
- E. Replace and compact hot-mix asphalt where core tests were taken.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.11 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
 1. Do not allow milled materials to accumulate on-site.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

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. This Section includes exterior cement concrete pavement for the following:
 - 1. Driveways and roadways.
 - 2. Curbs and gutters.
 - 3. Walkways, sidewalks.
 - 4. Unit paver base.
 - 5. Detectable/tactile warning surfaces.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
 - 2. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.
 - 3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Qualification Data: For testing agency.

- D. 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:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- E. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
 - 1. Cementitious materials.
 - 2. Steel reinforcement and reinforcement accessories.
 - 3. Admixtures.
 - 4. Curing compounds.
 - 5. Joint fillers.
- F. Field quality-control test reports.
- G. Mock-ups:
 - 1. Provide mock-up sample area of Medium-to-Coarse-Textured Broom Finish for Architect's review and approval on concrete walkways or other areas scheduled to receive this finish.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
- C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
- D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- E. Preinstallation Conference: Conduct conference at scheduled project meeting.
 - a. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
 - 1. Use flexible or curved forms for curves with 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.

2.2 STEEL REINFORCEMENT

- A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- D. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source throughout the Project:
 - 1. Portland Cement: ASTM C 150, Type I:

- B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate, uniformly graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
 - 1. Products:
 - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
 - c. Euclid Chemical Company (The); Kurez DR VOX.
 - d. Kaufman Products, Inc.; Thinfilm 420.
 - e. Lambert Corporation; Aqua Kure-Clear.
 - f. L&M Construction Chemicals, Inc.; L&M Cure R.
 - g. Meadows, W. R., Inc.; 1100 Clear.

2.5 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Detectable/Tactile Warning Surfaces: vitrified polymer composite (VPC) cast in place detectable/tactile warning surface tile.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ADA Solutions, Inc.
 - b. Armorcast Products Company
 - c. Armor-Tile by Engineered Plastics Inc.

2.6 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 4000 psi.
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
 - 3. Slump Limit: 4 inches.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size
- D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides 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.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire reinforcement 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.
- 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 overlap of adjacent mats.

3.5 JOINTS

- A. General: Form construction, isolation, 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.
- 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. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 - 2. Provide tie bars at sides of pavement strips where indicated.
 - 3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 - 5. Doweled Joints: 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.

- C. Isolation Joints: Form isolation 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, unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 4. 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. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes.
 - 2. Doweled Contraction Joints: 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. Edging: After initial floating, tool edges of paving, gutters, curbs, walkways and joints in concrete with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes.

3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site.
- F. Do not add water to fresh concrete after testing.

- G. 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.
- H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- I. Screed pavement surfaces with a straightedge and strike off.
- J. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- K. 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.
- L. 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, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.
- M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.

- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. 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 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.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
 - 1. Moist 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 lap over adjacent absorptive covers.
 - 2. 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.

3.9 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 - 1. Elevation: 1/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot- long, unlevelled straightedge not to exceed 1/4 inch.
 - 4. Joint Width: Plus 1/8 inch, no minus.

3.10 WHEEL STOPS

- A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded in holes drilled or cast into wheel stops at one-quarter to one-third points. Firmly bond each dowel to wheel stop and to pavement. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least 1 composite sample for each 5000 sq. ft. or fraction thereof of each concrete mix placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 - 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.12 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B. Drill test cores, where directed by Architect or Testing Agency, 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.
- E. Protect tactile tiles against damage during construction period to comply with Tactile Tile manufacturer's specification.
- F. Protect tactile tiles against damage from rolling loads following installation by covering with plywood or hardwood.
- G. Clean tactile tiles not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean tactile tile by method specified by Tactile Tile manufacturer.
- H. Comply with manufacturers maintenance manual for cleaning and maintaining tile surface and it is recommended to perform annual inspections for safety and tile integrity.

3.13 CONCRETE FINISH SCHEDULE

CONCRETE FINISH SCHEDULE	
ITEM	FINISH

Lean concrete fill at soft soils or over Excavations	N/A
Exterior walks, stoops, steps, aprons, and curbs, and exterior concrete not otherwise indicated	Medium-to-Coarse-Textured Broom Finish
Exterior formed concrete exposed to view not otherwise indicated	Fine Broom Finish

END OF SECTION 321313

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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Cold-applied joint sealants.

- B. Related Sections:

- 1. Division 07 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.
 - 2. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
 - 3. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, Samples of materials that will contact or affect joint sealants.

- 1. Use manufacturer's standard test method to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

1.4 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Submit joint locations.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS

- 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: As selected by Architect from manufacturer's full range.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Crafcro Inc., an ERGON company; RoadSaver Silicone.
 - b. Dow Corning Corporation; 888.
 - c. Pecora Corporation; 301 NS.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Crafcro Inc., an ERGON company; RoadSaver Silicone SL.
 - b. Dow Corning Corporation; 890-SL.
 - c. Pecora Corporation; 300 SL.
- C. Multi-Component, Pourable, Traffic-Grade, Modified-Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; Urexpan NR-300.
 - b. Sika Corporation. Construction Products Division; Sikaflex - 2C SL.

- c. Tremco Incorporated; THC-900.

2.3 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 Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

2.4 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.
- 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. 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 for products and applications indicated unless more stringent requirements apply.

- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install joint-sealant backings of kind indicated to support joint 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 joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place joint sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
 - 1. Remove excess joint sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

- A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- 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 and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.

1. Joint Location:

- a. Expansion and isolation joints in cast-in-place concrete pavement and where slab adjoins the building or other vertical walls.

END OF SECTION 321373

(This page intentionally left blank)

SECTION 321723 - PAVEMENT MARKINGS

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 painted markings applied to new and existing asphalt and concrete pavement.
- B. Related Requirements:
 - 1. Section 099123 "Painting and Finishing" for painting exterior concrete surfaces other than pavement.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include technical data and tested physical and performance properties.
- B. Samples: For each type of product requiring color selection.
 - 1. Sample of special pavement coating including all available colors.
- C. Shop Drawings: For pavement markings.
 - 1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
 - 2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Akzo Nobel Paints LLC.
 - 2. Benjamin Moore & Co.
 - 3. PPG Industries.
 - 4. Sherwin-Williams Company (The).

2.2 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type I, with drying time of less than 45 minutes.
 - 1. Color:
 - a. White – for automobile markings.
 - b. Blue – for handicapped markings.
- B. VOC Content: Pavement markings used on building interior shall have a VOC content of 150 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.
- B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.
- C. All pavement markings shall be per ODOT item 640 and 642. All pavement markings to be type 1, unless application is required when air and pavement temperatures are between 35°F. and 50°F., then obtain approval from the Owner and apply only pre-qualified Type 1A Cold weather traffic paint per Item 640 and 740.

3.2 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for a minimum of sixty (60) days before starting pavement marking.

1. Submit a request to the Architect if the 60 day cure time is not feasible including manufactures recommendations.
 2. Apply a primer prior to applying pavement marking material meeting manufacturers recommendations if the 60 day curing time is not feasible.
- 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.
1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.
 2. Apply a primer prior to applying pavement marking material if the 60 day curing time is not

3.3 PROTECTING AND CLEANING

- A. Protect pavement markings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

(This page intentionally left blank)

SECTION 329200 - TURF AND GRASSES

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. Seeding.
2. Hydroseeding.
3. Sodding.

- B. Related Sections:

1. See Section 012300 – Alternates for Turf and Grass 12 Month Warranty.
2. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
3. Section 312000 "Earth Moving" for excavation, filling and backfilling, and rough grading.
4. Section 329300 "Plants" for border edgings.
5. See SWPPP Drawings for Erosion-control seeding specifications included in the drawing set.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. Pests: Living organisms that occur where they are not desired or that can cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- B. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Three years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress
 - 4. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- C. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk fertilizers, lime and soil amendments with appropriate certificates.

1.8 PROJECT CONDITIONS

- A. A.Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.
 - 1. Spring Planting: March 15 through April 15
 - 2. Fall Planting: August 15 through October 7
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.9 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
 - 1. Seeded Turf: Not less than 60 days from date of planting completion.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species as follows
 - 1. Seed Mix
 - a. Basis of Design: Green Velvet Trophy XRE Turf Tall Fescue Blend
 - 2. : Proportioned by weight as follows
 - a. 100 percent Elite Tall Fescue 3 varieties
 - b. Seeding Rate: 8-10 lbs. per 1000 sq. ft.
- C. Turfgrass Sod: Certified complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- D. Turfgrass Species: Sod of grass species as follows:
 - a. Basis of Design: Green Velvet Trophy XRE Turf Tall Fescue Blend

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: Apply ground agricultural limestone if necessary , at the rate determined by Contractor's soil tests to adjust pH of topsoil at no less than 6.5.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through ¾ inch sieve; soluble salt content of 5 to 10 Deci-siemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50-60 percent of dry weight.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.
- C. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
- D. Manure: Well-rotted, unbleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.4 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: 20 lb./1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.5 PLANTING SOILS

- A. Topsoil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 3/4 inch or larger in any dimension and other extraneous materials harmful to plant growth. Mix ASTM D 5268 topsoil with soil amendments and fertilizers, as needed to produce planting soil.
- B. Planting Soil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - 1. Supplement with another planting soil when quantities are insufficient.
 - 2. Mix existing, native surface topsoil with soil amendments and fertilizers in to produce planting soil:
 - a. Ratio of Loose Compost to Topsoil by Volume: 1:4.
 - b. Ratio of Loose Muck Peat to Topsoil by Volume: 1:3.
 - c. Weight of Lime per 1000 Sq. Ft.:
 - d. Volume of Sand Plus 10 Percent Diatomaceous Earth, Zeolites per 1000 Sq. Ft.:
 - e. Weight of Bonemeal per 1000 Sq. Ft.:
 - f. Weight of Superphosphate per 1000 Sq. Ft.:
 - g. Weight of Commercial Fertilizer per 1000 Sq. Ft.: 20 pounds.
 - h. Weight of Slow-Release Fertilizer per 1000 Sq. Ft.: 1 pound.

2.6 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.7 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results..
 - 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydro mulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.

3.3 TURF AREA PREPARATION

- A. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- B. Limit turf subgrade preparation to areas to be planted.

- C. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 3/4 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Apply superphosphate or commercial fertilizer directly to subgrade before loosening.
 - 2. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - 3. Spread stockpiled ftopsoil to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.
 - b. Reduce elevation of planting soil to allow for soil thickness of turf.
- D. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows.
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Loosen surface soil to a depth of at least 6 inches Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Apply fertilizer directly to surface soil before loosening.
 - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- E. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- F. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- G. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

- B. Apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq. ft.
 - 1. Incorporate fertilizer into soil before seeding.
- C. Sow seed at a total rate of 3 to 4 lb/1000 sq. ft.
- D. Rake seed lightly into top 1/4 inch of soil, roll lightly, and water with fine spray.
- E. Protect seeded areas with slopes exceeding 1:4 and all open ditches with erosion-control blankets stapled according to manufacturer's written instructions.
- F. Protect seeded areas with slopes not exceeding 1:4 by spreading straw mulch. Spread uniformly to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment or apply tackifier.
 - 2. Anchor straw mulch with tackifier at the rate of 10 to 30 gal/1000 s.f. Take care to prevent damage to adjoining areas. Immediately clean damaged or stained areas.

3.5 HYDROSEEDING

- A. Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application. This slurry shall then be uniformly applied to the prepared seed bed.

3.6 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

3.7 TURF MAINTENANCE

- A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.

- B. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- C. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- D. Repair deficiencies immediately.
- E. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.
- F. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain 2 1/2" grass height.
- G. Turf Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.
 - 1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. (but no more than 1-1/2 lb/1000 sq. ft.) to turf areas.

3.8 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
 - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
 - 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.9 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 329300 - PLANTS

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. Plants.
2. Planting soils.
3. Tree stabilization.
4. Landscape edgings.

- B. Related Requirements:

1. Section 1311000 "Site Clearing" for protection of existing trees and plantings topsoil subsurface aggregate drainage and drainage backfill materials.
2. Section 312000 "Earth Moving" for excavation, filling, and rough grading for stripping and stockpiling, and site clearing
3. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, sodding and erosion-control materials.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container.
- D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.
- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

- F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- G. Finish Grade: Elevation of finished surface of planting soil.
- H. Manufactured Planting Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce r planting soil.
- I. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- J. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- K. Planting Area: Areas to be planted.
- L. Planting Soil: Existing topsoil that is modified with soil amendments and fertilizers to produce a soil mixture best for plant growth or imported soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- M. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- N. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- O. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- P. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- Q. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
- R. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at project site.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
- B. Samples for Verification: For each of the following:
 - 1. Mulch: Submit in sealed plastic bags. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup
 - 2. Weed Control Barrier: 12 by 12 inches (300 by 300 mm).
 - 3. Slow-Release, Tree-Watering Device: One unit of each size required.
 - 4. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
 - 5. Gravel Mow Strip Material. Submit in sealed plastic bags. Each Sample shall be typical of the stone to be furnished

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis of standard products.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Material Test Reports: Existing native surface topsoil.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.
- F. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
 - 1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
 - 2. Experience: Three years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1. Plant stock must originate in same hardiness zone as project site.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
 - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
 - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
 - 1. Notify Architect of sources of planting materials 7 days in advance of delivery to site.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

- C. Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- E. Handle planting stock by root ball.
- F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- H. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
 - 1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
 - 2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 - 3. Do not remove container-grown stock from containers before time of planting.
 - 4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 SUBSTITUTIONS

- A. Any substitution request must be submitted at least 3 weeks prior to planting operations.

1.12 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

- B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated.
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of each service or utility.
- C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 1 to June 1.
 - 2. Fall Planting: Sept 1 to October 31.
- D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
- F. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.13 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
 - b. Structural failures including plantings falling or blowing over.
 - c. Faulty performance of tree stabilization and/ or edgings.
 - 2. Warranty Periods: from Date of Planting Completion.
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
 - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
 - c. Annuals: Three 3 months.
 - 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.

- d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

1.14 MAINTENANCE SERVICE

- A. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
 1. Maintenance Period: 12 months from date of planting completion.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots are unacceptable.
 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
- E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
1. Size: 10 gram tablets.
 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 PLANTING SOILS

- A. Provide Planting Soil or Manufactured Planting Soil: Provide fertile, friable soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter and free of roots, stumps, stones, and other extraneous or toxic matter harmful to plant growth and been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth

2.4 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
1. Type: Ground or shredded bark.
 2. Size Range: 1/2 inch (13 mm) minimum.
 3. Color: Natural. No dyed mulch is acceptable.

2.5 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood free of knots, holes, cross grain, and other defects, 2" x 2" x 8', pointed at one end.
 2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles.
 3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
 4. Guy Cables: Five-strand, 3/16-inch- (4.8-mm-) diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches (75 mm) long, with two 3/8-inch (10-mm) galvanized eyebolts.
 5. Hose: High quality braided rubber or plastic hose, 3/4" diameter and suitable length.
 6. Proprietary Staking-and-Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and according to manufacturer's written recommendations.

2.6 MOW STRIP GRAVEL AGGREGATE

- A. See Drawing Sheet SP3 for Material specification.

2.7 LANDSCAPE EDGINGS

- A. Spade Formed Edge see section 3.9.:

2.8 TREE-WATERING DEVICES

- A. Watering Pipe: PVC pipe 4 inches (100 mm) in diameter, site-cut to length as required, and with snug-fitting removable cap.
- B. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over two to three weeks, manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

2.9 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Burlap: Non-synthetic, biodegradable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
 - 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 PLANTING AREA ESTABLISHMENT

- A. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading
- B. Loosen subgrade of planting areas as shown on planting details. Remove stones larger than 3/4 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Apply fertilizer directly to subgrade before loosening.
 - 2. Spread planting soil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
- C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 - 1. For shrub beds, excavate entire bed shown on drawings. Do not excavate individual holes for individual plants.

2. Excavate approximately three times as wide as ball diameter for balled & burlapped stock.
 3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
 4. Maintain required angles of repose of adjacent materials. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 5. Maintain supervision of excavations during working hours.
 6. Keep excavations covered or otherwise protected after working hours.
 7. If drain tile is shown on Drawings or required under planting areas, excavate to top of porous backfill over tile.
 8. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 9. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
- B. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 6 feet, whichever is less, and backfill with free-draining material.
- C. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- D. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE AND SHRUB PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock and Container Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.
1. Use planting soil for backfill.
 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
 - a. Quantity: Two per plant.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root 2 inches (50 mm) above adjacent finish grades.
1. Spread roots without tangling or turning toward surface. Plumb before backfilling and maintain plumb while working.
 2. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
 3. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
- E. Watering Pipe: During backfilling, install watering pipe 4 feet (1.25 m) deep into the planting pit outside the root ball with top of pipe 1 inch (25 mm) above the mulched surface.
- F. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE STABILIZATION

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:
1. Upright Staking and Tying: Stake trees of less than 2-inch caliper to prevent wind tip out. Stakes to penetrate at least 18 inches below bottom of backfilled excavation and to extend one-third of trunk height above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
 2. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
 3. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.7 GROUND COVER AND VINE PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, a minimum 12 inches apart or as indicated on the drawings in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Prepare entire plant bed prior to digging holes for individual.
- D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.8 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. Trees and Tree-like Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with a 36 inch radius around trunks or stems. Do not place mulch within [6 inches of trunks or stems.
 - 2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.
 - 3. Limit of mulch for trees shall be area of pit at minimum, and for shrubs and ground cover in beds, entire area of bed

3.9 INSTALLATION OF EDGING

- A. Shovel-Cut Edging: Separate mulched areas from turf areas with a 45-degree, 4- to 6- inch deep, shovel-cut edge, maintain smooth curves, no broken-back curves
- B. Mow-Strip Installation:
 - 1. Excavate for mow strip.
 - 2. Compact subgrade uniformly beneath mow strip.
 - 3. Apply nonselective, pre-emergent herbicide that inhibits growth of grass and weeds.
 - 4. Install edging, delineating the edge of mow strip.

3.10 INSTALLATION OF SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.11 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use

of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Retain one or both of first two subparagraphs below; revise to suit Project.
 - 1. Provide new trees of same size as those being replaced.

3.13 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and inspection, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.14 ACCEPTANCE OF WORK

- A. Prior to final acceptance of work:
 - 1. Labels, ropes and other foreign objects must be removed from all planting.
 - 2. Plant beds must have at least 3" thick layer of mulch.
 - 3. Plant beds must have clean, well-defined spade-formed edges.
 - 4. Plants must be as listed on the drawings or previously accepted substitutions and in healthy condition.

END OF SECTION 329300

33

UTILITIES

DIVISION

(This page intentionally left blank)

SECTION 331000 - WATER UTILITY DISTRIBUTION PIPING

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. Local authority with jurisdiction shall be followed for work.

1.2 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for combination water service and fire-service mains.
- B. Install water pipe and accessories according to the Miami County Water Department.
- C. Install hydrant and hydrant valve according to the City of Troy Fire Department.
- D. Connect at public water main and extend water service piping though the site and into the building at the location indicated including the hydrant, hydrant tee and valves.
- E. Contact the Miami County Water Department for tapping the existing 12" water main.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
- C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:

1. Water Service system shall comply with the Miami County Engineer's standard requirements and other authorities having jurisdiction. Include tapping of water mains and backflow prevention.
 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
 3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. 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.
- D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- F. NSF Compliance: Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.5 PREINSTALLATION MEETING

- A. Preinstallation Conference: Conduct conference at project site.
1. Coordinate with and Miami County Water Department and Troy Fire Department.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
1. Ensure that valves are dry and internally protected against rust and corrosion.
 2. Protect valves against damage to threaded ends and flange faces.
 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.

1.7 COORDINATION

- A. Coordinate connection to water main with Miami County Water Department.

PART 2 - PRODUCTS

2.1 PIPE, VALVES, ACCESSORIES AND SPECIALTIES

- A. Refer to the specifications and details on the Site Drawings.
- B. Hydrant fittings or specials in sizes 12" through 48" shall conform to all requirements of AWWA C-153. Fittings and specials 12" and smaller shall be Class 250. Larger fittings and specials shall be Class 150. Fittings and specials shall have mechanical joints and shall be ductile iron. Cluster valves whenever possible.

2.2 FIRE DEPARTMENT CONNECTIONS

- A. Covered under the Fire Protection Specifications Division 21.

2.3 PVC PIPE AND FITTINGS

- A. Refer to Site Drawings for Piping.
- B. Pipe shall meet the requirements of ANSI/NSF 61 "Drinking Water System Components Health Effects" and be made from unplasticized PVC compounds having a minimum cell classification of 12454 as defined in ASTM D 1784.
- C. The seal shall meet the requirements of ASTM F477 "Standard for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

2.4 FIRE HYDRANTS

- A. Comply with City of Troy Fire Department for hydrant and hydrant valve installation.
- B. Fire Hydrants:
 - 1. American Darling B84B.
 - 2. Two 2-1/2" hose nozzles with Dayton thread connections.
 - 3. One 4" 1.0 (4-1/2" 0.0.) With 5" Stortz pumper nozzle not National Standard Threads, conforming to AWWA; CCW to open; self-draining.
 - 4. Break flanges 3" above grade.

- C. Fire Hydrant Bases –
 - 1. Hydrant inlet shall be designed for multi-purpose material use with a wide range of pipe outside diameters (0.0.)
 - 2. Inlet shall incorporate a stab-fit design requiring the use of only one type 304 stainless steel fastener,
 - 3. Restraint accessories shall be factory installed and all hydrant inlets shall be Alpha Design furnished by American Flow Control.
 - 4. Hydrants Fittings: or specials in sizes 12" through 48" shall conform to all requirements of AWWA C-153. Fittings and specials 12" and smaller shall be Class 250. Larger fittings and specials shall be Class 150. Fittings and specials shall have mechanical joints and shall be ductile iron. Cluster valves whenever possible.
- D. Hydrant Gate Valves
 - 1. Shall be AWWA C-515, resilient wedge, non-rising stem, mechanical joint, 150 PSI working pressure, CCW to open with arrow indicating open direction, Mueller or equivalent. domestic made only.
 - 2. Valve shall be placed as close to the water main as possible.
- E. Hydrant Valve Boxes
 - 1. Shall be 3-piece, adjustable 36" to 48", 5.25" diameter nominal, adjustable screw type, cover marked "WATER", domestic made only.
- F. All hydrant fittings to be restrained and AWWA C-153 ductile iron, compact.
- G. All hydrants and valves shall open left by turning in a counter-clockwise direction.
- H. Contractor to face hydrant as required by the Troy Fire Department.
- I. Hydrant body shall be yellow, and dome shall be white.
 - 1. Yellow- Dopani Yellow 3186 or approved equal.
 - 2. White- Polar White with reflective clear coat 822900.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
- B. Refer to the Site Drawings for installation details.

3.2 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.
 - 1. Make connections larger than NPS 2 with tapping machine in accordance with the jurisdiction having authority.
 - 2. Make connections NPS 2 and smaller with drilling machine in accordance with the jurisdiction having authority.

- B. Comply with NFPA 24 for fire-service-main piping installation.
- C. Bury piping with depth of cover over top at least 48 inches below finishgrade.
- D. Install PVC, water-service piping according to AWWA C605 "Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water".
- E. **Connect to public water main and extend water service piping into the building location where indicated.**
 - 1. Extend water piping into building and turn-up above the concrete floor and cap with a flanged fitting.
 - 2. Refer to Plumbing Drawings for location in building.
 - 3. Verify type of flange fitting above the building floor with fire protection contractor.
 - 4. Anchor piping to building floor with a retainer flange in accordance with Miami County Water Department.
 - 5. Coordinate with the General Contractor and Plumbing Contractor.

3.3 ANCHORAGE INSTALLATION

- A. Anchorage, General: Only the following may be used for anchorages and restrained-joint types:
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
 - 4. Bolted flanged joints.
 - 5. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, and valves.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.4 VALVE INSTALLATION

- A. Comply with requirements of the Miami County Water Department for all valve installation except for hydrant and hydrant valve installation.
- B. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- C. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- D. MSS Valves: Install as component of connected piping system.
- E. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with Service box.

3.5 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

END OF SECTION 221113

SECTION 331313 - SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section. Local authority with jurisdiction shall be followed for work.

1.2 SUMMARY

- A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
 - 1. Cleanouts.

1.3 PERFORMANCE REQUIREMENTS

- A. Sanitary sewer system shall comply with the Miami County Engineer's standard requirements.
- B. Gravity-Flow, Non-pressure, Piping Pressure Rating: at least equal to system test pressure.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Cleanouts.
 - 2. Pipe.
- B. Coordination Drawings: Show pipe sizes, locations, and elevations.
- C. Field quality-control test reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, for solvent cement or gasketed joints with ASTM F 477, elastomeric seals.

2.4 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

2.5 CLEANOUTS

- A. PVC Cleanouts:
 - 1. PVC SDR 35 with adaptor: Include PVC sewer pipe fitting and riser to clean out of same material as sewer piping.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
- B. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials for each size range:

1. NPS 3 and NPS 4: NPS 4 PVC sewer pipe and fittings, gaskets, and gasketed joints.
2. NPS 5 and NPS 6: NPS 6 PVC sewer pipe and fittings, gaskets, and gasketed joints.
3. NPS 8 and NPS 10: PVC sewer pipe and fittings, gaskets, and gasketed joints.
4. NPS 12 and NPS 15: PVC sewer pipe and fittings, gaskets, and gasketed joints.

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- D. Install gravity-flow, nonpressure, drainage piping according to the following:
 1. Install piping pitched down in direction of flow.
 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 3. Install piping with 48-inch minimum cover.
 4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- E. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Preparatory to making pipe joints, all joint surfaces shall be cleaned of all dirt, dust, and foreign matter and shall be dry, smooth, and free of imperfections before placing joining materials. Gaskets, lubricants, primers, adhesives, or other joining materials shall be used as recommended by the pipe or joint manufacturer's specifications. Generally, lubricants and primers and adhesives shall be placed on both the bell and spigot portions of the joint. The pipe shall then be placed, fitted, joined, and adjusted in such a workmanlike manner as to obtain the degree of watertightness required. In the event that pipe previously laid is disturbed due to any cause, it shall be removed and re-laid.
- B. Joints that show leakage will not be accepted. If after backfilling and inspection, any joints are found to be allowing groundwater to enter the sewer, such joints shall be sealed by the contractor at no cost to the Owner.

- C. No fittings (except service wyes and repair couplings) shall be allowed in gravity sewers. Open ends of wyes shall be plugged or sealed until service laterals are installed
- D. Join gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
 - 2. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.5 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."
- B. Make connections to existing piping and underground manholes.
 - 1. Connect into existing stubbed lateral if possible. If existing lateral is not located proceed as follows.
 - 2. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 3. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000psi.
 - 4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate

3.6 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.

2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 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.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
 - b. Option: Test concrete gravity sewer piping according to ASTM C 924.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.7 CLEANING

- A. Clean interior of piping of dirt and superfluous material.

END OF SECTION 331313

SECTION 334100 - STORM DRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section. Local authority with jurisdiction and ODOT requirements and specifications shall be followed for work.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Cleanouts.
 - 3. Nonpressure transition couplings.
 - 4. Catch basins and stormwater inlets.
 - 5. Downspout boots.
- B. All Storm Drainage Piping shall be in compliance with the Miami County requirements.

1.3 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Non-pressure, Drainage-Piping Pressure Rating: 10-foot head of water. Pipe joints shall be at least silt tight, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.
 - 2. Cleanouts.
- C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- D. Product Certificates: For each type soil pipe and fitting, from manufacturer.
- E. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle catch basins, and stormwater inlets according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

- A. Corrugated Smooth Line PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
 - 2. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
- B. Corrugated Smooth Line PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
 - 1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
 - 2. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.2 PVC PIPE AND FITTINGS

- A. PVC Smooth Line Corrugated Sewer Piping:
 - 1. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
 - 3. Gaskets: ASTM F 477, elastomeric seals.
 - 4. See Site drawings.

2.3 NONPRESSURE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

- B. See Site drawings.

2.4 CLEANOUTS

- A. PVC Cleanouts:
- B. PVC SDR 35 with adaptor: Include PVC sewer pipe fitting and riser to clean out of same material as sewer piping.
- C. See Site drawings.

2.5 CATCH BASINS AND STORMWATER INLETS

- A. See Site drawings.

2.6 DOWNSPOUT BOOTS

- A. Plastic boot for transition from storm pipe to rectangular metal building downspout.
- B. Plastic boot sized to accept the rectangular metal building downspout
 1. Metal downspout size: 3.75" x 4.75".

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."
- B. See Site drawings.

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install 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.
- D. Install gravity-flow, non-pressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install PE corrugated sewer piping according to ASTM D 2321.
4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 1. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
 2. Join dissimilar pipe materials with nonpressure-type flexible couplings.
- B. See Site drawings.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches for cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.
- D. See Site drawings.

3.5 CATCH BASIN AND STORMWATER INLET INSTALLATION

- A. Set frames and grates to elevations indicated.
- B. See Site drawings

3.6 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 1. Use warning tape over nonferrous piping and over edges of underground structures.

3.7 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.
 - c. Option: Test concrete piping according to ASTM C 924.
- C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 334100

(This page intentionally left blank.)