PROJECT MANUAL

Volume 2

Specifications Sections 20 through 33

MARIAN UNIVERSITY
ALUMNI HALL

MARIAN CAMPUS – Indianapolis, Indiana

Bid Package 2 Construction Documents

October 4, 2013

Owner:
Marian University

Architect:
RATIO Architects, Inc.

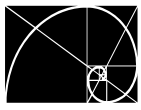
Structural Engineer
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Civil Engineer:
Snelling Engineering

Construction Manager:
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RATIO



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Ratio Project No. 12103.000

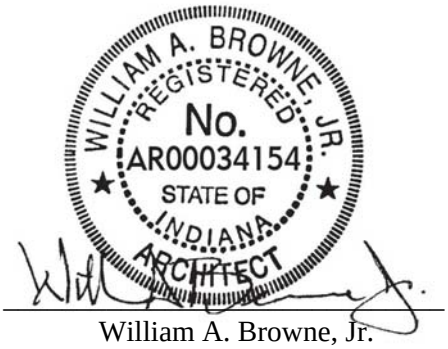
PROJECT MANUAL
VOLUME TWO – DIVISIONS 20 THROUGH 33

MARIAN UNIVERSITY ALUMNI HALL
Bid Package 2 - Construction Documents
Indianapolis, Indiana

OWNER:

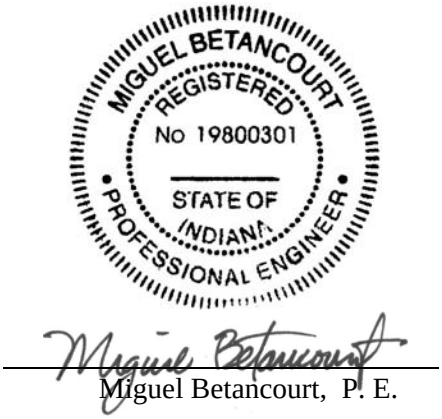
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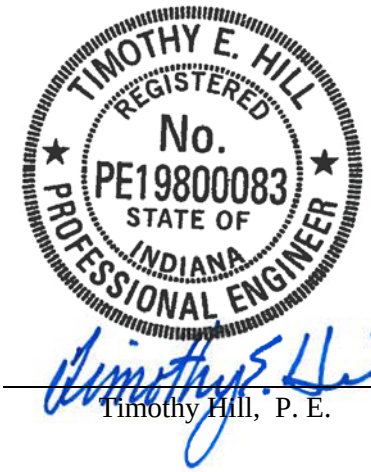
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Date: October 4, 2013

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

ISSUED SEPARATELY BY WILHELM

DIVISION 01 - GENERAL REQUIREMENTS

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Section 012600	Contract Modification Procedures
Section 012900	Payment Procedures
Section 013100	Project Management and Coordination
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NOT USED

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Section 061600	Sheathing
Section 064023	Interior Architectural Woodwork

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Section 071616	Crystalline Waterproofing
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Section 072713	Modified Bituminous Sheet Air Barriers
Section 074213.16	Metal Plate Wall Panels
Section 074213.23	Metal Composite Material Wall Panels
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Section 083316	Overhead Coiling Grilles
Section 083700	Canopy Tilt-up Doors
Section 084113	Aluminum-Framed Entrances and Storefronts
Section 084126	All-Glass Entrances and Storefronts
Section 084413	Glazed Aluminum Curtain Walls
Section 087100	Door Hardware
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Section 088000	Glazing
Section 088300	Mirrors

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Section 095113	Acoustical Panel Ceilings
Section 096513	Resilient Base and Accessories
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Section 096813	Tile Carpeting
Section 096900	Access Flooring
Section 098413	Sound Absorptive Panels
Section 099100	Painting
Section 099500	Wall Coverings

DIVISION 10 - SPECIALTIES

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Section 101400	Signage
Section 101419	Dimensional Letter Signage
Section 101426	Post and Panel/Pylon Signage
Section 102113	Toilet Compartments
Section 102226	Sliding Partition
Section 102238	Operable Glass-Panel Partitions
Section 102600	Wall and Door Protection
Section 102800	Toilet, Bath, and Laundry Accessories
Section 103100	Manufactured Fireplaces
Section 104413	Fire Extinguisher Cabinets
Section 104416	Fire Extinguishers
Section 106500	Automatic Vertically Folding Acoustical Walls

DIVISION 11 - EQUIPMENT

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DIVISION 12 - FURNISHINGS

Section 122413	Roller Window Shades
Section 129300	Site Furnishings

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NOT USED

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NOT USED

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Section 200060	Common Pipe, Valves, Fittings and Hangers for Fire Suppression, Plumbing and HVAC
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DIVISION 22 – PLUMBING (not included in DD Pricing Set)

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Section 221123	Domestic Water Pumps
Section 221319	Sanitary Waste Piping Specialties
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Section 260923	Lighting Control Devices
Section 260943.23	Relay-Based Lighting Controls
Section 262413	Switchboards
Section 262416	Panelboards
Section 262726	Wiring Devices
Section 262813	Fuses
Section 262816	Enclosed Switches and Circuit Breakers
Section 262913	Enclosed Controllers
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Section 270000	Communications
Section 270526	Grounding and Bonding for Communications Systems
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Section 270544	Sleeves and Sleeve Seals for Communications Pathways and Cabling
Section 270553	Identification for Communications Systems
Section 271100	Communications Equipment Room Fittings
Section 271101	Equipment Room Fittings
Section 271116	Cabinets, Racks, Frames, and Enclosures
Section 271119	Termination Blocks and Patch Panels
Section 271300	Communications Backbone Cabling
Section 271500	Communications Horizontal Cabling
Section 271500.23	Audio Video Horizontal Cabling
Section 271513	Copper Horizontal Cabling
Section 271543	Faceplates and Connectors
Section 275231	Security Emergency Call, Duress Alarm and Telecommunications

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

Section 280513	Conductors and Cables for Electronic Safety and Security
Section 280544	Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling
Section 281300	Access Control
Section 282300	Video Surveillance
Section 283000	Access Control System
Section 283111	Digital, Addressable Fire-Alarm System

DIVISION 31 – EARTHWORK (Bid Package 1)

NOT USED

DIVISION 32 – EXTERIOR IMPROVEMENTS

Section 321216	Asphalt Paving
Section 321313	Concrete Paving
Section 321316	Decorative Concrete Paving
Section 321373	Concrete Paving Joint Sealants
Section 321400	Unit Paving
Section 329119	Landscape Grading
Section 329223	Sodding
Section 329300	Plants

DIVISION 33 – UTILITIES (Bid Package 1)

NOT USED

END OF TABLE OF CONTENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this and all Sections of Divisions 20, 21, 22 and 23.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

1. Requirements of Regulatory Agencies.
2. Abbreviations contained in Specifications.
3. Shop Drawings.
4. Record Drawings
5. Operation and Maintenance Manuals.
6. Drawings.
7. Construction Documents.
8. Work and Workmanship.
9. Coordination between Contractors.
10. Assignment of Miscellaneous Work.
11. Equipment Warranty and Early Equipment Startup.
12. Material Equipment Transport
13. Material Storage.
14. Product and Material Approval.
15. Protection and Treatment of Property.
16. Demolition and Removal of Equipment.
17. Electrical Connections to Equipment and Control Wiring.
18. Attaching to Building Construction.
19. Rough-ins.
20. Mechanical Installations.
21. Cleaning and Touch-up.
22. General Completion Startup/Owner Orientation.
23. Air Filters.

1.3 REQUIREMENT OF REGULATORY AGENCIES

A. All materials and workmanship shall comply with all applicable codes, specifications, local ordinances, industry standards and utility company regulations.

B. In case of difference between building codes, specifications, state laws, local ordinances, industry standards, utility company regulations and Contract Documents, the most stringent shall govern. Contractor shall promptly notify Engineer in writing of any such difference.

C. Non-compliance: should Contractor perform any work that does not comply with requirements of applicable building codes, state laws, local ordinances, industry standards and utility company regulations, he shall bear all costs arising in correcting the deficiencies.

D. Applicable codes and standards shall include all state laws, local ordinances, utility company regulations and applicable requirements of the most recent editions of the following nationally accepted codes and standards:

1. The Indiana Building Code. (IBC)
2. The Indiana Electric Code.
3. The Indiana Mechanical Code. (IMC)
4. The Indiana Plumbing Code. (UPC)
5. The Indiana Elevator Code.
6. The Indiana Handicapped Accessibility Code.
7. National Fire Protection Associates (NFPA) codes and regulations.
8. Regulations of the Indiana State Board of Health.
9. Regulations of the Insurance Bureau of Indiana.
10. Requirements of Factory Mutual (FM).
11. Regulations of the Indiana Department of Fire Prevention and Building Services.
12. The Americans with Disabilities Act (ADA).
13. All local and municipal codes and/or regulations.

E. Except as otherwise specified herein, all piping work and materials are to conform to the American Standards Association Code for Pressure Piping.

F. All fired and unfired pressure vessels furnished and installed under this contract are to conform to all requirements of current edition of State of Indiana Rules and Regulations for Boilers and Unfired Pressure Vessels. Copies of all certificates of tests and construction as required by this code to be turned over to Owner.

G. Permits: Contractor shall pay for all building permits required by work and permits for opening streets and for connection to various utilities, including fees for water meter installation and any other requirements necessary to carry out his work. Where streets or sidewalks are cut, same must be repaired to at least as good a condition as they were before, all at expense of this Contractor. Permits shall be posted in prominent place at building site properly protected from weather and physical damage.

1.4 ABBREVIATIONS CONTAINED IN SPECIFICATIONS

A.	AABC	Associated Air Balance Council
B.	AASHTO	American Assn. of State Highway and Transportation Officials
C.	ABMA	American Bearing Manufacturers Association (formerly Anti-Friction Bearing Manufacturers Associates)
D.	ABMA	American Boiler Manufacturers Association
E.	ACI	American Concrete Institute
F.	ACIL	The Association of Independent Scientific, Engineering, and Testing Firms
G.	ACPA	American Concrete Pipe Association
H.	ADA	Americans with Disabilities Act
I.	ADC	Air Diffusion Council
J.	AFBMA	Anti-Friction Bearing Manufacturers Association (see ABMA)
K.	AGA	American Gas Association
L.	AIA	American Insurance Association
M.	AIHA	American Industrial Hygiene Association
N.	AISC	American Institute of Steel Construction
O.	AISI	American Iron and Steel Institute
P.	AMA	Air Moving & Conditioning Association
Q.	AMCA	Air Movement and Control Association International, Inc.
R.	ANSI	American National Standards Institute
S.	API	American Petroleum Institute

T.	AREA	American Railway Engineering Association
U.	ARI	Air-Conditioning and Refrigeration Institute
V.	ASA	American Standards Association
W.	ASA	Acoustical Society of America
X.	ASC	Adhesive and Sealant Council
Y.	ASHRAE	American Society of Heating, Refrigerating & Air-Conditioning Engineers
Z.	ASME	American Society of Mechanical Engineers
AA.	ASPE	American Society of Plumbing Engineers
BB.	ASTM	American Society for Testing Materials
CC.	AWS	American Welding Society
DD.	AWWA	American Water Works Association
EE.	AABC	Associated Air Balance Council
FF.	CAGI	Compressed Air and Gas Institute
GG.	CE	Corps of Engineers (U.S. Department of the Army)
HH.	CGA	Compressed Gas Association
II.	CISPI	Cast Iron Soil Pipe Institute
JJ.	CPPA	Corrugated Polyethylene Pipe Association
KK.	CTI	Cooling Tower Institute
LL.	DIPRA	Ductile Iron Pipe Research Association
MM.	DOT	Department of Transportation
NN.	EPA	Environmental Protection Agency
OO.	FAA	Federal Aviation Administration
PP.	FCC	Federal Communications Commission
QQ.	FDA	Food and Drug Administration
RR.	FIA	Factory Insurance Association
SS.	FCI	Fluid Controls Institute
TT.	FM	Factory Mutual System
UU.	HEI	Heat Exchange Institute
VV.	HI	Hydraulic Institute
WW.	HI	Hydronics Institute (Division of Gas Appliance Manufacturers Association)
XX.	INCE	Institute of Noise Control Engineering
YY.	IEEE	Institute of Electrical & Electronic Engineers
ZZ.	IRI	Industrial Risk Insurance
AAA.	ISA	International Society for Measurement and Control
BBB.	ITS	Intertek Testing Services (Formerly Inchcape Testing Services)
CCC.	MCAA	Mechanical Contractors Association of America
DDD.	MSS	Manufacturing Standardization Society of the Valve and Fittings Industry
EEE.	NACE	National Association of Corrosion Engineers
FFF.	NBS	National Bureau of Standards
GGG.	NCAC	National Council of Acoustical Consultants
HHH.	NCCA	National Coil Coaters Association
III.	NCPI	National Clay Pipe Institute
JJJ.	NCSPA	National Corrugated Steel Pipe Association
KKK.	NEBB	National Environmental Balancing Bureau
LLL.	NEC	National Electric Code
MMM.	NECA	National Electrical Contractors Association
NNN.	NEMA	National Electrical Manufacturers Association
OOO.	NETA	InterNational Electrical Testing Association
PPP.	NFPA	National Fire Protection Association
QQQ.	NIA	National Insulation Association (Formerly National Insulation and Abatement)
RRR.	NIST	National Institute of Standards and Technology (U.S. Department of Commerce)
SSS.	NUSIG	National Uniform Seismic Installation Guidelines
TTT.	OSHA	Occupational Safety & Health Administration (U.S. Department of Labor)
UUU.	PCA	Portland Cement Association
VVV.	PDI	Plumbing and Drainage Institute
WWW.	PPFA	Plastic Pipe and Fittings Association

XXX.	PPI	Plastics Pipe Institute
YYY.	RMA	Rubber Manufacturers Association
ZZZ.	SAE	SAE International
AAAA.	SAE	Society of Automotive Engineers
BBBB.	SMACNA	Sheet Metal & Air Conditioning Contractors' National Association
CCCC.	STI	Steel Tank Institute
DDDD.	SWPA	Submersible Wastewater Pump Association
EEEE.	UL	Underwriters Laboratories
FFFF.	UNI	Uni-Bell PVC Pipe Association
GGGG.	WSC	Water Systems Council

1.5 SHOP DRAWINGS

A. Review of Shop Drawings does not relieve Contractor of responsibility for correct ordering of material and equipment.

B. Contractor review should insure that equipment will fit into available space.

C. Shop Drawings shall be prepared and submitted in accordance with Division 1 "Submittals".

D. Include all significant data on Shop Drawing Submittals shown in Specifications and Equipment Schedule. Including, but not limited to the following:

1. Name each piece of equipment by scheduled name, noted as: "Mark No." as indicated on drawings, i.e., FC-A, CSAC-A, etc.
2. Pressure drops at design flow.
3. Electrical characteristics.
4. Description of construction and material types and gauge of materials used.
5. Entering and leaving air and or water temperature at design conditions.
6. Performance characteristics/efficiency.
7. Dimensional drawing showing locations of all field connections including piping, control, power and sheet metal as well as equipment configuration.
8. Dimensional drawing showing locations of all field connections including piping, control, power and sheet metal as well as equipment configuration.
9. Note any special tools required for equipment service.

E. Items Requiring Submittals:

1. Each individual section list the required items to be submitted.

1.6 RECORD DRAWINGS

A. Contractor shall be responsible for furnishing to Engineer a complete, accurate and neat set of marked-up blueline drawings in accordance with Division 1. This set shall contain all deviations between actual construction and Contract Drawings. **Writer to coordinate specified deliverables from contractor with Division 1.**

B. Contractor shall maintain a mark-up set of as-built drawings on the project site and shall keep all drawings up-to-date as construction progresses. This marked-up set shall be returned to Contractor, as many times as necessary, in order to obtain desired results.

C. Engineer's employees shall inspect Drawings regularly on project site for accuracy and omissions. Pay request will not be approved if marked-up record drawings are not onsite and up to date.

D. Refer to Division 1 “CONTRACT CLOSEOUT” for further instructions.

1.7 CONSTRUCTION DOCUMENTS

A. Construction documents shall include all divisions of specifications, all drawings and all issued addenda.

B. In a case of conflict between the drawings and specifications, or between divisions of specifications, the most stringent condition shall apply.

1.8 OPERATION AND MAINTENANCE MANUALS

A. Prepare Operation and Maintenance Manuals including the following information for equipment items:

1. Complete index identifying contents of manual. Also provide a comprehensive list of manufacturers, suppliers, subcontractors, etc., with name of contact person, address and phone number for each manufacturer, supplier and subcontractor.
2. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and exploded drawing of devices with names and part numbers of replacement parts.
3. Manufacturer’s printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
4. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
5. Servicing instructions and lubrication charts and schedules.
6. Warranty letter from contractor stating general warranty and any extended warranty items included in this contract.
7. Refer to Division 1 “Contract Closeout” for additional instructions.

1.9 DRAWINGS

A. Mechanical Drawings show general arrangement of all piping, equipment and appurtenances. They shall be followed as closely as actual building construction and work of other trades will permit. Mechanical work shall conform to requirements shown on all Drawings. General and Structural Drawings shall take precedence over Mechanical Drawings. Because of small scale of Mechanical Drawings, it is not possible to indicate all offsets, fittings and accessories, which may be required. Contractor shall investigate structural and finish conditions affecting work and shall arrange his work accordingly, providing such fittings, valves and accessories as may be required to meet such conditions.

B. For purpose of clarity and legibility, Drawings are essentially diagrammatic, although size and location of equipment and piping are drawn to scale wherever possible. Verify Contract Document information at site.

C. Drawings indicate required sizes and points of termination of pipes and ducts and suggested routes. It is not the intention of Drawings to indicate all necessary offsets. Install work in manner to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear. Do not scale from Drawings.

D. In case of a conflict in construction documents, Contractor shall receive clarification, prior to bidding, in the form of an addendum or include in his price, the greater amount of work of the conflicts shown, i.e., if two pipe sizes are indicated for the same pipe, the Contractor shall price the larger of the two pipes.

1.10 WORK AND WORKMANSHIP

A. Provide all required labor, materials, equipment and Contractor's services necessary for complete installation of systems required in full conformity with requirements of authorities having jurisdiction; and as indicated on Drawings and herein specified.

B. Finished job shall be functional and complete in every detail, including any and all such items required for a complete system, whether or not these items are specified or shown on drawings.

C. Any apparatus, material or work not shown on Contract Drawings but mentioned in the Specifications, or vice versa, or any incidental accessories or minor details not shown but necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided without additional expense to the Owner.

D. Special attention shall be given to accessibility of working parts and controlling parts. Adjustable parts shall be within easy reach. Removable parts shall have space for removal.

E. Each Contractor shall acquaint himself with details of all work to be performed by other trades and take necessary steps to integrate and coordinate his work with other trades.

F. It is assumed the Mechanical Contractor is familiar with standard first class installation procedures. Therefore, these Specifications do not attempt to include every detail or operation necessary for the complete installation.

G. It should be particularly noted that the terms "furnish" and "provide" are interchangeable and that each of these terms means to provide, install and connect, unless otherwise stated.

H. Whenever tables or schedules show quantities of materials, they shall not be used as a guide to Contractor. Each Contractor shall be responsible for furnishing all materials noted on Drawings and as specified.

I. Craftsman trained in each respective trade shall install work in that trade.

1.11 COORDINATION BETWEEN CONTRACTORS

A. Each Contractor and Subcontractor shall study all Drawings applicable to this work so complete coordination between trades will be effected. Special attention shall be given to points where ducts cross other ducts or piping, where lights fit into ceilings and where pipe, ducts and conduit pass through walls and columns.

B. It is responsibility of each Contractor and Subcontractor to leave necessary room for other trades. No extra compensation will be allowed to cover cost of removing piping, conduit, ducts or equipment found encroaching on space required by others.

1.12 ASSIGNMENT OF MISCELLANEOUS WORK

A. Lintels required by Contractor shall be furnished by *****RESPECTIVE/OTHER***** Contractor. Contractor shall notify other Contractor of correct size and locations for all lintels prior to wall construction.

B. Painting: ***** RESPECTIVE/OTHER ***** Contractor will provide prime painting on all ferrous metals such as supporting steel or hangers for mechanical piping and equipment. Piping itself is not to be

primed. Any finish painting required, including painting of all mechanical items exposed to outside environment will be painted by ***** RESPECTIVE/OTHER ***** Contractor.

C. Color Code Painting: piping shall be color coded by the ***** RESPECTIVE/OTHER***** Contractor as specified in Section 15050.

D. Roof Openings: required by Mechanical Contractor shall be cut by ***** RESPECTIVE/OTHER***** Contractor. Mechanical Contractor is responsible for correct size and location of same.

E. Roof Curbs and Bases: for roof mounted mechanical equipment shall be furnished and anchored to structure by ***** RESPECTIVE/OTHER ***** Contractor.

F. Flashing: for roof curbs and bases shall be furnished by ***** RESPECTIVE/OTHER ***** Contractor.

G. Counter flashing for roof curbs and bases shall be furnished by ***** RESPECTIVE/OTHER ***** Contractor.

H. Sanitary Vent Lead Pans and Flashing: by ***** RESPECTIVE/OTHER ***** Contractor.

I. Louvers: furnished by *****RESPECTIVE/OTHER***** Contractor. Size and location verified by *****RESPECTIVE/OTHER***** Contractor.

J. Pads and Foundations: for mechanical equipment shall be formed and poured by *****RESPECTIVE/OTHER***** Contractor. The *****RESPECTIVE/OTHER***** Contractor shall verify pad sizes, locations and all anchoring devices.

K. Platforms and Supporting Stands: for mechanical equipment shall be furnished by *****RESPECTIVE/OTHER***** Contractor unless noted otherwise.

L. Penetrations: holes required for piping or ductwork shall be cut in field at expense of *****RESPECTIVE/OTHER***** Contractor. Engineer shall give approval prior to any cutting.

M. Penetrations through Structure: holes required for piping or ductwork shall be *****cut or installed as walls are erected***** at the expense of the *****RESPECTIVE/OTHER***** Contractor unless indicated by others as detailed on structural drawings. Mechanical Contractor to coordinate location and size of all openings prior to building erection or he will assume all costs for providing openings. Engineer shall give approval prior to cutting.

N. Excavating and Backfilling: for mechanical work shall be by *****RESPECTIVE/OTHER***** Contractor.

O. Outside Downspouts: shall be by *****RESPECTIVE/OTHER***** Contractor. Downspouts shoe shall be by *****RESPECTIVE/OTHER***** Contractor.

P. Fuel Oil Tank: filled by **Respective Contractor/Owner.**

Q. Chemical Treatment of closed loop systems by **Respective Contractor/Owner.**

R. Chemical Treatment of open loop systems by **Respective Contractor/Owner.**

S. Caulking of all plumbing fixtures shall be by Mechanical Contractor.

T. All fire stopping of mechanical penetrations by *****RESPECTIVE/OTHER***** Contractor.

U. All caulking of mechanical penetrations through interior partitions by *****RESPECTIVE/OTHER ***** Contractor. All sleeve seals for mechanical penetrations through exterior below grade penetrations by Mechanical Contractor.

V. Mechanical Contractor will install all taps, control valves and thermo wells in piping for all temperature sensors, flow switches, pressure sensors and any other control device installed in piping whether shown or not on the Drawings.

W. Dust Protection:

1. Temporary partitions or barriers required to protect existing building or facilities specifically in areas requiring primarily mechanical work; i.e., cross country pipe, etc., shall be provided by *****RESPECTIVE/OTHER***** Contractor. *****RESPECTIVE/OTHER***** Contractor shall coordinate necessity and location of such protection with Owner.
2. Temporary filters for protection of new and existing ductwork and equipment as required during construction is to be by the *****RESPECTIVE/OTHER***** Contractor.

X. Pipe identification shall be by Mechanical Contractor as specified in Section 20 00 50.

Y. Kitchen Equipment: furnished and set in place by *****RESPECTIVE/OTHER***** Contractor. Rough-in shall be by *****RESPECTIVE/OTHER***** Contractor. Final connections shall be by *****RESPECTIVE/OTHER***** Contractor.

Z. Temporary Use of Equipment: should it become necessary or desirable to operate any equipment before final acceptance, Owner shall be allowed to do so, ONLY after proper adjustments and trial operation by Contractor specified. *****RESPECTIVE/OTHER***** Contractor shall be responsible for instructing Owner, or his Representative, as to proper operation and care of equipment so used. If equipment is used prior to final acceptance of job, date of first usage will begin warrantee period.

AA. All electrical control wiring between mechanical equipment (i.e., air cooled chiller and condensing unit, etc.) shall be by *****ELECTRICAL***** Contractor.

BB. Cutting and Patching: *****RESPECTIVE/OTHER***** Contractor shall cut and patch finished areas as required by Mechanical Contractor.

CC. Wall Sleeves in new construction for Mechanical systems shall be provided by the *****RESPECTIVE/OTHER***** Contractor and coordinated by Mechanical Contractor.

DD. Wall Sleeves in existing construction shall be provided and installed by the *****RESPECTIVE/OTHER***** Contractor.

EE. Ceiling and Wall Access Panels: shall be located by mechanical contractor and installed by *****RESPECTIVE/OTHER***** Contractor.

1.13 EQUIPMENT WARRANTY AND EARLY EQUIPMENT STARTUP

A. Contractor shall provide a complete warranty for all equipment, controls, etc. that includes parts and labor, any equipment that fails shall be repaired and/or replaced at no cost to owner.

B. The warranty shall start on the date of substantial completion. On projects with multiple phases, the date of substantial completion of the final phase shall be the date that the warranty starts for all phases, i.e. the entire project. No exceptions.

C. If special extended warranties exist they will be noted in the respective sections. Extended warranty start on the date of Substantial Completion of the final phase, unless another date is agreed to by all parties.

D. If equipment startup is required to provide suitable climate conditions for carpentry finish trim, painting, ceiling tile installation, etc., then this contractor is responsible for starting, operating equipment and providing an extended warranty.

E. Respective Contractor shall provide temporary filters over ductwork on all equipment if equipment is started early.

F. The "umbrella" warranty for the project shall be one year.

G. Some devices such as Control Valves, VFD's, etc. require extended warranties. Extended warranties are noted in the Specification Section for that piece of equipment. The prime Contractor shall be responsible for all implementation and cost of extended warranty work.

1.14 MATERIAL AND EQUIPMENT TRANSPORT

A. All material and equipment, shipped to site, shall be suitably covered and protected during shipment to site.

B. Protection shall include shrink wrapping and dessicant bags for humidity controls.

C. Protect equipment from weather, road salts, road dirt, condensation, damage and all other situations that can be detrimental to the condition of the equipment and material being shipped.

D. Engineer will not be on site during delivery, however, engineer reserves the right to reject material or equipment after the fact that is delivered to site in unsatisfactory condition.

1.15 MATERIAL STORAGE

A. Provide suitable protection from weather and vandalism for all materials and equipment to be installed. Storage shall be dry, clean and safe. Provide heat as required to stop condensation. Condensation occurs during periods of large ambient temperature swings, i.e. spring or fall. Any materials or equipment damaged, deteriorated, rusted or defaced due to improper storage shall be fully repaired, refinished or replaced, as directed by Engineer at no additional cost.

PART 2 - PRODUCTS

2.1 PRODUCT AND MATERIAL APPROVAL

A. A Specification followed by one or more manufacturers is limited to those manufacturers. Names of other manufacturers may be submitted for approval, to the Engineer, a minimum of ten calendar days prior to receiving bids. Approval will be issued by Addendum if approval is granted.

B. The mechanical equipment shall be new, listed by UL and shall confirm to NEMA requirements.

C. If changes in pipe, ductwork, conduit, wiring, structural support and ceiling space, etc. are required as a result of the contractor's decision to purchase equipment with a different arrangement than shown on the Drawings, the Contractor shall be responsible for including all associated costs in their bid. Note that manufacturers listed as equals may have physical characteristics, which require more coordination,

piping, wiring, and/or general construction changes. The Mechanical Contractor will be responsible for all additional costs associated with the installation of this equipment.

PART 3 - EXECUTION

3.1 PROTECTION AND TREATMENT OF PROPERTY

A. Repair and replace all property damaged in installation of underground lines to meet approval of Owner and authorities having jurisdiction.

B. Repair streets, which are part of State Highway System to satisfaction of State Highway Department.

C. Replace base and wearing surfaces of streets with same kind and thickness of material as existing. Replace brick, concrete and asphalt surface to width 6" wider than disturbed area. Replace entire surface if more than 30% has been disturbed.

D. Replace sidewalks, curbs, gutters, driveways, with same kind and thickness of material. Replace entire section of concrete walks or driveways.

E. Re-grade and replant lawn areas.

F. Protect existing utilities. Cap existing utilities that are abandoned.

G. All property in existing facilities that is damaged/removed, by contractor operations shall be repaired/replaced to previous operating and appearance condition.

3.2 DEMOLITION AND REMOVAL OF EQUIPMENT

A. Contractor shall remove all equipment, hangers and support for portion of mechanical system in present building as indicated on Drawings and/or implied by nature of the work to be removed. Contractor shall remove all pipes and ductwork back to source made obsolete by removing equipment unless specifically instructed otherwise.

B. Contractor shall properly support remaining portions of the work. Contractor shall provide valves, plugs, vents, etc. as required so existing systems remain operational.

C. Owner shall have first right of refusal on all equipment, piping, etc., being removed. If owner decides to keep removed items, then the contractor shall move items to a location on this project site as directed by owner.

D. Openings remaining after equipment has been removed shall be patched to match surrounding surfaces and in conformance with good practice.

3.3 ELECTRICAL CONNECTIONS TO EQUIPMENT AND CONTROL WIRING

A. All electrical work shall be done in accordance with the latest edition of the National Electric Code.

B. All above ground wiring shall be installed in metallic conduit with a minimum conduit size of ¾ inch. All wiring shall be concealed, except in equipment rooms, crawl spaces, tunnels and mechanical or electrical closets. Conduit shall be fastened securely at regular intervals and shall be run parallel to the building lines.

C. Running low voltage wire above bar joist in roof/floor metal deck flutes is not permitted. Wire to be run above bottom chord of truss and fastened to structure with wire ties at maximum 4' o.c.

D. All flexible conduit shall not exceed 2 foot.

E. All below ground wiring shall be installed in rigid conduit with minimum size of ¾". Conduit system shall be sealed watertight.

F. Provide all wire, conduit, fittings, miscellaneous materials and labor as required for mounting and connecting the electrical control devices furnished in this contract.

G. All wiring shall be continuous from point to point. No splicing between terminations allowed.

H. In the event that a Supplier of equipment requires a larger starter, disconnect wiring conduit, etc. than those indicated in Contract Documents, he shall reimburse Contractor supplying these items for the difference.

I. Connections and wiring diagrams shown on Drawings or described in Specifications are typical and for bidding purposes only. Detailed diagrams and instructions shall be provided by Contractor supplying the equipment. If connections are different from those shown on Drawings, Mechanical Contractor shall reimburse Electrical Contractor for those differences.

J. Additional relays switches, contactors, etc. which may be required for control purposes in addition to those specified and indicated on Drawings shall be provided by Mechanical Contractor.

K. In the event that several pieces of mechanical equipment from different Suppliers are combined in one system, Mechanical Contractor shall furnish complete wiring and control diagrams to enable Electrical Contractor to make proper connections. Diagrams shall be submitted to Engineer for review, prior to actual wiring.

L. Mechanical Contractor shall furnish to Electrical Contractor written notice of approval and acceptance for all control wiring installed for mechanical systems by Electrical Contractor. Such approval shall be given within 30 days of completion of all such control wiring. Two copies of letter shall be sent to Engineer.

3.4 ATTACHING TO BUILDING CONSTRUCTION

A. Equipment and pipe supports shall be attached to structural members (beams, joists, etc.) rather than to floor or roof slabs. Support from structural members shall be in accordance with manufacturer recommendation of structural member and/or approved by Structural Engineer.

B. Where piping is suspended from new concrete construction, furnish, locate and install black steel channel type concrete inserts before concrete is placed. Fasten inserts to forms and install reinforcing bars through openings at top of inserts. Inserts shall provide for horizontal and vertical adjustments.

C. Where piping is suspended from existing concrete or masonry construction, use expansion shields to attach pipe supports to construction.

1. Anchors shall be installed horizontally into the sides (vertical portion) of concrete beams at a minimum of 5" from the bottom of the beam.
2. When support location is between concrete beams, then unistrut shall be attached to sides of concrete beams and span continuously between the concrete beams. Unistrut shall be sized per manufacturer's data to carry load.
3. Contractor must receive prior approval before attaching to the underside of concrete slabs or concrete beams.

4. Install all anchors according to manufacturers written instructions. Expansion shield bolt diameter shall be same size as support rod diameter hereinafter specified. If, in the opinion of the Owner/Engineer, existing structure is questionable, an angle will be required with two expansion shields to carry each vertical support rod. Expansion shields shall be combined friction and keying hold type wedge anchor like HILTI Red Head or approved equal.

D. Where existing masonry is not suitable to receive and hold expansion shields or where other means of attachment is advantageous, Contractor shall submit alternate method for approval of *****OWNER/ENGR.***.**

E. Where piping is suspended from structural steel building framing or supporting members, furnish and install beam clamps for attaching piping support device to building member.

F. Obtain approval from *****OWNER/ENGR.***** before cutting or welding to structural member or before hanging heavy equipment.

G. Support piping and ductwork from structure so that equipment connections are not being used for support.

3.5 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be installed.

B. Refer to shop drawings for equipment rough-in requirements.

3.6 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Keep all major equipment covered, in buildings until major dust producing activities are complete. Equipment to be covered includes chillers, pumps, VFD's and AHU's.

2. All equipment must be installed such that maintenance and service may be properly accomplished. If necessary, the Owner, at their option, may require the contractor to demonstrate the service on any piece of equipment to determine sufficient service space exists. If the service space is not adequate, the equipment shall be relocated at no additional cost to the Owner such that sufficient service space is achieved.
3. Coordinate mechanical systems, equipment, and materials installation with other building components.
4. Verify all dimensions by field measurements.
5. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
6. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
7. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
8. Where mounting heights are not detailed or dimensioned, install systems, material, and equipment to provide the maximum headroom possible.

9. Coordinate connection of mechanical 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.
10. Install systems, materials, and equipment to conform with engineer reviewed submittal data. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.
11. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
12. Install mechanical 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.
13. Extend grease fittings to an accessible location.
14. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at specified slope.
15. All shutdowns required to connect to existing systems shall be scheduled and coordinated with the Owner. Contractor shall prefabricate and install new materials as much as possible to keep shutdown duration to a minimum.
16. All pipe, duct and mechanical equipment shall be installed as high above floor (close to structure) as possible. When any pipe, duct or mechanical piece of equipment is installed lower than 7'-0" above finished floor, foam type insulation with black and yellow caution marker tape shall be installed on bottom leading edges.
17. Contractor shall field verify all locations, sizes and connection points to existing piping, ductwork and systems as shown on the drawings. Contact Engineer with any discrepancies.
18. Provide all contact information to Test and Balance Contractor 30 days prior to start up of equipment.
19. Contact Test and Balance Contractor after leakage and pressure test on air and water systems has been successfully completed.

B. Platforms and Supporting Stands

1. Each piece of equipment or apparatus suspended from ceiling or mounted above floor level shall be provided with suitable structural support, platform or carrier, in accordance with best recognized practice.
2. Contractors shall exercise extreme care that structural members of building are not overloaded by such equipment. In all cases, details of such hangers, platforms and supports, together with total weights of mounted equipment, shall be approved by *****OWNER/ENG*****.

C. Drive Guards

1. All belt-driven equipment shall have belt guards with provisional slot for tachometer reading access at shaft. All rotating equipment and drives shall have safety guards.

3.7 CLEANING AND TOUCH UP

A. All mechanical equipment, cabinets, control panels and other enclosures shall be cleaned and have paint touched up as necessary to duplicate factory finished appearance. Touch up paint shall exactly match color, composition and quality of factory applied finish.

B. Equipment furnished with factory applied finish shall be protected from damage by the installing Contractor. Any damaged surface shall be repaired or replaced by the installing Contractor to match original finish or shall be replaced before final acceptance.

3.8 GENERAL COMPLETION, STARTUP

A. Work Included: furnish materials and labor required to perform startup of equipment and systems installed on project and provide operating instructions to Owner.

B. It is Mechanical Contractors' responsibility to conduct an owner orientation meeting which will review all systems, their operation and operation of all equipment.

C. General Requirements.

1. Inspect bearings for cleanliness and alignment and remove any foreign materials found. Grease as necessary and in accordance with manufacturer's recommendations. Replace bearings that run rough or noisy.
2. Adjust tension in V-belt drives, adjust vari-pitch sheaves and drives for proper equipment speed. Change belts and sheaves if necessary to obtain proper equipment speed; remove any foreign materials from sheaves or belts before starting operations; adjust drives for alignment of sheaves and v-belts. Construe proper speed as that which produces intended performance. Change sheaves so that design CFM is achieved when VFD is at 100%. Slowing VFD to meet maximum design CFM is not acceptable.
3. Tighten flanges and packing glands after system has been placed in operation. Replace gaskets in flanges that show any signs of leakage after tightening.
4. Inspect screwed joints for leakage and remake each joint that appears to be faulty. Do not wait for rust to form. Clean threads on both parts, apply compound and remake joint.
5. Adjust pipe hangers and supports for correct pitch and alignment.
6. Flush systems and clean all strainers. After 30 days of operation clean strainers again.
7. Provide such continuing adjustment services as is necessary to insure proper functioning of all mechanical systems after building occupancy and during guarantee period.

3.9 Air Filters

A. Provide a total of three (3) sets of air filters for each piece of equipment.

B. Never operate equipment without air filters. Provide construction set of air filters for equipment operation prior to substantial completion.

C. Replace construction air filters in each and every piece of equipment within 2 weeks after substantial completion. Provide one additional set of air filters to Owner.

END OF SECTION 200010

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this and all Sections of Divisions 20, 21, 22 and 23.

1.2 SUMMARY

A. Provide equipment, materials, labor and services common to more than one section of Divisions 20, 21, 22 and 23. The work generally includes, but is not limited to the following:

1. Vibration Isolators **[Note – If critical, put in separate section and delete from this section. i.e. Recital Hall, Recording Studio, etc.]**
2. Electric Motors
3. Pressure Gauges
4. Thermometers

[**OR**OR**OR]

5. Thermometers **(D&A Standard)**
6. Separable Sockets
7. Pressure and Temperature Test Plugs (Pete's Plugs)
8. Sleeves
9. Firestop Sealants and Caulks
10. Mechanical Sleeve Seals
11. Elastomeric Joint Sealants
12. Pipe Identification
13. Mechanical Service Color
14. Paint
15. Grout
16. Concrete
17. Ceiling and Wall Access Panels

1.3 SUBMITTALS

A. If specified products are provided, submittals are not required for products provided in this section.

B. If it is desired to use products that are not specified then those products must be submitted for review prior to ordering said products.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. General: Mount equipment on isolators as noted in Schedule of Usage and as noted in specific specification sections. Isolators shall be furnished by manufacturer of isolators. They shall be engineered for specific piece of equipment.

1. Manufacturers:

a. Mason Industries, Inc.
b. Kinetics Noise Control, Inc.

B. Types of Isolators

1. Neoprene Pad: Cross ribbed pad 3/8" thick.
2. Cork Rib Pad: 1" thick laminated pad consisting of cork bonded between 2 layers of ribbed neoprene. Vibration Mountings Cork Rib Pak.
3. Steel Spring Mounting: Steel housing containing steel springs with top plate, leveling bolt, snubber fastening slots and neoprene pad bonded to bottom.
4. Rubber in Shear Hanger: Neoprene single or double deflection as required.
5. Spring Type Hangers: Deflection to 2".
6. Combination Spring and Rubber in Shear Hangers: Deflection to 2 1/2".

C. Submittals shall show frequency, required efficiency and designed deflection.

D. All vibration isolators shall be selected at 95% efficiency.

E. Schedule of Usage.

1. Blower Unit Heater: Rubber in shear hangers.
2. Central Station Air Conditioners: Internally Spring Isolated.

2.2 ELECTRIC MOTORS

A. Service:

1. Constant Speed Motors: PREMIUM-EFFICIENCY, NEMA Design B, Class B insulation, nameplated and designed for electrical characteristics noted on Drawings in accordance with NEMA and IEEE Standards.
2. Variable Speed Motors: PREMIUM-EFFICIENCY, NEMA Design B, drive rated with Class F insulation, nameplated and designed for electrical characteristics noted on Drawings and in accordance with NEMA and IEEE Standards. All end plates shall be cast iron. Aluminum end plates are not acceptable.

a. Variable speed motors shall include installation of a maintenance free, circumferential, conductive micro fiber shaft grounding brush to divert shaft currents to ground. Aegis model SGR or approved equal.

B. General: Motor shall be at least HP specified.

C. Bearings: Ball, sleeve or roller bearings with dustproof rings.

D. Temperature Rise: Continuous rating at 104°F (40°C) above ambient.

E. Base: Cast iron or steel with adjustable slide rail.

F. Rating: Motors specified for voltage of 220 to 240 volts and 440 to 480 volts shall have 230/460 rating. Motors specified for voltage of 208 volts shall be designed and nameplated for 200 volts.

G. Enclosures:

1. Hazardous Locations:

a. Explosive Liquid Vapor and Gasses: Class I Explosion Proof.
b. Combustible Dust (i.e., Coal, grain flower:): Class II - Dust Ignition Resistant.

2. Outside: Totally Enclosed Fan Cooled (TEFC).
3. All others: Open Drip-Proof (ODP) unless noted otherwise with a specific piece of equipment.

NEMA Premium™

Product Scope and Nominal Efficiency Levels

The NEMA Premium™ efficiency electric motor program scope is single-speed, polyphase, 1-500 horsepower, 2, 4 and 6 pole, squirrel cage induction motors, NEMA Design A or B, continuous rated. Products must meet or exceed the nominal energy efficiency levels presented below:

Table 1
Nominal Efficiencies for "NEMA Premium™" Induction Motors
Rate for 600 Volts or Less (Random Wound)

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	94.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4

50	94.1	94.5	93.0	94.1	94.1	93.0

H. Sizing:

1. Select motors to have required capacity to operate driven equipment under all conditions of operation without overload.
2. Do not include motor service factor when determining motor size.

I. Manufacturers:

1. Allis Chalmers
2. General Electric
3. Louis Allis
4. Reliance
5. Westinghouse
6. Century
7. Marathon
8. Baldor

2.3 PRESSURE GAUGES

A. Accuracy ASME/ANSI B40.1 Grade 1A (1%).

B. 4-1/2" minimum diameter dial, stainless steel bourdon tube, lower connection.

1. Manufacturers:

a. Ashcroft 1379S
b. Hellicoid 440
c. U.S. Gauge 1600
d. Duro United Series #10
e. Weksler 300 Series
f. Trerice No. 4500 Series

C. Pressure Snubbers: Piston type like WEKSLER RS1.

2.4 THERMOMETERS

A. Provide and install light powered digital thermometers to meet the following criteria.

1. Display: 3/8" LCD digits
2. Accuracy: 1%
3. Range: -40/300^{o}F
4. Humidity: Operational in ambient conditions up to 100% RH.
5. Case: High impact
6. Stem length to fit separable sockets. Reference separable sockets for required length.
7. Adjustable joint mounting so head can swivel and rotate for best visibility.
8. Heads shall be replaceable without any loss of water from system.

B. Manufacturers:

1. Weiss Vari-angle digital thermometer
2. Trend Instruments Inc.
3. Winters 9IT
4. Trerice

2.5 SEPARABLE SOCKETS

A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.

1. Material: Brass, for use in copper piping.
2. Material: Stainless steel, for use in steel piping.
3. Material: Steel, for use in steel piping
4. Extension-Neck Length: Nominal thickness of 2 inches (50 mm), but not less than thickness of insulation. Omit extension neck for sockets in piping not insulated.
5. Insertion Length: To extend to a minimum of 1/3 (one-third) of diameter of pipe.

2.6 PRESSURE AND TEMPERATURE TEST PLUGS (PETE'S PLUGS)

A. Plug shall be brass or stainless steel arranged for a 1/8" diameter shaft to enter into the plug. The plug shall be rated for 350^{o}F for water and 200^{o}F for gases. The plug shall be equipped with a pipe cap. The plug system shall be rated for zero leakage to 250 PSIG.

B. Manufacturer:

1. Sisco
2. Trerice
3. Peterson Equipment

2.7 SLEEVES

A. Steel Sheet Metal: 0.0239-inch (0.6-mm) minimum thickness, galvanized, round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, plain ends.

C. Cast Iron: Cast or fabricated “wall pipe” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

E. Sleeves shall be in accordance with following schedule unless otherwise specified.

PIPE SIZE	UNINSUL.	1" INSUL.	1-1/2" INSUL.	2" INSUL.
1"	2	4	6	6
1-1/2"	3	4	6	8
2"	3	6	8	8
3"	4	6	8	10
4"	6	8	10	10
6"	8	10	12	12

8"	10	12	12	14

2.8 FIRESTOP SEALANTS AND CAULKS

A. Penetration Sealant:

1. 3M Brand “Moldable Putty Pads and “Moldable Putty Stix”.
2. 3M Brand “Fire Barrier” Caulk, Putty or Penetrating Sealing Systems.
3. Dow Corning “Fire Stop Foam” and “Fire Stop Sealant” systems.
4. Insta-Foam Products, Inc. “Insta-Fire Seal Silicone RTV Foam”.
5. Standard Oil Engineering Materials Company “Fyre Putty”.

B. Intumescent Sealant:

1. 3M Brand “Fire Barrier” caulk or putty, FS-195 Wrap Strip and CS-195 Composite Sheet.
2. Dow Corning “Fire Stop Intumescent Wrap Strip”.
3. Fox Couplings, Inc. “The Fox Cast-in-Place Coupling”.
4. For plastic pipe penetrations up to 4” diameter: Use 3M pre-manufactured fire barrier plastic pipe devices or equal.
5. For plastic pipe penetrations larger than 4” diameter: Use 3M fire barrier RC-1 restricting collar with FS-195+ wrap/strip or equal.

C. Performance Characteristics: Firestopping materials shall conform to both Flame (F) and Temperature (T) rating as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire tests.

1. F Rating shall be a minimum of one hour but not less than the fire resistance rating of the assembly being penetrated.
2. Conduct the fire test with a minimum positive pressure differential of 0.01” of water column.

D. Quality Assurance: Installer qualifications – firm specializing in firestopping installation with not less than two years of experience or trained and approved by firestopping manufacturer.

2.9 MECHANICAL SLEEVE SEALS

A. Description: Modular design with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

B. Manufacturers: Thunderline/Link-Seal; Calpico, Inc.; MetraFlex Co.

2.10 ELASTOMERIC JOINT SEALANTS

A. Sealant: Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated. Per ASTM C 920 like Dow Corning 995 GE Silicones, Tremco Spectrum 1 or equal.

B. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26^{o}F (minus 32^{o}C). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance. Verify compatibility with Elastomeric Joint Sealant Manufacturer prior to use.

C. Primer: Material 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.

D. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.

2.11 PIPE IDENTIFICATION <**DESIGNER TO CHOOSE WHICH ONE APPLIES – LABELING ONLY ON MOST PROJECTS**>

A. Labeling shall consist of the following:

1. Pipe identification to comply with ASME A13.1.
2. Identification of medium in pipe using all uppercase letters.
3. Arrow indicating direction of flow.

B. Banding shall consist of the following:

1. Color-coded band to conform to color code hereinafter specified.

a. For pipe diameter of 6” or less (including insulation):

PIPE DIA.	SIZE OF LETTERS	LENGTH OF COLOR FIELD **(Use only if banding)**
3/4” – 1 3/8”	1/2”	8”
1 1/2” – 2 3/8”	3/4”	8”
2 1/2” – 6”	1 1/4”	12”

1) Manufacturer: Seton Setmark “SNA” Marker or approved equal.

b. For pipe diameter of 6” or greater (including insulation):

PIPE DIA.	SIZE OF LETTERS	LENGTH OF COLOR FIELD **(use only if banding)**
6” – 7 7/8”	1 1/4”	12”
8” – 10”	2 1/2”	24”
Over 10”	3 1/2”	32”

1) Manufacturer: Seton Setmark “STR” Marker or approved equal.

C. Coded Pipe Color Selection

1. Match Existing

<****OR**OR**OR*OR**OR**OR****>

2.12 MECHANICAL SERVICE COLOR **<(THIS IS ISU STANDARD) THIS IS TO STAY IN SPECIFICATINS WITH BANDING AND/OR PAINTING OF PIPING OR CHANGE PER CLIENT STANDARDS>**

			Glidden	Rustoleum
Domestic Water	Light Blue		8O-L-2	886
Fire Lines, Sprinklers, etc.	Red	452O		964
<Include on basic project>				
Chilled Water Supply	Dark Green	4554		H-3
Chilled Water Return	Dark Green	4554		H-3

Hot Water Heating Supply	Light Green	71-L-2	H-27
Hot Water Heating Return	Light Green	1-L-2	H-27
Condenser	Burnt Orange		
Refrigerant Relief	Violet		
Sanitary Waste	Black	4551	978
Air Conditioner Condensate Drain	Black	4551	978
Low Pressure Steam Supply	Gray	4572	975
Low Pressure Steam Return	Dark Blue	4564	721
High Pressure Steam Supply	Gray	4572	975
High Pressure Steam Return	Dark Blue	4564	721
Cond. Pump Discharge	Light Orange		
Steam Relief Vent	Platinum Light Gray		
Compressed Air	Gold Ingot Gold		
Natural Gas	Safety Yellow <**Include on basic project**>		
L.P. Gas	Jienna Brown		

2.13 PLASTIC LAMINATE SIGNS FOR EQUIPMENT IDENTIFICATON

A. ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore.

1. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
2. Punch for mechanical fastening.
3. Thickness: 1/8 inch (3.2mm) , unless otherwise indicated.
4. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.
5. Nomenclature: Name and plan number as shown on Equipment Schedules and on Drawings or as directed by the Owner.
6. Size: Approximate 2 1/2 by 4 inches (65 by 100mm) for control devices, dampers, and valves; and 4 1/2 by 6 inches (115 by 150 mm) for equipment.

2.14 PAINT <**USE FOR CORROSIVE/WET ENVIRONMENTS**>

A. Sherwin-Williams "TILECLAD II" 2-part epoxy, color: gray or white.

2.15 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psig (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.16 CONCRETE

A. Reference Concrete Portion of Specifications.

<*OR OR OR OR OR OR OR OR OR OR OR***>**

B. Concrete shall be 1 part Portland cement, 2 parts sand and 4 parts gravel or broken stone that will pass through a 1" diameter hole. Clean sharp sand, washed gravel and Portland cement, Atlas, Alpha, LoneStar, Universal or approved equal, shall be thoroughly mixed in a dry condition until color of mixture is uniform. This mixture shall be uniformly spread and gravel evenly distributed thereon, then wet and thoroughly mixed to a consistency that will need no tamping but can be easily faced for spading. Hand mixed concrete shall be prepared upon substantially constructed, tight bottom platforms and shall be mixed in batches not to exceed 1 cubic yard per batch. If concrete is machine-mixed, it shall not be mixed until same can be immediately placed. No concrete which has taken initial set shall be used.

2.17 CEILING AND WALL ACCESS PANELS

A. Plastered Wall or Ceiling: 24" x 12" unless otherwise noted. Constructed to receive plaster to match adjacent finish. Milcor Style B. **<Verify>**

PART 3 - EXECUTION

3.1 PRESSURE GAUGES

A. Connection in Piping: provide spare pressure snubbers and install ahead of each gauge to minimize gauge needle pulsations as directed by Engineer. Install 1/2" ball valve to isolate each gauge. Mount gauges for maximum visibility from floor.

B. Where gauges are installed across pumps to measure differential pressure, install two (2) 1/2” ball valves, one in pipe from pump suction and one in pipe from pump discharge.

C. Install siphons on all steam gauges: brass or steel.

D. Scale Ranges **<Edit as required for system pressures>**

1. Hot Water Heating: 0-160 psig
2. Domestic Water: 0-150 psig
3. Chilled Water: 0-160 psig
4. Condenser Water: 0-160 psig
5. Steam High Pressure: 0-160 psig
6. Steam Low Pressure: 0-60 psig
7. Steam Condensate: 0-60 psig

3.2 THERMOMETERS

A. Connection in piping

1. Mount sockets in vertical up position to facilitate their being filled.
2. Mount and adjust thermometers so they may be read standing on floor without using ladder or straining back.

B. Scale Ranges **<Not required if digital thermometers chosen>**

1. Chilled and Condenser Water: 0-120^{o}F
2. Hot Water Heating: 30-240^{o}F
3. Domestic Cold Water: 0-130^{o}F
4. Domestic Hot Water: 30-240^{o}F

3.3 PRESSURE AND TEMPERATURE TEST PLUGS (PETE'S PLUGS)

A. Install Pete's Plugs at each and every piece of hydronic equipment including coils, heat exchangers and pumps and install where shown on Drawings.

B. Install Pete's Plugs in 1/4" plugged bosses at pump suction and pump discharge flanges.

C. Always install Pete's Plugs on equipment side of balance valves to measure true differential pressure across equipment, and not across balance valve.

3.4 ESCUTCHEONS

A. Escutcheons: Manufactured wall, ceiling and floor plates; deep-pattern if type required to conceal protruding fittings and sleeves.

1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
2. OD: Completely cover opening and sleeve.

B. Cast Brass: One piece, with set screw.

1. Finish: Rough brass.
2. Finish: Polished chrome-plate.

C. Cast Brass: Split casting, with concealed hinge and set screw.

1. Finish: Rough brass.
2. Finish: Polished chrome-plate.

D. Install pipe escutcheons for exposed pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:

1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
2. Un-insulated Piping Wall Escutcheons: Cast brass or stamped steel, with chrome-plated finish and set screw.
3. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.

3.5 SLEEVES / PENETRATIONS

A. Sleeves are not required for core drilled holes through poured in place concrete walls.

B. Install sleeves for pipes passing through masonry walls, gypsum-board partitions and concrete floor slabs.

C. Cut sleeves to length for mounting flush with both surfaces when penetrating walls.

D. Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

E. Build sleeves into new walls and slabs as work progresses. Core drilling of poured in place concrete walls is acceptable.

F. Install sleeves large enough to provide 1/4 inch (6.4 mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. Steel Pipe Sleeves: For pipes smaller than 6 inch NPS (DN150).
2. Steel, Sheet-Metal Sleeves: For pipes 6 inch NPS (DN150) and larger, penetrating gypsum-board partitions.
3. Cast-iron "wall pipes" for sleeves 6 inches (150 mm) in diameter and larger.
4. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.

G. When sleeve is installed in existing floor or masonry wall, seal space between sleeve and wall with nonshrink, nonmetallic grout.

H. Above Grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants.

I. Below Grade Exterior-Wall, Floors of Mechanical Spaces or other wet areas Pipe Penetrations: Seal penetrations using mechanical sleeve seals. Size for 1-inch (25-mm) annular clear space between pipe and opening for installing mechanical sleeve seals.

1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

J. Fire-Barrier Penetrations:

1. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire sealants and caulks.
2. This assembly must maintain a watertight seal between floor or wall and pipe when used on exterior walls, or floors of wet areas. Also use mechanical link seals in these cases.
3. Use intumescent sealant for applications where combustible penetrants are involved (i.e., insulated or plastic pipe).
4. Install in all penetrations where required by code.

K. Sealant Application

1. Install sealants around all piping penetrations.
2. Comply with sealant manufacturer’s written installation instructions for products and applications indicated, unless more stringent requirements apply.
3. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of sealants as applicable to materials, applications, and conditions indicated.
4. Acoustical Sealant Application Standard: Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
5. Install sealant backings of type indicated to support sealants during applications and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

    a. Do not leave gaps between ends of sealant backings.
    b. Do not stretch, twist, puncture, or tear sealant backings.

6. Install sealants by proven techniques to comply with the following and at the same time backings are installed:

    a. Place sealants so they directly contact and fully wet joint substrates.

b. Completely fill recess between pipe and opening.
c. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
d. Remove excess sealants from surfaces adjacent to joint.
e. Clean off excess sealants 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 product in which joints occur.

3.6 PIPE IDENTIFICATION

A. Install Pipe Identification on each system. Include pipe service as abbreviated on Drawings i.e. CHWS, CHWR, etc. and arrows showing normal direction of flow.

1. [**Stenciled Markers: According to ASME A13.1 (use where plastic markers not specified.)**]

<****OR**OR**OR**OR**OR****>

[**Plastic markers, with application systems. Install on insulation segment of required for hot, un-insulated piping.**]

2. Locate pipe identification as follows:

a. Exposed piping in unfinished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, above lay-in ceilings and exterior non-concealed locations.
b. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, if flow pattern or service is not obvious.
c. Adjacent to penetrations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.

d. At access doors, manholes and similar access points that permit view of concealed piping.
e. At all major equipment and other points of origination and termination.
f. Spaced at maximum of 50 foot (15 m) intervals along each run. Reduce intervals to 25 feet (7.5 m) in congested areas of piping and equipment and in equipment rooms.

B. [**In addition to pipe identification, piping shall have color coded band adjacent to each label.**]

<****OR**OR**OR**OR****>

[**In addition to pipe identification all piping to be color code painted in its entirety in all Mechanical Rooms.**]

C. In all cases, Fire Protection and Natural Gas piping shall be painted inits entirety in all exposed areas including unfinished areas.

3.7 EQUIPMENT IDENTIFICATION

A. Install engraved plastic-laminate sign on each scheduled piece of mechanical equipment.

1. Lettering Size: Minimum 1/4 inch (6.4 m) high lettering for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (12.7 mm) high lettering for distances up to 72 inches

(1800 mm) and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principle lettering.

2. Text of Signs: Provide specific name of unit as identified on Equipment Schedule on Drawings or as directed by the Owner. Inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
3. Locate identifying devices as necessary for unobstructed view in finished construction.

3.8 VALVE IDENTIFICATION <**CHECK WITH OWNER PRIOR TO INCLUDING**>

A. Install 1 1/2" x 4" tag on each main shutoff valve for each service and identify as MAIN SHUTOFF and identify type of services (COLD WATER, GAS, STEAM, etc.) Tags to be laminated plastic with 3/8" black letters engraved. Connect tag to valve with stainless steel chain.

B. Install consecutively numbered brass tags with 1/4" engraved characters on each operating valve in this contract (i.e. main or branch line shut-off valves, manual and automatic flow control valves, temperature control valves, etc.) Connect tags to valves with stainless steel chain.

<CHOOSE ONE OF THE FOLLOWING>

C. [**Provide thumbtack in ceiling below valves located above ceiling.**]

<****OR**OR**OR**OR****>

[**Where valves are located above ceilings, provide an extra tag made of aluminum of same general description as brass tags and affix to access panel.**]

D. This Contractor shall also prepare typewritten chart to show valve number, valve function and valve location. Valve chart shall be framed under glass and mounted where directed.

3.9 PAINTING

A. **[Refer to Division 9 Section "Painting" for paint materials, surface preparation and application of paint.] <Select this if there is a Division 9 "Painting" in specifications>**

<*OR *OR OR>

B. **[Use paint type and method of application as follows:] <Use if no Division 9 painting section and if Mechanical Contractor is painting.>**

1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
6. Exterior, Ferrous Steel Supports: Use semigloss acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.

7. Exterior or Interior Ferrous Supports for Cooling Towers, Tank Supports or any Wet or Corrosive Environment: Use epoxy paint.
8. Exterior Aluminum Rooftop Equipment: Factory applied Kynar, Dark Bronze. **<ISU Standard.>**

C. Do not paint piping specialties with factory-applied finish.

D. Adhere strictly to paint manufacturer's written instructions for application.

E. Damage and Touch-Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

F. Paint the following: **<Select items to be painted.>**

1. All exposed insulated and or uninsulated pipes, equipment, ductwork including insulation, etc. in finished areas.
2. All exposed ventilation equipment and ductwork in finished areas.
3. All equipment located in boiler room or equipment spaces.
4. All exposed bare pipe.
5. All hangers, platforms, supports and miscellaneous steel.
6. All exterior galvanized iron steel surfaces, including cooling towers, rooftop units, piping ventilators, intake cowls, wall frames, louvers, exhaust vents, boiler stack and other miscellaneous surfaces.
7. All sheet metal pipe enclosures in finished spaces to be painted to match adjacent surfaces.
8. Convector cabinets, fin pipe enclosures and cabinet unit heaters.
9. All supply, return and exhaust grilles painted to match adjoining surfaces.
10. All roof mounted ventilation equipment.
11. All access panels.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGE

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

B. Field Welding: Comply with AWS D1.1, "Structural Welding Code – Steel".

3.11 HOUSEKEEPING PADS

A. Install housekeeping pads below all equipment located in Mechanical Room.

B. Pads shall be constructed of poured-in-place concrete, Nominal 6" thick (form using standard 2" x 6" lumber) with 1" chamfer on all horizontal edges.

C. Pads shall extend a minimum of 6" beyond equipment in all directions or as detailed on the Drawings.

3.12 GROUTING

A. Install nonmetallic, nonshrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout. To ensure complete grout base with no voids, pack grout from one side until grout is forced out of opposite side of base.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases to provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout according to manufacturer's written instructions.

3.13 EXCAVATION AND BACKFILLING

A. Properly support banks of excavation with safety sheet pile. Install barricades, fences, guards, etc. as required for safety and by OSHA.

B. Provide adequate pumping equipment and keep excavation free of water.

C. Excavate pipe trenches to proper depth and slope as required for piping

D. Pipes passing under or through footings shall be sleeved (minimum two pipe sizes larger than pipe).

E. Pipes passing under or through corrosive fills shall have external coating to protect from corrosion.

F. Support and protect underground piping so it remains in place without settling and without damage during and from backfilling. Replace any piping so settled or damaged. Pipe shall not be supported on blocks to grade.

G. Lay underground piping on 6" bed of sand. Sand to fill from trench bottom to 6" above top of pipe. Carefully fill around pipe.

H. Backfill with clean earth, crushed rock, gravel or sand. Use only sand inside buildings. Carefully fill around piping. Fill first two feet in 6" lifts and remainder in 12" lifts. Tamp and puddle each layer

I. Provide 6" wide marker tape buried directly underground above utility lines continuously along length of pipe. Marker tape shall be a minimum of 12" above utility line. Marker tape shall be a minimum of 6" wide.

J. Replace all surfaces with like, kind, i.e. grass, road, sidewalk, etc., or as specified elsewhere.

END OF SECTION 200050

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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 specifies piping, valves and fittings including piping support for all systems. These systems include the following:

1. System Piping Schedule #11, #11A & #11B
   Refrigeration
   R-410 Refrigerant

2. System Piping Schedule #13
   Coil Condensate

3. System Piping Schedule #14
   Sanitary Inside Building
   Vent Inside Building
   Storm Gravity Inside Building

4. System Piping Schedule #15
   Sanitary Outside Building
   Vent Outside Building
   Storm Gravity Outside Building

5. System Piping Schedule #16
   Sanitary Forced Main
   Storm Forced Main

6. System Piping Schedule #17
   Domestic Hot Water Aboveground
   Domestic Cold Water Aboveground

7. System Piping Schedule #19
   Fire Protection

8. System Piping Schedule #20
   Gas Piping

B. All specialty valves for specific systems are listed in specification sections for those systems. Specialty valves for specific systems can be found in the following sections:

1. Plumbing Specialty Valves – 22 00 00 “Plumbing”
2. Fire Protection Specialty Valves – 21 00 00 “Fire Protection”
3. Refrigeration Specialty Valves – 23 00 00
4. Hydronic Specialty Valves – 23 00 00 “Heat Transfer”
5. Control Valves – 23 00 00 “Temperature Controls”

C. Related sections include the following:

1. 20 00 10 Common Work Results for Fire Suppression, Plumbing and HVAC
2. 20 00 50 Common Materials and Methods for Fire Suppression, Plumbing and HVAC
3. 20 01 80 Common Insulation for Plumbing and HVAC
4. 21 00 00 Fire Suppression
5. Division 22 Plumbing
6. Division 23 Mechanical

1.3 SUBMITTAL

A. Submit product data for valves and fittings used in each system.

B. Submittal data to be in compliance with Section 20 00 10.

C. Product data shall include pressure and temperature classifications, model numbers, material types, actuators, trim, valve handle extensions and all pertinent data as required for complete evaluation by Engineer.

D. Maintenance data for valves shall include adjusting, servicing, disassembly, exploded view with part numbers and repair instructions.

E. Piping submittals are not required. However piping to meet all specifications.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

B. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

C. Welded and Soldered Pipe

1. Pipe welding shall comply with provisions of latest revision of applicable code, whether ASME Boiler & Pressure Vessel Code, ASTM Code for Pressure Piping, or such state or local requirements as may supersede code mentioned above.
2. A copy of his welding procedure specification together with proof of its qualification as outlined and required by most recent issue of code having jurisdiction.
3. Submit Operator's qualification record in conformance with provisions of code having jurisdiction, showing that operator was under proven procedure specifications submitted by Contractor.
4. Standard procedure specifications and operators qualified by National Certified Pipe Welding Bureau shall be considered as conforming to requirements of these specifications.
5. Welders to have ASME test papers not more than 5 years old.

6. Each manufacturer or Contractor shall be responsible for quality of welding done by his organization and shall repair or replace work not in accordance with these specifications.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set globe and gate valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
3. Stack piping above grade and covered.

C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 PIPE MATERIAL DESIGNATIONS

A. Refer to System Schedules in Execution portion of this Section for designation of pipe types to be used for each piping system. When more than one piping type is designated, contractor may choose which type is installed.

B. Piping Designations

1. CP-2 Steel:

a. 3/4" to 2" ASTM A53, Type S (seamless) or Type F (furnace-butt welded) Grade A Black steel (galvanized if so noted). U.S. Steel; Laclede; Republic; Youngstown, Jones & Laughlin.
b. 2-1/2" to 12" ASTM A53, Type E (electric resistance welded) Grade A Black steel (galvanized if so noted).
c. 14" to 20" ASTM A53, Type E (electric resistance welded) Grade B or Type S (seamless), (galvanized if so noted). U.S. Steel; Laclede; Republic; Youngstown; Jones & Laughlin.

2. CP-7 DWV Copper Tube: ASTM B306, Drawn Temper.

3. CP-8 Copper: ASTM B75, B88, B251 and B447; ASA H23.1-1947 seamless copper tubing, hard temper (soft copper if so noted). Type K or L. (as noted) Chase; Bridgeport, Anaconda; Scovill.

4. CP-20 Ductile Iron Mechanical Joint: AWWA C151 with Mechanical Joint Bell and plain spigot end, cast iron pipe, centrifugally cast with asphaltum coating. Class as noted in schedule. Pipe to be marked and carry nominal weights and dimensions as required by state and local codes. As manufactured by James B. Clow & Sons; American Cast Iron Pipe; Alabama Pipe; U.S. Pipe & Foundry.

5. CP-29 Copper ACR – ASTM B-280 seamless copper tubing, hard tempera, 50 ft., soft in coils as noted in schedules. Tubing is cleaned and sealed at the manufacturers. Chase, Bridgepoint, Anaconda, Scovill.

6. CP-30 PVC: polyvinylchloride; ASTM D 1785 schedule as noted. As manufactured by A.M. Byers; U.S. Steel; Carlon, Crescent; **normal or high impact as noted**.

7. CP-32 PVC SDR 35: (4" to 15") Polyvynlchloride Pipe, Type PSM conforming to ASTM D 3034. Reworked material is not acceptable. Cell Classification of 12454-B as defined in ASTM D 1782 and SDR (standard dimension ratio) of not greater than 35.

8. CP-33 PVC DWV Drainage Pipe: ASTM D2665, polyvinylchloride pipe solid-wall, waste, and vent. Schedule as noted.

9. CP-34 ABS Pipe: ASTM D 2661, Solid Wall.

10. CP-40 Cast Iron (HUB) Bell and Spigot: ASTM A74, extra heavy bell and spigot cast iron soil pipe centrifugally metal or sand spun cast with asphaltum coating. American Brass & Iron; Tyler; Charlotte. Pipe and fittings shall be labeled with the trademark of the Cast Iron Soil Pipe Institute.

11. CP-41 Soil Pipe: Cast Iron no hub ASTM A888, CISPI 301. No hub cast iron soil pipe centrifugally metal or sand spun cast with asphaltum coating. American Brass & Iron; Tyler; Charlotte. Pipe and fittings shall be labeled with the trademark of the Cast Iron Soil Pipe Institute.

2.2 PIPE FITTING DESIGNATIONS

A. Refer to System Schedules in Execution portion of this Section for designation of fitting types to be used for each piping system. Fittings to be of the same strength of piping in each respective piping system. When more than one type is designated, contractor may choose which type is installed.

B. Fitting Designations:

1. CF-1 Malleable Iron: ASME B16.3. 300# (or as noted) black band malleable iron threaded fitting (galvanized if so noted). Grinnell; Flagg; Kuhns; Illinois Malleable, Stockham.

2. CF-2 Cast Iron: ASME B16.4; 250# (or as noted) black cast iron threaded fitting (galvanized if so noted). Grinnell; Kuhns, Illinois Malleable; Stockham.

3. CF-5 Wrought Steel fittings: ASTM, B16.9, B16.11, B16.28. Steel butt welding fitting. All elbows shall be long radius, unless otherwise noted. Tube Turns; Midwest; Taylor Forge; Ladish; NIBCO; Grinnell; Weld Bend; Babcock Wilcox.

4. CF-6 Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47 (ASTM A 47M), Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated

steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings. All elbows shall be long radius unless otherwise specified. Completely Victualic coated if used with copper pipe UL listed, FM approved for fire service.

5. CF-8 Wrought Copper: ASME B16.22. Wrought copper solder joint fitting as manufactured by Flagg; Mueller; Chase, NIBCO; Anaconda; American Brass.

6. CF-8A Wrought Copper Cold Press Fitting: Fitting specifically design to be field installed with hand held portable press tool. Fitting to be certified by NSF, UL and be compliant with ICC, UPC, PHCC, NFPA13, 13D and 13R. Fittings to be ProPress Smart Connect installed by RIGID Portable Press tool.

7. CF-10 Cast Brass: cast brass solder joint as manufactured by Flagg; Mueller; Chase; NIBCO; Anaconda.

8. CF-11 Copper Drainage: ASME B16.23 cast copper, or ASME B16.29 wrought copper, type DWV as manufactured by Flagg; Mueller; Chase, NIBCO; Anaconda.

9. CF-20 Mechanical Joint: AWWA C111 ductile or grey-iron, standard pattern, same class as noted for pipe. Alabama Pipe, U.S. Pipe & Foundry.

10. CF-30 PVC: Polyvinylchloride; same schedule and impact as noted. Schedule 40 ASTM D 2466 Socket Type, Sch 80 ASTM D 2467 Socket. Carlon; Crescent; A.M. Byers; U.S. Steel; Chemtrol.

11. CF-32 PVC Drainage Fitting: ASTM D 3034, SDR 35 for gasketed joints.

12. CF-33 PVC Drainage Fittings: ASTM D2665, socket type, made to ASTM D 3311 drain waste and vent patterns.

13. CF-34 ABS Drainage: ASTM D 2661, made to ASTM D 3311, drain, waste and vent pattern socket fittings.

14. CF-40 (HUB) Bell and Spigot: Cast iron bell and spigot Type fitting DWV configuration, extra heavy duty. American Brass & Iron; Tyler; Charlotte.

15. CF-41 (NO-HUB) Mechanical Joint: Cast iron no hub type fitting - DWV configuration. American Brass & Iron; Tyler; Charlotte.

2.3 PIPE JOINT DESIGNATIONS

A. Refer to System Schedules in Execution portion of this Section for designations of joint types to be used for each piping system. When more than one type is designated, contractor may choose which type is installed.

B. Piping Joint Designations:

1. CJ-1 Threaded: threads shall conform to ASME B1.20.1, ASTM B16.3, B16.4, B16.12. Remove all burrs. Ream pipe ends to full bore and remove all chips. Use pipe compound on male ends only. Approved pipe compounds: Blue Seal; Key Tite.

2. CJ-5 Welded Pipe: standard specification provision for fabrication and erection of piping systems as recommended by National Certified Pipe Welding Bureau. All welding of pipe, regardless of condition of is to be installed as follows:

    a. Pipe welding shall comply with provisions of latest revision of applicable code, whether ASME Boiler & Pressure Vessel Code, ASTM Code for Pressure Piping, or such state or local requirements as may supersede code mentioned above.
    b. A copy of his welding procedure specification together with proof of its qualification as outlined and required by most recent issue of code having jurisdiction.
    c. Submit Operator's qualification record in conformance with provisions of code having jurisdiction, showing that operator was under proven procedure specifications submitted by Contractor.
    d. Standard procedure specifications and operators qualified by National Certified Pipe Welding Bureau shall be considered as conforming to requirements of these specifications.
    e. Welders to have ASME test papers not more than 5 years old.
    f. Each manufacturer or Contractor shall be responsible for quality of welding done by his organization and shall repair or replace work not in accordance with these specifications.

3. CJ-6: grooved mechanical-joint couplings: Ductile or malleable-iron housing and synthetic rubber EPDM (+230^{o}F) gasket of central cavity pressure-response design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings; Victaulic Style 77, Gruvlok Figure No. 7401 or equal.

4. CJ-8: 95% tin, 4.85% copper, 0.15% selenium. Premium Contractor Grade solder. 410^{o}F Minimum working temperature; 7130 PSI Tensile Strength, ASTM B32. Like Taramet Sterling, Taracorp.IMACO, Winston-Salem, NC. Cut ends of tubing square with wheel type cutter, ream to remove burrs, wipe clean on inside, apply paste type solder flux on external surface. Apply solder (no lead allowed).

5. CJ-8A: Cold Press connection 0-250°F, 200 psig. Connection made using a hand held portable press system. Joint to be certified by NSF, UL and be compliant with ICC, UPC, PHCC, NFPA13, 13D and 139 like RIGID VIEGA ProPress System.

6. CJ-9 Silver Solder: minimum working temperature of 1100°F (copper to copper) AWS A5.8, Bag1. Make brazed joints in accordance with Section G of Code for Pressure Piping, ASME B16.22. Approved products: Handy Harmon SilFos or United Wire & Supply Phosphon 15. Approved fluxes: Handy Flux or Sil-Flux (lead content shall be .2% or less).

7. CJ-20 Mechanical Joint: AWWA C 111 ductile - or grey - ironglands, rubber gasket and steel bolts. Reinforce joint at hydrants, fittings or valves with heavy wrought iron clamps and wrought iron rods in accordance with standard details of National Board of Fire Underwriters. Apply heavy coat of bituminous solution to assembly.

8. CJ-32 Gasket for PVC Sewer pipe: ASTM F 477 elastomeric seals.

9. CJ-33 PVC

    a. Solvent Cement: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1) Comply with ASTM F 402 for safe-handling practice of cleaners, primers and solvent cements.
2) ABS piping: ASTM D 2235 and ASTM D 2661.
3) CPVC Piping: ASTM D 2846 and ASTM F-493.
4) PVC Pressure Piping: ASTM D 2672.
5) PVC Nonpressure Piping: ASTM D 2665.
6) PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to ASTM D 3138.

b. Heat Welding: ASTM D 2657
c. Threads: Use only where noted on schedules. Install as outlined for steel pipe but only to be used on Schedule 80 or 120 pipe. Use strap wrench for tightening.

10. CJ-40 (HUB) Bell & Spigot: Gasket-ASTM C 564, Rubber. American Brass & Iron; Tyler; Charlotte.

11. CJ-41 (No HUB) Coupling: Stainless steel couplings CISPI 310 with ASTM A 167, Type 301 or ASTM A 666 Type 301 Stainless steel corrugated shield; stainless steel bands and sleeve. American Brass & Iron; Tyler; Charlotte.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimension; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Thomson Plastics, Inc.

C. Plastic-to-Metal Transition Unions: MSS SP-107, [**CPVC**] [**PVC**] [**CPVC and PVC**] four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. [**Available**] Manufacturers:

a. NIBCO, Inc.
b. NIBCO, Inc.; Chemtrol Div.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company/
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300- psig minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company
d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.

d. Victaulic Co. of America

2.6 UNIONS AND FLANGED CONNECTIONS

A. 150 pound malleable iron with ground joint and brass to iron seats. Crane 1280.

B. 125 pound wrought copper or cast brass union with solder joint fittings. Crane 633.

C. 150 pound forged steel flanges with welding neck. Crane 568.

D. 150 pound bronze flanges with tube stop. Mueller F900.

2.7 VALVE DESIGNATIONS

A. Refer to System Schedules in Execution portion of this Section for designation of valve types to be used for each piping system.

B. All valves shall be compatible with the type of piping material installed in the system

PART 2 - PRODUCTS (Continued) VALVE SCHEDULES

1 Refer to System Schedules in Execution portion of this Section for designation of valve types to be used for each piping system.

2	VALVE DESIGNATION	CV-4	
3	TYPE	Globe	
4	MAXIMUM WORKING		
4.1	Pressure - PSIG	125	
4.2	Temperature - ^{o}F	Sat. Stm.	
5	SIZE LIMITS - Inches	1/2 - 2 1/2	
6	DESCRIPTION		
6.1	Body	Bronze	
6.2	Trim	Bronze	
6.3	Disc/plug	Renewable Composite	
6.4	Bonnet	Screw-in	
6.5	Stem	Rising-Silicon Bronze	
6.6	Seat	Integral	
6.7	Agency Compliance	MSS SP-80	
	APPROVED PRODUCTS	Soldered	Threaded
7.1	Nibco	S211	T211
7.2	Crane	1310	1

8 NOTES

8.1 Provide manufacturer’s standard stem packing for service intended.

8.2 Valves with rising stems suitable for repacking under pressure.

PART 2 - PRODUCTS (Continued) VALVE SCHEDULES

1 Refer to System Schedules in Execution portion of this Section for designation of valve types to be used for each piping system.

2	VALVE DESIGNATION	CV-5	CV-6
3	TYPE	Globe	Angle
4	MAXIMUM WORKING		
4.1	Pressure - PSIG	125	125
4.2	Temperature - ^{o}F	Sat. Stm.	Sat. Stm.
5	SIZE LIMITS - Inches	3 - 12	3 - 12
6	DESCRIPTION		
6.1	Body	Iron ASTM A126	Iron
6.2	Trim	Bronze	ASTM B-584
6.3	Disc/plug	Renewable Composite	Renewable Composite
6.4	Bonnet	Bolted	Bolted
6.5	Stem	OS&Y	OS&Y
6.6	Seat	Renewable Rings	Renewable Rings, ASTM B584
6.7	Agency Compliance	MSS SP-85	MSS SP-85
7	APPROVED PRODUCTS		
7.1	Nibco	F-718-B	F-818-B
7.2	Crane	351	353
7.3	Jenkins	613CJ	615CJ
8	NOTES		
8.1	Provide manufacturer’s standard stem packing for service intended.		
8.2	Valves with rising stems suitable for repacking under pressure.		

PART 2 - PRODUCTS (Continued) VALVE SCHEDULES

1 Refer to System Schedules in Execution portion of this Section for designation of valve types to be used for each piping system.

2	VALVE DESIGNATION	CV-7		CV-8	
3	TYPE	Horizontal Swing Check		Horizontal Swing Check	
4	MAXIMUM WORKING				
4.1	Pressure - PSIG	125		125	
4.2	Temperature - ^{o}F	Sat. Stm.		Sat. Stm.	
5	SIZE LIMITS - Inches	0 - 3		2 1/2 - 12	
6	DESCRIPTION				
6.1	Body	Bronze ASTM-B62		Iron ASTM A-126	
6.2	Trim	Bronze		Bronze	
6.3	Disc/plug	Bronze		Renewable Bronze	
6.4	Bonnet	Screw-in		ASTM B-584	
6.5	Seat	Integral		Renewable Rings	
6.6	Agency Compliance	MSS SP-80		MSS SP-71 TYPE I	
7	APPROVED PRODUCTS	Soldered	Threaded	Threaded	Flanged
7.1	Crane	1342	37	372	373
7.2	Nibco	S41BB	T-413B	T-918-13	F-918-13
7.3	Jenkins	762A			
7.4	Victaulic	Series 716		Series 779	

PART 2 - PRODUCTS (Continued) VALVE SCHEDULES

1 Refer to System Schedules in Execution portion of this Section for designation of valve types to be used for each piping system.

2	VALVE DESIGNATION	CV-10	CV-11
3	TYPE	Lubricated Plug Cock	Lubricated Plug Cock
4	MAXIMUM WORKING		
4.1	Pressure - PSIG	200	175
4.2	Temperature - ^{o}F	150	150
5	SIZE LIMITS - Inches	1/2 – 2 (Threaded)	2 1/2 – 4 (Flanged)
6	DESCRIPTION		
6.1	Body	Iron	Iron
6.2	Trim	Iron	Iron
6.3	Disc/plug	100% Pipe Area Plug	100% Pipe Area Plug
6.4	Seat	Integral	Integral
7	APPROVED PRODUCTS		
7.1	Nordstrum	114	142, 143
7.2	Walworth	1700	1796, 1797
8	NOTES		
8.1	Provide manufacturer’s standard stem packing for service intended.		

PART 2 - PRODUCTS (Continued) VALVE SCHEDULES

1 Refer to System Schedules in Execution portion of this Section for designation of valve types to be used for each piping system.

2	VALVE DESIGNATION	CV-16		CV-17
3	TYPE	Eccentric Plug		Eccentric Plug
4	MAXIMUM WORKING			
4.1	Pressure - PSIG	125		150
4.2	Temperature - ^{o}F			
5	SIZE LIMITS - Inches	1/2 - 2 (Threaded)	2 1/2 - 4 (Flanged)	5 - 12 (Flanged)
6	DESCRIPTION			
6.1	Body	Iron		Semi-Steel
6.2	Trim	St. Steel		Iron
6.3	Disc/plug	Dezurik Bronze with FS55 (250)		Dezurik Resilient Faced Plug RS55 (250)

7 NOTES

7.1 Provide manufacturer's standard stem packing for service intended.

7.2 Provide lever actuator for each valve except where special actuator is noted on Drawings.

7.3 Where eccentric plug valves are noted on Drawings as balancing valves, they are to have position stop, plastic cap and 1/8" downstream tap.

PART 2 - PRODUCTS (Continued) VALVE SCHEDULES

1	Refer to System Schedules in Execution portion of this Section for designation of valve types to be used for each piping system.	
2	CLASS NO.	CV-20
3	TYPE	Ball - Full Port
4	MAXIMUM WORKING	
4.1	Pressure - PSIG	150
4.2	Temperature - ^{o}F	Sat. Stm.
5	SIZE LIMITS - Inches	1/2 – 2 1/2”
6	DESCRIPTION	
6.1	Body/End Piece	2-Piece Construction - ASTM B 584 Bronze Body Alloy 844 Forging Brass ASTM B-124 Alloy 377
6.2	Ball	Chromeplated Brass Conventional Port
6.3	Stem	Bronze or Brass
6.3.1		Provide with Stem Extension on insulated pipes
6.4	Seats/Seals	Teflon
6.5	Agency Compliance	MSS SP-110
7	APPROVED PRODUCTS	Threaded
7.1	Nibco	T585-70
7.2	Crane/Capri	9200
7.3	Combraco Industries, Inc.	70-100
	Apollo Series	
8	NOTES	
8.1	Soldered valves are not allowed.	
8.2	Provide stem extension on insulated valves.	

PART 2 - PRODUCTS (Continued) VALVE SCHEDULES

1	Refer to System Schedules in Execution portion of this Section for designation of valve types to be used for each piping system.	
2	CLASS NO.	CV-22
3	TYPE	Ball - Full Port - AGA Gas Ball Valve
4	MAXIMUM WORKING	
4.1	Pressure - PSIG	5 psig Ambient - Valve Rated at 600 psig at 250^{o} F
5	SIZE LIMITS - Inches	1/2 - 2
6	DESCRIPTION	
6.1	Body/End Piece	Cast Brass ASTM B684 - C85700 Forged Brass ASTM B124 - C37700
6.2	Ball	Chromeplated Brass Conventional Port
6.3	Stem	Bronze or Brass
6.4	Seats/Seals	PTFE
6.5	Agency Compliance	
6.5.1	ANSI	Z21.15
6.5.2	FM	1/4" - 2"
6.5.3	UL	MHKZ; YSTD: VOGU (1/2" - 1"); YRBX (1 1/4" - 2"); YRPV (1 1/4" - 2")
7	APPROVED PRODUCTS	Threaded
7.1	McDonald	#10710

PART 2 - PRODUCTS (Continued) VALVE SCHEDULES

1	Refer to System Schedules in Execution portion of this Section for designation of valve types to be used for each piping system.	
2	CLASS NO.	CV-23
3	TYPE	Butterfly
4	MAXIMUM WORKING	
4.1	Pressure - PSIG	150
4.2	Temperature - ^{o}F	200
5	SIZE LIMITS - Inches	3 – 6 (see note below)
6	DESCRIPTION	
6.1	Body/End Piece	Cast Iron ASTM A-126 Threaded Lug for dead end service
6.2	Disc	AL. Bronze ASTM B-148 Alloy 954/955
6.3	Stem	416 Stainless steel ASTM A-582 Collar bushings upper and lower bushing
6.4	Seats	EPDM Rubber
6.5	Agency Compliance	MSS SP-67
7	OPERATOR	
7.1	Standard Lever-lock handle w/memory stop **Delete this line if worm gear actuator is used**.	
7.2	**Self-locking worm gear type actuator with adjustable stops and disc position indicator.**	
7.3	**Provide with chain wheel where noted on Drawings.**	
8	APPROVED PRODUCTS	
8.1	Nibco	LD 2000-3
8.2	Crane	14-TL
8.3	Apollo	6L-31
8.4	Lunkenheimer	FIG. 4735
8.5	Stockham	LD-711-BS3-E
8.69	Victaulic	300 Series
9.0	NOTES	
9.1	Do not use butterfly valves on pipes size 2 1/2” and smaller. LD-711-BS3-E	

PART 2 - PRODUCTS (Continued) VALVE SCHEDULES

1	Refer to System Schedules in Execution portion of this Section for designation of valve types to be used for each piping system.	
2	CLASS NO.	CV-24
3	TYPE	Butterfly
4	MAXIMUM WORKING	
4.1	Pressure - PSIG	150
4.2	Temperature - ^{o}F	200
5	SIZE LIMITS - Inches	8 - 12
6	DESCRIPTION	
6.1	Body/End Piece	Cast Iron ASTM A-536 Threaded Lug for dead end service
6.2	Disc	AL. Bronze ASTM B-148 Alloy 954/955
6.3	Stem	416 Stainless steel ASTM A-582 Collar bushings upper and lower bushing
6.4	Seats	EPDM Rubber
6.5	Agency Compliance	MSS SP-67
7	OPERATOR	
7.1	Self-locking worm gear type actuator with adjustable stops and disc position indicator.	
7.2	**Provide with chain wheel where noted on Drawings.**	
8	APPROVED PRODUCTS	
8.1	Nibco	LD 2000-5
8.2	Crane	14-TL
8.3	Apollo	6L-31
8.4	Lunkenheimer	FIG. 4735
8.5	Stockham	LD-711-B53-E
8.6	Victaulic	300 Series

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pipe, valves and fittings for each system as designated in the System Schedules on the following pages.

B. Reference Products, Part 2 of this Section for specifications and manufacturers of pipes, valves and fittings designated to be installed in System Schedules.

PART 3 - EXECUTION (Continued)

SYSTEM PIPING SCHEDULE 11
REFRIGERATION
Refrigerants R-22 and R134A

1 Install pipe, valves and fittings as designated in this Schedule for this System.

2	LOCATION	ABOVE GROUND		BELOW GROUND	
3	PIPING DESIGNATIONS	LOW SIDE	HIGH SIDE	LOW OR HIGH SIDE	
3.1	CP-29	3/8" – 4 1/8"	3/8" – 4 1/8"	Note 4.1	
	CP-8	L 5"-12"			
	CP-8	K	5" – 12"	3/8"-12"	
3.2	Fittings	Wr. Copper	CF-8	Wr. Copper	CF-8
3.3	Joints	Silver Brazed	CJ-8	Silver Brazed	CJ-9

4 NOTES

4.1 Use K 3/8-1 3/8 shall be soft annealed and 1 5/8-12 K shall be hard drawn below ground.

4.2 All copper tubing shall be hard drawn except as stated in "Note 4.1."

PART 3 - EXECUTION (Continued)

SYSTEM PIPING SCHEDULE 11A
REFRIGERATION
R-410A REFRIGERANT ONLY

1 Install pipe, valves and fittings as designated in this Schedule for this System.

2	LOCATION	ABOVE GROUND		BELOW GROUND	
3	PIPING DESIGNATIONS	LOW SIDE	HIGH SIDE	LOW OR HIGH SIDE	
3.1	CP-29	3/8”-4 1/8”		Note 4.1	
	CP-8	L 5”-12”	3/8” – 1 3/8”		
	CP-8	K	1 5/8” – 2 1/8”	3/8” – 2 1/8”	
	CP-2	Sch. 40 A53	2 1/2” – 4”	2 1/2” – 4”	
3.2	Fittings	Wr. Copper	CF-8	Wr. Copper	CF-8
3.3	Joints	Silver Brazed	CJ-9	Silver Brazed	CJ-9
		Weld	CJ-5		CJ-5

4 NOTES

4.1 3/8 – 1 3/8 shall be soft annealed copper, and 1 5/8 – 2 1/8 shall be hard drawn below ground.

4.2 All tubing shall be hard drawn except as stated in “Note 4.1.”

4.3 CP-2 steel pipe shall be A53 Sch. 40 seamless.

4.4 Buried steel pipe shall be protected. Use Pasco “Pipewrap Primer” then 20 mil Pasco “Pipe Protection Tape System” or an approved equal. Refer to Section 20 00 50 for trenching and backfilling.

PART 3 - EXECUTION (Continued)

SYSTEM PIPING SCHEDULE 11B
REFRIGERATION

Refrigerants R-404A, R-507, R407C

1 Install pipe, valves and fittings as designated in this Schedule for this System.

2	LOCATION	ABOVE GROUND		BELOW GROUND	
3	PIPING DESIGNATIONS	LOW SIDE	HIGH SIDE	LOW OR HIGH SIDE	
3.1	CP-29	3/8”-4 1/8”	3/8” – 1 3/8”	Note 4.1	
	CP-8	L 5”-12”			
	CP-8	K	1 5/8 – 2 1/8	3/8” – 2 5/8”	
	CP-2	Sch. 40 A53	2 1/2” – 4”	2 1/2” – 4”	
3.2	Fittings	Wr. Copper	CF-8	Wr. Copper	CF-8
3.3	Joints	Silver Brazed	CJ-9	Silver Brazed	CJ-9
		Weld	CJ-5		CJ-5

4 NOTES

4.1 3/8 – 1 3/8 shall be soft annealed copper, and 1 5/8 – 2 1/8 shall be hard drawn below ground.

4.2 All tubing shall be hard drawn except as stated in “Note 4.1.”

4.3 CP-2 steel pipe shall be A53 Sch. 40 seamless.

4.4 Buried steel pipe shall be protected. Use Pasco “Pipewrap Primer” then 20 mil Pasco “Pipe Protection Tape System” or an approved equal. Refer to Section 20 00 50 for trenching and backfilling.

PART 3 - EXECUTION (Continued) SYSTEM PIPING SCHEDULE 13
COIL CONDENSATE AND DRIP WASTE

1 Install pipe, valves and fittings as designated in this Schedule for this System.

2	NOMINAL SIZE RANGE	
2.1	Minimum Diameter	1”
2.2	Maximum Diameter	4”
3	DESIGN	
3.1	Working Pressure Ft. Hd.	10
3.2	Working Temperature °F	Ambient
4	PIPING DESIGNATIONS	
4.1	Hard “L” Copper	CP-8
4.2	Sch. 40 PVC	CP-30
5	FITTING DESIGNATIONS	
5.1	Wrought	CF-8
5.2	Sch. 40 PVC	CF-30
6	JOINT DESIGNATIONS	
6.1	Solder	CJ-8
6.2	Solvent Cement	CJ-33

PART 3 - EXECUTION (Continued) SYSTEM PIPING SCHEDULE 14
SANITARY, VENT AND STORM GRAVITY-INSIDE BUILDING

1 Install pipe, valves and fittings as designated in this Schedule for this System.

2 ABOVE GRADE

2.1	SANITARY & STORM PIPE DESIGNATIONS		FITTING DESIGNATIONS		JOINT DESIGNATIONS	
2.1.1	1 1/2” and Larger					
2.1.1.1	Cast Iron No Hub	CP-41	No Hub	CF-41	Coupling	CJ-41
2.1.1.2	DWV Copper	CP-7	Copper	CF-11	Solder	CJ-8
2.1.1.3	Sch. 40 DWV PVC	CP-33	PVC	CF-33	Solvent	CJ-33
2.2	VENT PIPE DESIGNATIONS					
2.2.1	1 1/2" and Larger					
2.2.1.1	Cast Iron No Hub	CP-41	No Hub	CF-41	Coupling	CJ-41
2.2.1.2	DWV Copper	CP-7	Copper	CF-11	Solder	CJ-8
2.2.1.3	Sch. 40 DWV PVC	CP-33	PVC	CF-33	Solvent	CJ-33
3	BELOW FLOOR					
3.1	SANITARY, STORM AND VENT					
3.1.1	2” and Larger					
3.1.1.1	Cast Iron Hub	CP-40	Hub	CF-40	Gasket	CJ-40
3.1.1.2	Sch. 40 DWV PVC	CP-33	PVC	CF-33	Solvent	CJ-33

4 NOTES

4.1 PVC in return air plenums shall be insulated. Reference Insulation Section 200180.

PART 3 - EXECUTION (Continued)

SYSTEM PIPING SCHEDULE 15
SANITARY, VENT AND STORM
GRAVITY-OUTSIDE BUILDING

1 Install pipe, valves and fittings as designated in this Schedule for this System.

2	SANITARY & STORM PIPE DESIGNATIONS		FITTING DESIGNATIONS		JOINT DESIGNATIONS	
2.1	2” and 3”					
2.1.1	Sch. 40 DWV PVC	CP-33	PVC	CF-33	Solvent	CJ-33
2.1.2	Sch. 40 ABS	CP-34	ABS	CF-34	Solvent	CJ-33
2.2	4” to 15”					
2.2.1	PVC SDR 35	CP-32	PVC	CF-32	Gasket	CJ-32

3 NOTES

3.1 Use concrete pipe below roads and driveways.

PART 3 - EXECUTION (Continued) SYSTEM PIPING SCHEDULE 16
SANITARY AND STORM, FORCED MAIN

1 Install pipe, valves and fittings as designated in this Schedule for this System.

2	SANITARY & STORM PIPE DESIGNATIONS		FITTING DESIGNATIONS		JOINT DESIGNATIONS	
2.1	ABOVE GRADE					
2.1.1	2” to 4”					
2.1.1.1	Type L Copper	CP-8	Wrought Copper	CF-10	Solder	CJ-8
2.1.1.2	Sch. 40 Galv. St.	CP-2	Ductile Iron	CF-6	Grooved Mech.	CJ-6
3	BELOW FLOOR – INSIDE BUILDING					
3.1	2” to 4”					
3.1.1	Ductile Iron	CP-20	Ductile Iron	CF-20	Mech. Joint	CJ-20
4	BELOW GRADE – OUTSIDE BUILDING					
4.1	2” to 4”					
4.1.1	Ductile Iron	CP-20	Ductile Iron	CF-20	Mech. Joint	CJ-20

PART 3 - EXECUTION (Continued)

SYSTEM PIPING SCHEDULE 17
DOMESTIC HOT & COLD WATER
ABOVE GROUND

1 Install pipe, valves and fittings as designated in this Schedule for this System.

2	NOMINAL SIZE RANGE		
2.1	Minimum Diameter	1/2"	4”
2.2	Maximum Diameter	3”	8”
3	DESIGN		
3.1	Working Pressure PSIG	125	125
3.2	Working Temperature °F	250	250
4	PIPING DESIGNATIONS		
4.1	Hard “L” Copper	CP-8	CP-8
5	FITTING DESIGNATIONS		
5.1	Cold Press	CF-8A	CF-8A
5.2	Wrought	CF-8	-
5.3	Grooved Mech.	-	CF-6
6	JOINT DESIGNATIONS		
6.1	Cold Press	CJ-8A	CJ-8A
6.2	Solder	CJ-8	-
6.3	Grooved	-	CJ-6
7	VALVES		
7.1	Ball	CV-20	Use only if specifically told to do so – CV-21
7.2	Angle	-	CV-6
7.3	Globe	CV-4, 5	CV-5
7.4	Check Horizontal Swing	CV-7, 8	CV-8
7.5	Butterfly	-	CV-23, 24
8	NOTES		
8.1	Install ball valves for balancing services.		
8.2	Use flange joint on 3” and larger pipe when connection to equipment or valves.		
8.3	See Division 22 “Plumbing” for special valves.		

PART 3 - EXECUTION (Continued) SYSTEM PIPING SCHEDULE 19
FIRE PROTECTION

1 Install pipe, valves and fittings as designated in this Schedule for this System

2	LOCATION LIMITES	BELOW GROUND	ABOVE GROUND	
3	NOMINAL SIZE RANGE			
3.1	Minimum Diameter	4”	1”	2 1/2"
3.2	Maximum Diameter	12”	2”	8”
4	DESIGN			
4.1	Working Pressure PSIG	175	175	175
4.2	Working Temperature °F	WOG	WOG	WOG
5	PIPING DESIGNATIONS			
5.1	Ductile Iron	CP-20	-	-
5.2	Sch. 40 Bl. St.	-	CP-2	-
5.3	Sch. 10 Bl. St.	-	-	CP-2
6	FITTING DESIGNATIONS			
6.1	Ductile Iron Mech. Joint	CF-20	-	-
6.2	250# Cast Iron	-	CF-2	-
6.3	Steel Grooved	-	-	CF-6
7	JOINT DESIGNATIONS			
7.1	Mechanical Joint	CJ-20	-	-
7.2	Threaded	-	CJ-1	-
7.3	Mech. Grooved	-	-	CJ-6
8	NOTES			

8.1 Valves are specified in Fire Protection Section 15500.

8.2 Provide manufacturer’s standard gasket for service intended on mechanical joint pipe.

8.3 Provide thrust blocks or tie-rods at all fittings below grade as required by NFPA #24, Chapter 8.

8.4 Above grade: Sch. 10 light wall pipe ASTM-A135 with victaulic fittings is acceptable for sprinkler system.

8.5 The minimum burial depth of exterior fire protection systems shall be 5’0”.

PART 3 - EXECUTION (Continued) SYSTEM PIPING SCHEDULE 20
GAS PIPING

1 Install pipe, valves and fittings as designated in this Schedule for this System.

2	NOMINAL SIZE RANGE		
2.1	Minimum Diameter	1/4"	2 1/2"
2.2	Maximum Diameter	2”	12”
3	DESIGN		
3.1	Working Pressure PSIG	5	5
3.2	Working Temperature °F	150	150
4	PIPING DESIGNATIONS		
4.1	Sch. 40 Bl. St.	CP-2	CP-2
5	FITTING DESIGNATIONS		
5.1	150# Mal. Iron	CF-1	-
5.2	Wrought St.	-	CF-5
6	JOINT DESIGNATIONS		
6.1	Threaded	CJ-1	-
6.2	Welded	-	CJ-5
7	VALVE DESIGNATIONS		
7.1	Cock	CV-10	CV-11
7.2	Eccentric Plug	CV-16	CV-16, 17
7.3	Ball	CV-22	-
7.4	Crane 270 Gas Cock in 1 1/2" and Under		

8 NOTES

8.1 Unions shall be malleable iron railroad unions for 500# WOG.

8.2 Pipe buried below ground to be Dupont Aldyl A or approved AGA equal.

8.3 Steel piping shall connect to plastic piping just below ground. Coat steel pipe which extends into ground with cold asphalt Reilly Tar & Chemical Enamel CA-50; Glass Fiber and Mat Roskote Glasswrap with coat enamel or approved equal.

8.4 Underground piping within building shall be installed in underground conduit, in accordance with National Fire Code 54. Conduit used to encasing gas pipe shall be Schedule 40 steel pipe, well wrapped or plastic coated. All joints to be welded. Provide cathode protection for electrolytic action. Conduit shall extend to outside for venting.

8.5 Inspection, testing and purging shall be done as set forth in NFPA #53, Part 4.

3.2 PIPE SUPPORT

A. PIPE SUPPORT

1. Furnish and install supports, guides, anchors and swaybraces required for proper installation and support of pipe lines except supports noted to be furnished by others.
2. Pipe suspension shall prevent excessive stress and excessive variation in supporting force. Fabrication and installation of supports for pipe lines shall not constrain piping to cause excess transfer of load from supports to piping or from support to support when expansion or contraction occurs. Supports shall be capable of taking entire piping load imposed by expansion or contraction.
3. Where pipe vibration transmits objectionable vibration to building structure or attached equipment, hangers shall be supplemented by spring cushions or an energy absorbing means in the supports themselves, or through the addition of flexible piping connectors or other auxiliary equipment.
4. Piping system where flexibility is not desired shall be supported by rigid hangers.
5. See Section 20 00 10, “Attaching to Building Construction” for attaching pipe support to structure.

B. Vertical Pipe Risers

1. Support vertical runs under 15' long with hanger adjacent to elbows.
2. Support vertical runs over 15' with steel riser clamps. Weld clamps to pipe and support on building structure. Space clamps at every floor with maximum spacing of 28'.

C. Hanger Rods

1. Support horizontal pipe with hot rolled steel rod manufactured in accordance with ASTM A107. Space hanger rods to eliminate pipe sagging. Space hangers as listed below. Place hangers within 12" of each horizontal elbow.
2. Steel and Copper Hanger Spacing

PIPE SIZE (NPS)	ROD SIZE (DIAMETER)	MAXIMUM HANGER SPACING
1/2" thru 1-1/4"	3/8"	6'0"
1-1/2" and 3"	1/2"	10'0"
4" and 5"	5/8"	10'0"
6"	3/4"	10'0"
8" thru 12"	7/8"	15'0"
14" thru 18"	Two 7/8"	15'0"
20" thru 24"	Two 1"	15'0"

3. PVC Pipe Support Spacing

PIPE SIZE (NPS)	ROD SIZE (DIAMETER)	MAXIMUM HANGER SPACING

1/2" thru 1"	3/8"	3'0"
1-1/4" thru 3"	3/8"	4'0"
4" thru 5"	1/2"	4'0"
6”	1/2"	4’0”

4. Piping with caulked joints to be supported at each joint.

D. Pipe Hangers (Pipe Suspended from Above)

1. For Hot Lines or Combination Hot and Cold Lines

   a. 2" and smaller iron or steel pipe: adjustable steel clevis hangers. Elcen 12; Grinnell 260; Fee & Mason 239; Crawford 11.
   b. 2" and smaller copper pipe: adjustable copper pipe ring. Elcen 394; Grinnell 97CP; Fee & Mason 365; Crawford.
   c. 2-1/2" thru 12" iron, steel and copper pipe: adjustable steel clevis hangers. Elcen 12; Grinnell 260; Fee & Mason 239; Crawford 11.
   d. 2-1/2" thru 12" iron, steel and copper pipe: adjustable swivel pipe roll (one hanger rod). Elcen 14; Grinnell 174; Fee & Mason 272; Crawford 129.
   e. 14" thru 24" o.d. iron or steel pipe: single pipe roll with adjustable sockets (two hanger rods). Elcen 15; Grinnell 171; Fee & Mason 170; Crawford 15.

2. For Cold Lines

   a. All sizes iron or steel pipe: Elcen 12; Grinnell 260; Fee & Mason 239; Crawford 11.
   b. All sizes copper pipe: adjustable copper-plated ring. Elcen 394; Grinnell 97CP; Fee & Mason 365; Crawford.

3. All hangers used on lines requiring insulation and vapor barrier shall have hangers oversized to allow insulation to pass thru hanger. Install insulation cradles or wood blocks the same thickness as insulation so insulation will not be crushed. Insulation cradles or wood blocks shall be designed for this specific use.

E. Pipe Carriers (Pipe Supported from Below on Racks, Piers, Stands or Trapeze Support)

1. For Hot Lines or Combination Hot and Cold Lines

   a. 3” and smaller Pipe: roller chair with steel U bar support. Elcen 16; Grinnell 176; Fee & Mason 168; Crawford 130.
   b. 4” and larger Pipe: adjustable pipe roll stand with base plate. Elcen 20; Grinnell 274; Fee & Mason 161; Crawford 19.

2. For Cold Lines: all pipe sizes supported on steel pipe chair designed to contain pipe movement in direction perpendicular to pipe run but allow some movement in direction of pipe run.
3. All hangers used on lines requiring insulation and vapor barrier shall have hangers oversized to allow insulation to pass thru hanger. Install insulation cradles or wood blocks the same thickness as insulation so insulation will not be crushed. Insulation cradles or wood blocks shall be designed for this specific use.

F. For sprinkler piping support refer to NFPA#13 (3-10 hangers).

G. Supports for sprinkler piping to be in conformance with NFPA 13, if modified by this section.

H. For piping hanger rod attachment to building, see Section 20 00 10 “Attaching to Building Construction.”

3.3 UNDERGROUND PIPING **Reference - Excavation and Backfilling**

A. See Excavation and Backfilling Section 20 00 50.

3.4 ESCUTCHEONS

A. See Escutcheons, Section 20 00 50.

3.5 INSTALLATION OF VALVES

A. Locate valves accessibly and arrange to permit easy removal of fixtures and equipment they serve.

B. Unless otherwise noted, all valves shall be full size of lines in which they are placed.

C. Install all piping and shut-off valves full pipe size as shown on Drawings. Reduce at control valves to control valve size.

D. Valves mounted in horizontal lines shall not have their stems and bonnets pointed below horizontal position unless indicated on Drawings.

E. Provide valves with 3/4" garden hose adaptor for draining low points, boilers, chillers, coils, etc. with cap and chain. Use ball valves for systems which operate below 120^{o}F. Use gate (Crane 431) or globe valves for systems which operate above 121^{o}F.

F. Mount all globe valves to close against flow pressure. Flow should be against bottom of plug.

G. Remove bonnets and trim from all valves before soldering, brazing or welding in piping system. Protect seating surfaces during installation. Clean valve parts thoroughly before reassembling. Install bonnet with valve in open position. Follow manufacturers written instructions to protect valves from overheating during installation.

H. Install all valves with discs or plugs in open position. Close only when assured that sealing parts are free from foreign material. Weld scale or similar foreign materials found embedded in sealing surfaces will require installation of new trim or complete valve.

I. If grooved piping system is used, then only grooved end valves shall be used. If grooved piping is used, it is not acceptable to use grooved to flanged adapters to install flanged valves.

J. Install valves as required by control contractor.

3.6 INSTALLATION OF PIPING

A. Offset piping to avoid interference with other work to increase head room under piping.

B. Contractor may, at his option, use pipe bending equipment to form full lengths of pipe to proper configuration indicated on Drawings.

C. Remove raised face from flanges that are to match cast iron flat face patterns.

D. Coat studs, nuts, flange faces and metallic gaskets with material similar to molybdenum disulphide before assembly.

E. Pipe sizes refer to nominal inside pipe diameter except on copper refrigeration lines and steel and wrought iron pipe 14" and larger.

F. Bonney Weldolet Forge Branch Outlet Fittings may be used where steel with welding fittings are specified in lieu of branch outlet tees, provided branch tee is 2 sizes smaller than main. Nipples welded into mains not acceptable.

G. Use galvanized fittings and unions with galvanized pipe.

H. Caulk clearance space in floor sleeves with plastic compound or fire stop material as required.

I. Caulk exterior wall sleeves with thiokol.

J. Install chromeplated pipe escutcheons on bare exposed pipe at wall, floor and ceiling penetrations. Reference 20 00 50 Escutcheons.

K. Use dielectric couplings when joining dissimilar piping materials.

L. Piping shall not pass over electrical apparatus. If conflict is shown on Drawings, notify Engineer prior to installing pipe.

M. Refer to General Requirements for installation of sleeves, escutcheons, cutting and fitting and attaching to building construction.

N. Refer to Insulation Section for insulation data.

O. Conceal all pipe where provisions have been made for this purpose.

P. In case of conflict on Drawings as to pipe size, the larger pipe size shall be installed.

Q. Joints shall be approved type, gas and watertight for system pressure.

R. All pipe shall be cut square, reamed, chamfered and free of all burrs and obstructions. Pipe ends shall have full-bore openings and not be undercut.

S. Piping not serving elevator equipment rooms shall not pass through elevator equipment rooms. If conflict is shown on drawings, notify Engineer prior to installing pipe.

T. Install wells, thread-o-lets and T’s as required by control contractor.

U. Copper pipe shall not come in direct contact with mortar or grout. Where copper pipes are exposed to mortar or grout, pipes shall be wrapped with duct tape. This typically happens when pipes pass through masonry walls.

V. All pipe to equipment and isolation valves shall be full pipe size as shown on Drawings regardless of equipment connection size. Use reducers at equipment to reduce to equipment size.

W. Grooved product must be installed per manufacturer's written instructions, which may or may not include extreme lubricant, torque wrench and specified torque ratings. Manufacturer's representative must provide on-site training to field personnel on installation of product.

3.7 PIPE CLEANING

A. Swab to remove dirt or scale.

B. Flush water system until water runs clear.

C. Operate steam systems until condensate runs clear.

D. Clean all strainers and traps.

3.8 TESTING PIPING

A. Test all piping at 1 1/2 times operating pressure.

B. Test all concealed work before covering with earth, insulation or furring.

C. Notify Engineer not less than 24 hours in advance of all tests.

D. Furnish all fuel and necessary equipment required for tests.

E. Promptly repair all leaks and reapply tests.

F. Install blind flanges or plugs in order to make tests.

G. See Specification Divisions 22 and 23 for additional pressure testing requirements.

3.9 STERILIZATION OF DOMESTIC WATER SYSTEM

A. Flush system thoroughly until water runs clear.

B. Entire system shall be filled with a water/chlorine solution containing 50 parts per million of chlorine. The system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing at least 200 parts per million of chlorine and allowed to stand for three hours.

C. Following the allowed standing time, the system shall be flushed with clean potable water until chlorine does not remain in the water coming from the system.

D. After the above requirements are satisfied, submit samples to local Board of Health for approval.

E. Sterilization shall be redone until approval from the State Board of Health is obtained.

3.10 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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 pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook", using lead-free solder alloy complying with ASTM C 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook", "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. 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 unless dry seal threading is specified.
2. 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.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Non-pressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. 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.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.11 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

END OF SECTION 200060

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes field applied insulation and jacket materials for all systems. These systems include:

1. System Insulation Schedule 3:
   Coil Condensate Pipe
   Domestic Cold Water Pipe
   Domestic Hot Water Pipe
   Sanitary Waste Pipe

2. System Insulation Schedule 4:
   Refrigeration Suction Pipe

3. System Insulation Schedule 7:
   Storm Water Pipe

4. System Insulation Schedule 8:
   Roof Drain Basins

5. System Insulation Schedule 9:
   Heating and Air Conditioning Supply Ductwork
   Outside Air Intake Ductwork

6. System Insulation Schedule 10:
   Return Air Ductwork

7. System Insulation Schedule 11:
   Fire Rated Duct for Kitchen Hood Exhaust

B. Any equipment that is to be factory insulated is specified with respective equipment.

C. All PVC piping installed (or existing to remain) in a ceiling plenum shall be insulated to provide a flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

D. Any piece of equipment, pipe, or duct, installed in this contract, which is typically insulated to prevent condensation, shall be insulated unless specifically noted otherwise.

E. Internally lined sheet metal is specified in Metal Ducts, Section 23 31 13.

F. Related sections include all applicable Mechanical Sections.

1.3 SUBMITTALS

A. Submit product data for insulation, jacket materials and fittings used in each system as required in Section 20 00 10, “Shop Drawings”.

B. Product data shall include thermal conductivity, thickness, jacket material, insulation material, sealing compounds, flame-spread and smoke-developed ratings for each type of product to be used.

C. Submit test reports of independent testing agency showing conformance with flame-spread and smoke-developed ratings.

1.4 QUALITY ASSURANCE

A. Insulation Contractor shall have completed a minimum of two (2) projects of similar scope. Upon request, the Insulation Contractor shall provide a list of similar projects and references to the Engineer. The engineer may wish to inspect work previously installed by the Insulation Contractor.

B. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

C. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. All insulation to be shipped to site in unopened containers as packaged by Insulation Manufacturers.

B. All containers shall state contents within.

C. Store in clean dry area properly protected from weather and physical damage.

D. Open only containers required to be opened as construction progresses.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers and insulation shields.

B. Coordinate hanger sizes and piping penetrations for pipes requiring insulation, wood blocking and saddles with piping installer.

1.7 SCHEDULING

A. Schedule insulation application after pipe testing and heat trace has been installed.

PART 2 - **PRODUCTS**

2.1 INSULATION MATERIALS

A. Refer to Insulation Material Schedules in Execution portion of this Section for Insulation types to be used for each system. When more than one is shown, contractor may choose which type is to be installed.

B. FIBERGLASS INSULATION

1. Glass fiber bonded with a thermosetting resin with thermal conductivity of .25 or less @ 75°F. 3-pound per cubic foot density. Designed for use to 850°F.

   a. Preformed Pipe Insulation with Jacket: ASTM C547, Type 1, Class 1 with factory applied all-purpose, vapor-retarder jacket, 0.02 perm max water vapor permeance.
   b. Board Insulation: with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil and vinyl film.
   c. Blanket Insulation: ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

2. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:

   a. Class 1, Grade A for bonding glass cloth and tape to un-faced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to un-faced glass-fiber insulation.
   b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.

3. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
4. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
5. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
6. Mineral-Fiber, hydraulic-setting insulating and finishing cement: Comply with ASTM C 449/C 449M.
7. Manufacturers:

   a. CertainTeed Manson
   b. Knauf Insulation.
   c. Owens-Corning Fiberglas Corp.
   d. Schuller International, Inc.
   e. Johns Manville

C. FOAMGLASS INSULATION

1. Inorganic cellular glass insulating material with hermetically sealed cells, non-absorptive and noncombustible. Designed for use from 35°F to 350°F.

   a. Preformed Pipe Insulation, without Jacket: Comply with ASTM C 552, Type II, Class I.
   b. Preformed Pipe Insulation, with Jacket: Comply with ASTM C 552, Type II, Class 2.
   c. Block Insulation: ASTM C 552, Type I.
   d. Special-Shaped Insulation: ASTM C 552, Type III.
   e. Board Insulation: ASTM C 552, Type IV.

2. Manufacturers:

a. Pittsburgh - Corning Corporation

D. FLEXIBLE ELASTOMERIC INSULATION

1. Closed cellular or expanded rubber material of high insulating efficiency (K of .25 or better @ 75°F) and designed for use with temperatures from -40° to 210°F. Odorless, self-extinguishing and vapor resistant in compliance with ASTM E-84, 25/50 flame smoke rating. Approved for use in return air plenums.

   a. Preformed pipe insulation: ASTM C 534, Type I.
   b. Sheet insulation: ASTM C 534, Type II.

2. Adhesive: As recommended by Insulation Material Manufacturer.
3. Ultraviolet – Protective Coating: As recommended by Insulation Manufacturer.
4. Manufacturers:

   a. Armstrong World Industries, Inc. - Armacell
   b. Rubatex Corp.
   c. K-Flex

E. CALCIUM SILICATE

1. Rigid hydrous calcium silicate heat insulating block with thermal conductivity of .4 or less @ 300°F. 15 pounds per cubic foot density. Designed for use to 1200°F. ASTM E 84 - 0 Flame Spread; 0 Smoke Developed.

   a. Preformed Pipe and Block Insulation: ASTM C 533, Type I.

2. Insulating Cements: ASTM C 195.
3. Manufacturers:

   a. Owens-Corning Fiberglas Corp.
   b. Pabco
   c. Schuller International, Inc.

F. DUCT LINER: See Section 23 31 13.

2.2 ADHESIVES

A. Adhesives or mastics used in the application or manufacture of insulating materials shall be fire retardant with UL flame rating not exceeding 25 and smoke developed rating not exceeding 50 (on dry film) when tested in accordance with ASTM E 84. All adhesives specifically designed for respective application as noted by insulation manufacturer.

2.3 JACKETS

A. PVC Jacket

1. High-impact

a. Fittings – Gloss White, preformed, 30 Mill, PVC jacket designed for use with and provided by same manufacturer of insulation. Fiberglass insert wrapped around fitting and covered by PVC preformed jacket piping insulation system.
b. Sheet – Gloss White, preformed, pre-cut and curled 20 mil PVC jacket designed for use with and provided by same manufacturer of piping insulation system. Ultraviolet-resistant suitable for outdoor service and temperature range 0 – 150^{o}F. Jacket to be completely sealed with solvent weld for vapor proof barrier where noted in schedule.

B. Foil and Paper Jacket

1. Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil. Maximum of .02 perms moisture vapor transmission, ASTM C 921, Type I, Max 25/50 flame smoke rating.

C. Aluminum Jacket

1. Aluminum roll stock .010" thick, ready for shop or field cutting and forming. ASTM B209, 3003 alloy, H-14 temper.
2. Aluminum Fittings - Preformed - same thickness and finish as jacket.
3. Jacket Bands - Aluminum 3/4" wide.

D. Stainless Steel Jacket

1. Stainless steel roll stock .010" thick, ready for shop or field cutting and forming. ASTM A66, Type 304 or 316.
2. Stainless steel fittings - Gore Type, same thickness and finish as jacket.
3. Jacket Bands - Stainless steel, Type 304, 3/4" wide.

2.4 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape

1. Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, pre-sized a minimum of 8 oz./sq. yd. (270 g/sq. m). Tape Width: 4 inches (100 mm).

B. Bands

1. 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket:

a. Stainless Steel: ASTM A 666, Type 304; 0.020 inch (0.5 mm) thick.
b. Aluminum: 0.007 inch (0.18 mm) thick.

C. Wire

1. 0.080-inch (2.0 mm), nickel-copper alloy; 0.062-inch (1.6 mm), soft-annealed, stainless steel; or 0.062-inch (1.6 mm), soft-annealed, galvanized steel.

D. Welded-Attached Anchor Pins and Washers

1. Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.

a. Welded Pin Holding Capacity: 100 lb (45 kg) for direct pull perpendicular to the attached surface.

E. Adhesive-Attached Anchor Pins and Speed Washers

1. Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

a. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperature of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb (45 kg) for direct pull perpendicular to the adhered surface.

F. Self-Adhesive Anchor Pins and Speed Washers

1. Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install Insulation for each system as designated in the Insulation Material Schedules on the following pages.

B. When more than one type of insulation system is specified, contractor may choose which type is installed.

C. Reference Products, Part 2 of this Section for specifications and manufacturers of insulation materials designated to be installed in Insulation Material Schedules.

3.0 EXECUTION (Continued)

SYSTEM INSULATION SCHEDULE 3:
COIL CONDENSATE PIPE
DOMESTIC COLD WATER PIPE
DOMESTIC HOT WATER PIPE
SANITARY WASTE PIPE

1	Install insulation materials as designated in this schedule for system(s) listed.		
2	LOCATION	INSIDE	OUTSIDE
3	INSULATION		
3.1	Pipe	Fiberglass-Preformed with Jacket	
3.2	Fitting	Fiberglass Blanket	
4	INSULATION THICKNESS		
4.1	Pipe Size	All	
4.2	Thickness	1"	
5	JACKETS		
5.1	Pipe	Integral to Insulation	
5.2	Fittings	Preformed PVC	
5.3	Vapor-Retardant	Yes	
6	NOTES		
6.1	On outside installations, use silicon sealant at all stainless steel joints for a water-tight installation.		
6.2	Application of insulation on sanitary waste pipe shall be as follows:		
6.2.1	Piping installed above ground floor.		
6.2.2	Piping receiving discharge from cooling coils or electric water coolers.		
6.2.3	If both of the above conditions are not met, insulation shall not be required..		
6.2.4	Where insulation is required, install along pipe lengths connecting fixture to waste stack/main building drain only.		

3.0 EXECUTION (Continued) SYSTEM INSULATION SCHEDULE 4:
REFRIGERATION SUCTION PIPE
REFRIGERATION HOT GAS PIPE

1 Install insulation materials as designated in this schedule for this system.

2	SERVICE	INSIDE	OUTSIDE
3	INSULATION MATERIAL		
3.1	Pipe	Elastomeric	Elastomeric
3.2	Fitting	Preformed	Preformed
4	INSULATION THICKNESS		
4.1	Pipe Size	All	All
4.2	Thickness	3/4"	3/4"
5	JACKETS		
5.1	Pipe	N/A	Ultraviolet
5.2	Fittings	N/A	
5.3	Vapor-Retardant	N/A	

3.0 EXECUTION (Continued) SYSTEM INSULATION SCHEDULE 7:
STORM WATER

1	Install insulation materials as designated in this schedule for system(s) listed.	
2	SERVICE	INSIDE - HORIZONTAL
3	INSULATION MATERIAL	
3.1	Pipe	Preformed Fiberglass with Jacket
3.2	Fitting	Fiberglass Blanket
4	INSULATION THICKNESS	
4.1	Pipe Size	All
4.2	Thickness	1"
5	JACKETS	
5.1	Pipe	Integral to Insulation
5.2	Fittings	Preformed PVC
5.3	Vapor-Retardant	Yes
6	NOTES	
6.1	Where pipe insulation is to be painted, install glass cloth jacket. Prior to finish paint, paint with one coat of fire retardant, washable, white liquid plastic coating. Confirm compatibility with finish paint prior to painting.	

3.0 EXECUTION (Continued)

SYSTEM INSULATION SCHEDULE 8:
ROOF DRAIN BASINS

1	Install insulation materials as designated in this schedule for system(s) listed.	
2	LOCATION	INSIDE
3	INSULATION MATERIAL	Elastomeric
4	INSULATION THICKNESS	3/4"
5	JACKETS	
5.1	Pipe	
5.2	Fittings	
5.3	Vapor-Retardant	Yes

NOTES TO DESIGNER

- Chillers are usually factory insulated. Reference 15700 for clarification

- Chilled water pumps should have condensate catch pan piped to floor drain.
- Insulate as last resort only.

- Chilled water expansion tanks do not get insulated.

3.0 EXECUTION (Continued)

SYSTEM INSULATION SCHEDULE 9:
HEATING AND AIR CONDITIONING SUPPLY DUCTWORK
OUTSIDE AIR INTAKE DUCTWORK

1 Install insulation materials as designated in this schedule for system.

2	LOCATION	INSIDE	INSIDE	INSIDE	OUTSIDE
3	INSULATION MATERIAL	3/4 lb. Flexible Fiberglass	3 lb. Rigid Fiberglass	Flexible Elastomeric	4.5 lb Rigid Fiberglass
4	INSULATION THICKNESS	1 1/2"	1 1/2"	1/2"	2”
5	JACKETS	FSK	FSK	FSK	Stainless Steel
5.1	Vapor-Retardant	Yes	Yes	Yes	Aluminum

6.0 NOTES

6.1 Use rigid or flexible elastomeric insulation in mechanical rooms. All other areas may be flexible fiberglass.

6.2 Where ductwork is to be painted, install 3 lb. rigid insulation with glass cloth jacket. Paint with one coat of fire retardant washable white liquid plastic coating. Confirm compatibility with finish paint prior to painting.

6.3 Insulate outside air intake ductwork within building envelope. No need to insulate when installed on outside of insulation barrier.

6.4 Insulate relief air plenums, ductwork, etc., from relief damper to a point where duct or plenum enters unconditioned space.

6.5 Insulate ends of reheat coils including VAV box reheat coils in all applications where heating coils are in air conditioning supply ductwork. Install vapor barrier over insulation and seal water tight to adjacent insulation vapor barrier.

6.6 Externally insulate supply air slot diffuser plenums with flexible fiberglass.

6.7 External insulation to have a 1” crown on top to shed water.

6.8 **Where supply and return air branch ducts containing volume dampers are covered using duct wrap, expose volume damper actuator through duct wrap and “spot” paint the duct wrap around the actuator a bright and contrasting color for ease in visually locating the actuator while standing on the floor below the duct.**

3.0 EXECUTION (Continued)

SYSTEM INSULATION SCHEDULE 10:
RETURN AIR DUCTWORK

1 Install insulation materials as designated in this schedule for this system.

2	LOCATION	SEE NOTES	SEE NOTES	SEE NOTES
3	INSULATION MATERIAL	3/4 lb. Fiberglass	3 lb. Fiberglass	Flexible Elastomeric
4	INSULATION THICKNESS	1 1/2"	1 1/2"	1/2"
5	JACKETS	FSK	FSK	FSK
5.1	Vapor-Retardant	No	No	No

6.0 NOTES

6.1 Insulate return air ductwork in unconditioned attics and in machine rooms.

3.0 EXECUTION (Continued) SYSTEM INSULATION SCHEDULE 11: FIRE BARRIER DUCT WRAP

1	Install insulation materials as designated in this schedule for this system.	
2	LOCATION	In Vertical Chases as indicated on Drawings
3	INSULATION MATERIAL	3M Fire Barrier Duct Wrap I5A
3.1		
3.2		
4	INSULATION THICKNESS	1 1/2" (for 1 hour enclosure)
4.1	Material	Inorganic Blanket
4.2	Density	1.38 lbs/ft^2
5	JACKETS	
5.1	Type	Scrim Reinforced Foil
5.2	Vapor-Retardant	
6	NOTES	
6.1	Insulation to be used for shaft enclosure. 2 Hour Shaft Enclosure requires two (2) 1 1/2" thick layers.	
6.2	Material and installation method to comply with NFPA 96, 2008 addition and 2006/2009 International Code.	
6.3	Vertical ducts floor penetrations to be sealed with approved sealants	

EXAMINATION

D. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. All insulation that is to be painted shall be covered with glass cloth jacket unless noted otherwise.

B. Apply insulation only after pipes, ducts and equipment have been tested and cleaned.

C. Protect furniture, equipment, ducts, pipes, etc. with tarpaulins. Keep premises clean.

D. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the entire length.

E. Refer to schedules at the beginning of this Section for insulation materials and thickness, jackets, and fittings required for each system. Unless otherwise indicated, insulation shall be the same type throughout the same service.

F. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

G. Where insulation is applied on ducts, pipes and equipment which are against columns, walls or other equipment without adequate space for insulation, finish off insulation in workmanlike manner to meet approval of Engineer.

H. Apply multiple layers of insulation with longitudinal and end seams staggered.

I. Seal joints, seams and ends of insulation with vapor-retardant mastic on insulation with a compound recommended by the insulation material manufacturer on systems indicated to receive a vapor retardant.

J. Keep insulation materials dry during application and finishing.

K. Insulation shall be applied by craftsmen who are qualified to install insulation.

L. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

M. Apply insulation with the least number of joints practical.

N. Apply insulation over fittings and specialties, with continuous thermal and vapor-retardant integrity, on systems noted to have vapor-retardant jacket.

O. Provide removable sections of insulation or insulation boxes at all points where access is required for servicing of equipment on systems not requiring vapor-retardant jacket.

P. Exposed is defined to mean visible from working zones of finished building. Concealed signifies opposite. Pipes and ducts above ceilings and in crawl tunnels are considered to be concealed. Finished rooms are defined as office, workrooms, instruction, store room areas, equipment rooms, walking tunnels, etc.

Q. Aluminum jackets shall be installed in high traffic areas subject to damage.

R. On systems not requiring vapor-retardant, neatly bevel insulation at all flanges, access cover plates, etc. so that bolts may be removed without disturbing insulation.

S. All hangers used on lines requiring insulation and vapor barrier shall have hangers oversized and insulation cradles to allow insulation to pass thru hanger.

T. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

U. Whenever Insulation Jacket is noted as Vapor Retardant: Overlap insulation facing at seams a minimum of one inch and secure with pressure-sensitive tape or adhesive as recommended by Manufacturer.

V. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.

W. Seal penetrations with vapor-retardant mastic.

X. Apply insulation for exterior applications tightly joined to interior insulation ends.

Y. Seal insulation to roof flashing with vapor-retardant mastic.

Z. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions.

AA. Insulation Terminations: For insulation application where vapor retardants are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retardant.

BB. Do not insulate over equipment and name plate data.

CC. Seal all punctures in vapor retardant jacket with vapor-barrier adhesive on cooling piping and air conditioning ducts.

DD. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

EE. Do not weld brackets, clips, or other attachment devices to item being insulated unless specifically noted to do so.

3.4 DUCTWORK AND EQUIPMENT INSULATION

A. Blanket Insulation Application

1. Apply insulation with integral jackets as follows:

a. Pull jacket tight and smooth.
b. Install anchor pins and speed washers to keep insulation from sagging when duct width exceeds 22".
c. Joints and Seams: Cover with tape and vapor retardant as recommended by insulation material manufacturer to maintain vapor seal.

d. Vapor-Retardant Mastics: Where vapor retardants are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

2. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire-rated wall and partition penetrations. Maintain vapor-retardant barrier.
3. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor. Provide vapor-retardant mastic on insulation indicated to receive vapor-retardant.

B. Board and Block Insulation Application

1. Blankets, Board, and Block Applications: Secure insulation with adhesive and anchor pins with speed washers.

a. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of surfaces to be insulated.
b. Groove and score insulation materials to fit as closely as possible to the surfaces, including contours. Bevel insulation edges for cylindrical surfaces for tight joint. Stagger end joints.
c. Protect exposed corners with secured corner angles.
d. Install adhesive-attached or self-adhesive anchor pins and speed washers on sides and bottoms of surfaces to be insulated as follows:

1) Do not weld anchor pins to ASME-labeled pressure vessels.
2) 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
3) Do not over-compress insulation during installation.
4) Cut and miter insulation segments to fit curved sided and dome heads of tanks and vessels.

2. Impale insulation over anchor pins and attach speed washers.
3. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. Secure each layer of insulation with stainless-steel bands.
5. Stagger joints between insulation layers at least 3 inches (75 mm).
6. Apply insulation in removable segments on access doors and other elements that require removal for service.
7. Bevel and seal insulation ends around access panels, manholes, hand holes, ASME stamps, and nameplates.
8. Apply vapor-retardant mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retardant.

C. Flexible Elastomeric Thermal Insulation Applications:

1. Apply insulation over entire surface to be insulated according to the manufacturer's written instructions.
2. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
3. Seal longitudinal seams and end joints for Vapor Retardant installation.

3.5 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

3.6 PIPING APPLICATION REQUIREMENTS

A. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Circumferential Joints: Cover with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches (100mm) o.c.
3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches (40 mm). Apply insulation with longitudinal seams at bottom pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.

    a. Exception: Do not staple longitudinal laps on insulation having a vapor retardant.

4. Vapor-Retardant Mastics: Where vapor retardants are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retardant mastic.

B. Apply insulation to fittings and elbows as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation where scheduled. Secure according to manufacturer's written instructions.
2. Apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
3. Apply jacket material overlapping seams at least 1 inch (25 mm) at each end. Secure with manufacturer's recommended adhesive, attachments and accessories. Seal seams with tape. Use vapor-retardant mastic on insulation indicated to receive vapor-retardant.

C. Apply insulation to valves and specialties as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
3. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape. Also, seal seams with vapor-retardant mastic on insulation indicated to receive vapor-retardant.
4. On piping 3" and smaller, not requiring vapor-retardant, fittings may be insulated with insulating cement equal in thickness to adjoining pipe insulation and troweled to smooth even finish. Do not insulate heating water pipe valves or unions.
5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

D. Floor Penetrations: Apply insulation continuously through floor assembly. Seal insulation with vapor-retardant mastic where floor supports penetrate vapor-retardant.

E. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retardant mastic.

F. Hangers and Anchors: All hangers used on lines requiring insulation shall have hangers oversized and insulation support shield to allow insulation to pass continuously thru hanger.

1. Install insert materials on all piping 1 1/2" and larger. Apply insulation to tightly joint the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
2. Fabricate inserts of heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:

1 1/2" to 2 1/2" pipe size	10" long
3" to 6" pipe size	12" long
8" to 10" pipe size	16" long
12" and over	22" long

3. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

G. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Apply jacket material with manufacturer’s recommended adhesive, overlapping seams at least 2 inch (50 mm), and seal joints with vapor-retardant mastic.

END OF SECTION 200180

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following fire-suppression piping inside the building:

1. Wet-pipe sprinkler systems.

B. See Division 10 Sections "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.

C. See Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

1.2 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:

a. Building Service Areas: Ordinary Hazard, Group 1.
b. Corridors: Light Hazard.
c. Display Cases: Light Hazard.
d. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
e. General Storage Areas: Ordinary Hazard, Group 1.
f. Janitors: Ordinary Hazard, Group 1.
g. Kitchens: Light Hazard.
h. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
i. Office and Public Areas: Light Hazard.
j. Restrooms: Light Hazard.

3. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm/sq.ft. over 1500 sq. ft.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm/sq.ft. over 1500 sq. ft.
c. Remote area may be reduced without revising the density where listed quick response sprinklers are used throughout the system an in accordance with NFPA 13.

4. Maximum Protection Area per Sprinkler:

a. Light hazard: 225 sq. ft.
b. Ordinary hazard: 130 sq. ft.
c. When using extended coverage sprinkler heads, maximum protection area per sprinkler may be increased up to 400 sq. ft. in unobstructed light hazard and ordinary hazard locations and as allowable based on hydraulic calculations.

5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:

    a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
    b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

1.3 SUBMITTALS

A. Product Data: For each product indicated.

B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable, and as follows:

1. Areas to be sprinkled.
2. Type of hazards and hazard locations.
3. Type and locations of valves, drains, and test pipes.
4. Alarm devices.
5. Riser diagrams.
6. Fire department connections.
7. Location and coordination of electrical connections.
8. Coordination with other trades.

C. Field test reports and certificates.

D. Field quality-control test reports.

E. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test. Work shall be performed by a Sprinkler Contractor engaged in the fire suppression industry for a minimum of five (5) years.

B. Equipment Qualifications

1. Each item of equipment shall be capable of performing its function over an extended period of time with a minimum of attention and maintenance. All equipment shall be constructed using new materials designed and built in accordance with the best practices of the industry.
2. The equipment manufacturer shall have been engaged in the fire suppression industry for a minimum of five (5) years.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems"; 2010 version.

PART 2 - PRODUCTS

2.1 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.

B. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

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

a. AGF Manufacturing Co.
b. Central Sprinkler Corp.
c. G/J Innovations, Inc.
d. Triple R Specialty of Ajax, Inc.

C. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

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

a. CECA, LLC.
b. Merit.

2.2 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Butterfly Valves: UL 1091.

1. NPS 2 and Smaller: Bronze body with threaded ends.

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

1) Global Safety Products, Inc.
2) Milwaukee Valve Company.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with grooved ends.

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

1) Central Sprinkler Corp.
2) McWane, Inc.; Kennedy Valve Div.
3) Mueller Company.
4) NIBCO.
5) Victaulic Co. of America.

C. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

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

a. Central Sprinkler Corp.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Grinnell Fire Protection.
e. Hammond Valve.
f. McWane, Inc.; Kennedy Valve Div.
g. Mueller Company.
h. NIBCO.
i. Potter-Roemer; Fire Protection Div.
j. Reliable Automatic Sprinkler Co., Inc.
k. Star Sprinkler Inc.
l. Stockham.
m. Victaulic Co. of America.
n. Watts Industries, Inc.; Water Products Div.

D. Gate Valves: UL 262, OS&Y type.

1. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

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

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Crane Co.; Crane Valve Group; Jenkins Valves.
3) Hammond Valve.
4) Milwaukee Valve Company.
5) Mueller Company.
6) NIBCO.

E. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch.
2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.

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

1) Milwaukee Valve Company.
2) NIBCO.
3) Victaulic Co. of America.

3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

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

1) Central Sprinkler Corp.
2) Grinnell Fire Protection.

3) McWane, Inc.; Kennedy Valve Div.
4) Milwaukee Valve Company.
5) NIBCO.
6) Victaulic Co. of America.

2.3 UNLISTED GENERAL-DUTY VALVES

A. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

B. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

C. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.4 SPECIALTY VALVES

A. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.

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

a. AFAC Inc.
b. Grinnell Fire Protection.

B. Double-Check Backflow-Prevention Assemblies; DCDV-A:

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

a. Ames Co.
b. FEBCO; SPX Valves & Controls.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Plumbing Products Group; Wilkins Div.

2. Capacity: Size, location, capacity, and model as indicated on Drawings.
3. Standard: ASSE 1015, UL listed and FMG approved, USC approved, Indiana Department of Environmental Management approved.
4. Operation: Continuous-pressure applications, unless otherwise indicated.
5. Body: Cast iron with FDA approved interior lining complying with AWWA C550 or stainless steel. Stainless-steel springs and corrosion resistant materials throughout.
6. End Connections: Flanged.
7. Configuration: Designed for horizontal, straight through flow. Unit consists of two resilient seated full flow isolation valves, two independently operating spring loaded poppet-type check valves.
8. Accessories:

a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet. Four resilient seated test cocks for field testing.

2.5 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

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

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco International.
3. Victaulic Co. of America.
4. Viking Corp.

C. Automatic Sprinklers: With heat-responsive element complying with the following:

1. UL 199, for nonresidential applications.

D. Sprinkler Types and Categories:

1. Nominal 1/2-inch orifice for standard flow sprinkler head.
2. Nominal 17/32-inch orifice extended coverage sprinkler head.
3. "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

E. Sprinkler types, features, and options as follows:

1. Concealed ceiling sprinklers, including cover plate.
2. Quick-response sprinklers.
3. Sidewall sprinklers.
4. Upright sprinklers.
5. Dry pendent sprinklers.

F. Sprinkler Finishes: Bronze and factory painted white.

G. Sprinkler Guards: Wire-cage type when head is installed below 7’-6” or in areas subject to physical damage, including fastening device for attaching to sprinkler.

2.6 ALARM DEVICES

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

B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

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

a. ADT Security Services, Inc.
b. Potter Electric Signal Company.
c. System Sensor.

C. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

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

a. McWane, Inc.; Kennedy Valve Div.
b. Potter Electric Signal Company.
c. System Sensor.

PART 3 - EXECUTION

3.1 GENERAL

A. Inspect preceding work. Verify all dimensions before proceeding with work and coordinate all work and placement of components with other trades.

B. Be responsible for all measurements, fitting and assembly of all work. Prefabrication is done at the Contractor's risk.

C. Installation

1. Drawings indicate general intent and location. Piping shall be installed in the most direct and straight manner as possible. All lines shall be run high enough to permit relocation of lights without moving ceiling grid.
2. Coordinate exact pipe locations with Drawings and other trades before design approval and fabrication of piping. This Contractor shall be responsible for any redesign and fabrication required to fit system into allowable space.
3. Sprinkler piping that passes through a non-sprinkled area shall be adequately protected as required by NFPA 13.
4. Do not route any piping over electrical panels, transformers, or other equipment requiring a clear space above per NEC and NFPA Codes.
5. All piping in finished areas shall be concealed unless shown otherwise on the Drawings.
6. All vertical lines shall be plumb and horizontal lines shall run parallel to building construction.
7. Install horizontal piping to slope to low points so that entire system may be emptied to facilitate testing.
8. Pipe drains to terminate outside the building wherever possible. Location of drains to the building exterior shall be as shown on Drawings or as approved by the Owner.
9. Pipe and fittings shall be inspected for soundness and cleaned of all dirt and other foreign matter prior to be installed. All damaged pipe and fittings will be rejected.
10. Protect open pipe ends whenever work is suspended during construction to prevent foreign material from entering.
11. Chrome plated or other polished finished components shall be installed with care so that marring does not occur to the finish.

D. Zoning

1. Sprinkler system shall be installed as a single zone.

E. Connection To Utilities

1. Contractor shall make all connections to utilities as required to install the system. All connections to utilities and their shutdown shall be arranged with the Owner.

F. Pipe Supports

1. All piping shall be supported from the structure above with UL approved hangers. Sizing, spacing, and installation will generally exceed the minimum requirements of NFPA 13. Comply with Section 200060 of this specification relating to Basic Mechanical Materials and Methods for sprinkler pipe installation.

G. Backflow Preventers

1. Install in compliance with state regulations. Mount horizontal, maximum 4 ft. above the floor.
2. Test backflow preventer to ensure proper operation. Inspection shall be performed by a registered inspector in accordance with the Indiana Department of Environmental Management. Submit reports to the Owner and include a copy in the Operation and Maintenance manuals.

H. Fire Department Inlet Connection

1. Coordinate installation with site utility contractor.

I. Inspectors Test Connection

1. Inspector test connections shall be installed at the most remote point of each sprinkler zone system. Test connections shall be provided with a 1" pipe and valve. Test pipe shall discharge to the outside through a corrosion resistant orifice of the proper size, where it can easily be seen. Location of discharge shall be as approved by the Owner.

J. Ball Drip Valves

1. Provide where shown and as required. Locate ball drips in accessible locations and pipe discharge full size to nearest floor drain.

K. Valve Supervisory Switches

1. Provide valve supervisory switches for all water supply shut-off valves.

L. Sprinkler Heads

1. Sprinkler heads shall be installed per manufacturer's recommendations. Heads shall be installed to satisfy all code requirements for head spacing and as herein specified.
2. Finishes shall be protected against scratches, dents and discoloration. Defective items will not be acceptable.

M. Wet Sprinkler System

1. Fire sprinklers shall be provided for the entire building.

N. Instructions

1. When required approvals of this work have been obtained, and at time designated by the Owner, demonstrate to the Owner's personnel the operation and maintenance of the systems.

3.2 VALVE APPLICATIONS

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

1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13.

a. Shutoff Duty: Use butterfly or gate valves.

2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13.

a. Shutoff Duty: Use butterfly or gate valves.
b. Throttling Duty: Use globe valves.

3.3 PIPING INSTALLATION

A. Refer to Division 20 Section "Pipe, Valves, Fittings, and Hangers for Fire Suppression, Plumbing, and HVAC" for basic piping installation.

B. 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.

C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

F. Install sprinkler piping with drains for complete system drainage.

G. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

H. Install alarm devices in piping systems.

I. Hangers and Supports: Comply with NFPA 13 for hanger materials except as modified herein.

1. Install sprinkler system piping according to specification section 20 00 60. **(Contractor should be aware the requirements for pipe support far exceed the minimum standards set forth in NFPA 13)**

J. Install pressure gages on riser or feed main, and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

K. Fill wet-pipe sprinkler system piping with water.

3.4 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty 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 preventers in potable-water supply sources.

3.5 SPRINKLER APPLICATIONS

A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Sprinkler Finishes:

    a. Upright Sprinklers: Rough bronze.
    b. Sidewall Sprinklers: Factory painted white, with white escutcheon.
    c. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

3.6 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of both dimensions of acoustical ceiling panels and tiles.

B. Do not install wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Connect water-supply piping to fire-suppression piping.

D. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

E. Electrical Connections: Power wiring is specified in Division 26.

F. Connect alarm devices to fire alarm.

G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.8 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. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
3. Coordinate with fire alarm tests. Operate as required.
4. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

C. Sterilization

1. Contractor shall sterilize all piping upstream of fire protection backflow preventer.

a. Flush system thoroughly until water runs clear.
b. Entire system shall be filled with a water/chlorine solution containing 50 parts per million of chlorine. The system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing at least 200 parts per million of chlorine and allowed to stand for three hours.
c. Following the allowed standing time, the system shall be flushed with clean potable water until chlorine does not remain in the water coming from the system.
d. After the above requirements are satisfied, submit samples to Indiana State Board of Health for approval.
e. Sterilization shall be redone until approval from the State Board of Health is obtained. Include copies of the approval in the Operations and Maintenance Manuals.

D. Testing

1. Testing to comply with NFPA 13 Standard.
2. Test backflow preventer to ensure proper operation. Inspection shall be performed by a registered inspector in accordance with the Indiana Department of Environmental Management. Submit reports to the Owner and include a copy in the Operations and Maintenance manuals.
3. Test all piping hydrostatically at not less than 200 psi for 2 hours without loss of pressure.
4. Retest piping that initially fails after corrective actions have been made.
5. All tests shall be made in the presence of the Owner's Representative or as directed by the Engineer. Allow for at least 24 hours notice of all tests.
6. Complete and sign "Contractor's Material and Test Certificates". Make arrangements and pay for all costs for all inspections by the authority having jurisdiction and obtain approval of the installation. Include copies of the certificates in the Operations and Maintenance Manuals.

END OF SECTION 211000

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Backflow preventers.
2. Balancing valves.
3. Temperature-actuated water mixing valves.
4. Expansion tanks.
5. Strainers.
6. Hose bibbs.
7. Hydrants.
8. Water hammer arresters.

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. Field quality-control test reports.

C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers; RPZ-A:

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

a. FEBCO; SPX Valves & Controls.
b. Watts Industries, Inc.; Water Products Div.
c. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Capacity: Size, location, capacity, and model as indicated on Drawings.
5. Body: Bronze.
6. End Connections: Threaded.
7. Configuration: Designed for horizontal, straight through flow.
8. Relief Valve: Designed to admit air directly into the reduced pressure zone via separate channel from the water discharge.
9. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
    c. Strainer: Bronze 'Y'-pattern strainer.

B. Reduced-Pressure-Principle Backflow Preventers; RPZ-B:

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

    a. FEBCO; SPX Valves & Controls.
    b. Watts Industries, Inc.; Water Products Div.
    c. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Capacity: Size, location, capacity, and model as indicated on Drawings.
5. Body: Bronze.
6. End Connections: Threaded.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
    c. Strainer: Bronze 'Y'-pattern strainer.

2.2 BALANCING VALVES

A. Memory-Stop Balancing Valves; CS-A, B:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bell & Gossett Circuit Setter Plus or a comparable product by one of the following:

    a. Conbraco Industries, Inc.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Hammond Valve.
    d. Milwaukee Valve Company.
    e. NIBCO INC.
    f. Red-White Valve Corp.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: Equal to pipe-size.
5. Body: Copper alloy with 1/4-inch NPT tapped drain/purge port.
6. Port: Standard or full port.

7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device. Nameplate to be calibrated to assure specific setting.
11. Operation: Valve to have differential pressure read-out ports across seat area and memory stop feature to allow it to be closed for service and then reopened to set point without disturbing balance position.

2.3 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves; TMV-A, B:

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

    a. Lawler Manufacturing Company, Inc.
    b. Leonard Valve Company.
    c. Powers; a Watts Industries Co.

2. Capacity: Size, location, capacity, and model as indicated on Drawings.
3. Standard: ASSE 1017.
4. Pressure Rating: 125 psig.
5. Type: Exposed-mounting, thermostatically controlled water mixing valve.
6. Thermostat: Liquid filled thermal motor and piston control mechanism or bi-metal spring type.
7. Flow Rate: High-low design capable of operating across the entire flow range without requiring a constantly operating circulation pump.
8. Material: Bronze body with corrosion-resistant interior components.
9. Connections: Threaded inlets and outlet.
10. Accessories: Check stops on hot- and cold-water supplies, adjustable, temperature-control handle, thermometer on hot water inlet and mixed water outlet.
11. Tempered-Water Setting: 120 deg F.
12. Valve Finish: Rough bronze.
13. Piping Finish: Copper.

2.4 EXPANSION TANKS

A. Thermal Expansion Tank; ET-A, B:

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

    a. Amtrol.
    b. Bell & Gossett.
    c. Taco.

2. Capacity: Size, location, capacity, and model as indicated on Drawings.
3. Pressure Rating: 150 psig maximum working pressure.
4. Construction: Diaphragm type expansion tank.
5. Tank: Welded steel with stainless steel system connection.
6. Liner: Polypropylene.
7. Factory charge: 40 psig.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with FDA-approved interior lining complying with AWWA C550 for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.020 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.100 inch.

6. Drain: Factory-installed, hose-end drain valve.

2.6 HOSE BIBBS

A. Hose Bibbs; HB-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Woodford Model 24 or approved equal.
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Brass.
4. Seat: Standard 'O' size washer, replaceable. Quarter-turn valves and/or ceramic cartridge valves are not acceptable.
5. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig.
8. Vacuum Breaker: Integral, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish: Rough brass.
10. Operation: Optional metal wheel handle.

2.7 HYDRANTS

A. Non-freeze Wall Hydrants; HYD-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Woodford Model B65 or approved equal.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Body Material: Brass.
4. Seat: Standard 'O' size washer, replaceable. Quarter-turn valves and/or ceramic cartridge valves are not acceptable.
5. Pressure Rating: 125 psig.
6. Operation: Self draining design shall incorporate a drainage tube that is pitched to the faceplate to provide positive drainage when water is shut off. Single tube hydrants that require the installation to be sloped in the wall are not acceptable.
7. Casing: Copper tubes.
8. Operating Rod: Solid brass rod, of length required to match wall thickness.
9. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
10. Outlet Connection: Concealed, with garden-hose thread complying with ASME B1.20.7.

11. Vacuum Breaker: Integral, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
12. Box: Cast brass, flush mounting with cover.
13. Box and Cover Finish: Chrome plated.
14. Wall Clamp: Required.
15. Operating Keys(s): One with each wall hydrant.

B. Non-freeze Roof Hydrants; HYD-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mapa MPH-24FP or approved equal:
2. Standard: ASSE 1057 for sanitary yard hydrants.
3. Body Material: Fully insulated stainless-steel shroud.
4. Mounting Hardware: Stainless-steel base with under-deck flange.
5. Valve: 1” bronze globe angle type.
6. Pressure Rating: 125 psig.
7. Operation: Powder coated cast aluminum weather-guard dome handle.
8. Drain: Stainless-steel reservoir (no drain piping required).
9. Supply Connections: NPS 3/4 threaded inlet.
10. Outlet Connection: Quick-disconnect fitting with integral hose-connection vacuum breaker complying with ASSE 1011.

2.8 WATER HAMMER ARRESTERS

A. Water Hammer Arresters; WHA:

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: Stainless-steel bellows with factory pressurized and sealed cushion chamber.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 20 Section "Pipe, Valves, Fittings, and Hangers for Fire Suppression, Plumbing, and HVAC" 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. 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.
2. 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. Install thermometers on hot water inlet and on mixed water outlet.

E. Install Y-pattern strainers for water on supply side of each control valve, solenoid valve, and pumps.

F. Install water hammer arresters in water piping as follows:

1. In accordance to PDI-WH 201.
2. In upright position.
3. At any fixture having quick-closing valves.
4. In an accessible location. Provide access panels as required.

G. Piping installation requirements are specified in other Division 20 Sections. Drawings indicate general arrangement of piping and specialties.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

3.3 ADJUSTING

A. Set field-adjustable flow of balancing valves. Test flow rate thru each balancing valve to ensure adequate system circulation in accordance with the Circuit Setter Schedule on Drawings.

B. Set field-adjustable temperature set points of temperature-actuated water mixing valves. Test setting at full hot water system flow, and at zero hot water system flow. Adjust heating system balance valve so that temperature does not increase or decrease under maximum and minimum design conditions.

END OF SECTION 221119

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic cold- and hot-water circulation:

1. Close-coupled, horizontally mounted, in-line centrifugal pumps.

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. Shop Drawings: Diagram power, signal, and control wiring.

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.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Circulation Pump; CP-A:

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

a. Armstrong Pumps Inc.
b. Bell & Gossett Domestic Pump; ITT Industries.
c. Taco.

2. Capacity: Size, location, capacity, and model as indicated on Drawings.
3. Description: Factory-assembled and -tested, overhung impeller, single-stage, close-coupled, horizontally mounted, in-line centrifugal pumps as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.
4. Pump Construction: All bronze.

a. Casing: Radially split, bronze, with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
e. Bearings: Oil-lubricated; bronze-journal or ball type.

5. Shaft Coupling: Rigid type if pump is provided with coupling.
6. Motor: Single speed, with grease-lubricated ball bearings.

2.2 CONTROLS

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

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

a. Honeywell International, Inc.
b. Square D.
c. White-Rodgers Div.; Emerson Electric Co.

2. Type: Water-immersion sensor, for installation in hot-water circulation piping.
3. Range: 65 to 200 deg F.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120 V, ac. Coordinate wiring with E.C.
7. Settings: Start pump at 110 deg F and stop pump at 117 deg F.

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 close-coupled, horizontally mounted, in-line centrifugal pumps with motor and pump shafts horizontal.

E. Install continuous-thread hanger rods and/or fabricate brackets as required. Hanger and support materials are specified in Division 20 Section "Pipe, Valves, Fittings, and Hangers for Fire Suppression, Plumbing, and HVAC."

F. Install immersion-type thermostats in hot-water return piping.

G. Piping installation requirements are specified in other Division 20 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

I. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 20 Section "Pipe, Valves, Fittings, and Hangers for Fire Suppression, Plumbing, and HVAC."

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 20 Section "Pipe, Valves, Fittings, and Hangers for Fire Suppression, Plumbing, and HVAC" for general-duty valves for domestic water piping and for strainers.

J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

L. Connect thermostats to pumps that they control.

END OF SECTION 221123

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PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Cleanouts for Vinyl Tile Floor:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4141S or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron
5. Outlet Connection: Spigot.
6. Closure: Bronze plug with straight threads and gasket.
7. Adjustable Housing Material: Cast iron with threads.
8. Frame and Cover Material and Finish: Nickel-bronze with 1/8 inch tile recess.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Light duty.

B. Cleanouts for Poured Floor:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4181S or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron
5. Outlet Connection: Spigot.
6. Closure: Bronze plug with straight threads and gasket.
7. Adjustable Housing Material: Cast iron with threads.
8. Frame and Cover Material and Finish: Nickel-bronze with 1/2 inch terrazzo recess.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Light duty.

C. Cleanouts for Carpet Floor:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4021S-Y or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron
5. Outlet Connection: Spigot.
6. Closure: Bronze plug with straight threads and gasket.
7. Adjustable Housing Material: Cast iron with threads.
8. Frame and Cover Material and Finish: Scoriated nickel-bronze with carpet marker.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Light duty.

D. Cleanouts for Concrete Floor:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4101S or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron
5. Outlet Connection: Spigot.
6. Closure: Bronze plug with straight threads and gasket.
7. Adjustable Housing Material: Cast iron with set-screws.
8. Frame and Cover Material and Finish: Scoriated nickel-bronze.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Extra heavy duty.

E. Exterior Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4251S or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron cleanout and cast iron double flanged housing.
5. Outlet Connection: Spigot.
6. Closure: Bronze plug with straight threads and gasket.
7. Frame and Cover Material and Finish: Scoriated cast iron with lifting device.
8. Frame and Cover Shape: Round.
9. Top Loading Classification: Heavy duty.

F. Wall Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4531S-Y or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping.
4. Body: Hub-less, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, drilled-and-threaded bronze plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains; FD-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 2041S-A or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Combination flashing collar and clamp with seepage openings.
6. Outlet: Side, spigot.
7. Coating on Interior and Exposed Exterior Surfaces: Not required.
8. Sediment Bucket: Not required.
9. Top or Strainer Material: Nickel bronze.
10. Top Description: Adjustable, round, heel-proof, flat.

11. Top Loading Classification: Light Duty.
12. Trap Material: Cast iron.
13. Trap Pattern: Integral deep-seal P-trap.
14. Trap Features: Cleanout.

B. Cast-Iron Floor Drains; FD- 2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 3510Y or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASME A112.6.3.
3. Pattern: Funnel floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Combination flashing collar and clamp with seepage openings.
6. Outlet: Bottom, no-hub.
7. Coating on Interior and Exposed Exterior Surfaces: Acid resistant coated interior.
8. Sediment Bucket: Not required.
9. Top or Strainer Material: Nickel bronze.
10. Top Description: Adjustable, round, flat, 4” diameter funnel attached to grate with concealed hardware.
11. Top Loading Classification: Light Duty.

C. Cast-Iron Floor Drains; FD- 3:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 3020Y or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Combination flashing collar and clamp with seepage openings.
6. Outlet: Bottom, no-hub.
7. Coating on Interior and Exposed Exterior Surfaces: Acid resistant coated interior.
8. Sediment Bucket: Bottom dome aluminum strainer.
9. Top or Strainer Material: Nickel bronze.
10. Top Description: Round, heel-proof, flat.
11. Top Loading Classification: Medium Duty.

D. Floor Sink; FS-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 3120Y-12 or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASME A112.6.3.
3. Pattern: 8-inch deep floor sink.
4. Body Material: Gray iron.
5. Seepage Flange: Flanged receptor with seepage openings.
6. Outlet: Bottom, no-hub.
7. Coating on Interior and Exposed Exterior Surfaces: Acid resistant coating.
8. Sediment Bucket: Bottom dome aluminum strainer.
9. Top or Strainer Material: Nickel bronze.
10. Top Description: 1/2 grate with nickel bronze rim.

E. Floor Sink; FS-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 3150Y-12 or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASME A112.6.3.
3. Pattern: 8-inch deep floor sink.
4. Body Material: Gray iron.
5. Seepage Flange: Flanged receptor with seepage openings.
6. Outlet: Bottom, no-hub.
7. Coating on Interior and Exposed Exterior Surfaces: Acid resistant coating.
8. Sediment Bucket: Bottom dome aluminum strainer.
9. Top or Strainer Material: Nickel bronze.
10. Top Description: 1/2 grate with nickel bronze rim.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 20 Section "Pipe, Valves, Fittings, and Hangers for Fire Suppression, Plumbing, and HVAC" 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 NPS 4. Use NPS 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 NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

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. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
2. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 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 221319

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Grease interceptors.
2. Solids separators.

1.2 SUBMITTALS

A. Product Data: For each type of interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

B. Shop Drawings: For each type and size of interceptor indicated. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

A. General

1. Capacity: Size, location, capacity, and model as indicated on Drawings.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

a. Thermaco.
b. Approved equal.

B. Grease Interceptor; GI-A1:

1. Furnish and install a hydro-mechanical grease interceptor system manufactured from linear low-density rotationally molded polyethylene. Unit shall be designed for below-ground installation and have the following characteristics:

a. ASME A112.14.3 rated at 75 gpm and factory-rated at 150 gpm peak flow.
b. 600+ pounds of grease storage capacity with a flat grease separation efficiency curve.
c. Crush-resistant cylindrical walls.
d. Twin integral portals for access by grease pump truck for grease removal.
e. Single separate integral portal for vacuum access for removal of solids.
f. Self guiding pipe for pump truck access/solids removal.
g. Integral non-floatation anchor ring.
h. Integral horizontal baffle.
i. Laminar inlet flow diverter.
j. Integral vessel vent.
k. Separate storage compartment for grease and solids.

l. Integral gas trap.
m. Fully removable polyethylene self-positioning keyed cover with sealed thread fasteners.

2. Furnish interceptor with extension collar to grade, equal to Thermaco ECA-400/600.
3. Furnish heavy duty lid rated for HS-20 loading. Coordinate installation with loading dock construction.

2.2 SOLIDS SEPARATORS

A. General

1. Capacity: Size, location, capacity, and model as indicated on Drawings.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

a. Thermaco.
b. Approved equal.

B. Solids Separator; SS-A1:

1. Furnish and install a solids removal system manufactured from linear low-density rotationally molded polyethylene. Unit shall be designed for below-ground installation and have the following characteristics:

a. Rated at 150 gpm peak flow.
b. 95 gallons of solids storage capacity.
c. Integral portal for vacuum access by pump truck for solids removal.
d. Integral vessel vent.
e. Fully removable polyethylene cover.

2. Furnish interceptor with extension collar to grade, equal to Thermaco ECA-400/600.
3. Furnish heavy duty lid rated for HS-20 loading. Coordinate installation with loading dock construction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install interceptors in accordance with manufacturers written instructions.

B. Install interceptor inlets and outlets at elevations indicated.

C. Install manhole risers from top of underground concrete interceptors to finished grade.

D. Set tops of manhole frames and covers flush with finished surface in pavements.

E. Set interceptors level and plumb.

F. Piping installation requirements are specified in other Division 20 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

G. Make piping connections between interceptors and piping systems.

H. Identification materials and installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.

1. Use warning tapes or detectable warning tape over ferrous piping.

I. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION 221323

BLANK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following storm drainage piping specialties:

1. Cleanouts.
2. Roof drains.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Cleanouts for Tile Floor:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4141S or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron
5. Outlet Connection: Spigot.
6. Closure: Bronze plug with straight threads and gasket.
7. Adjustable Housing Material: Cast iron with threads.
8. Frame and Cover Material and Finish: Nickel-bronze with 1/8 inch tile recess.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Light duty.

B. Cleanouts for Poured Floor:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4181S or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron
5. Outlet Connection: Spigot.
6. Closure: Bronze plug with straight threads and gasket.
7. Adjustable Housing Material: Cast iron with threads.
8. Frame and Cover Material and Finish: Nickel-bronze with 1/2 inch floor recess.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Light duty.

C. Cleanouts for Carpet Floor:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4021S-Y or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron
5. Outlet Connection: Spigot.
6. Closure: Bronze plug with straight threads and gasket.
7. Adjustable Housing Material: Cast iron with threads.
8. Frame and Cover Material and Finish: Scoriated nickel-bronze with carpet marker.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Light duty.

D. Cleanouts for Concrete Floor:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4101S or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron
5. Outlet Connection: Spigot.
6. Closure: Bronze plug with straight threads and gasket.
7. Adjustable Housing Material: Cast iron with set-screws.
8. Frame and Cover Material and Finish: Scoriated nickel-bronze.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Extra heavy duty.

E. Exterior Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4251S or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron cleanout and cast iron double flanged housing.
5. Outlet Connection: Spigot.
6. Closure: Bronze plug with straight threads and gasket.
7. Frame and Cover Material and Finish: Scoriated cast iron with lifting device.
8. Frame and Cover Shape: Round.
9. Top Loading Classification: Heavy duty.

F. Wall Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4531S-Y or a comparable product by one of the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Tyler Pipe; Wade Div.
    d. Watts Drainage Products Inc.
    e. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping.
4. Body: Hub-less, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, drilled-and-threaded bronze plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, stainless-steel cover plate with screw.

2.2 ROOF DRAINS

A. Cast-Iron Roof Drains; RD-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 1015Y-C-R-CID or a comparable product by one of the following:

    a. Tyler Pipe; Wade Div.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASME A112.21.2M.
3. Pattern: Roof drain.
4. Body Material: Cast iron.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Flow-Control Weirs: Not required.
7. Outlet: Bottom, No-hub.

8. Dome Material: Cast iron.
9. Adjustable Extension Collars: Required.
10. Underdeck Clamp: Required.
11. Sump Receiver: Required.

B. Cast-Iron Overflow Roof Drains; ORD-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 1045Y-C-R-CID or a comparable product by one of the following:

   a. Tyler Pipe; Wade Div.
   b. Watts Drainage Products Inc.
   c. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASME A112.21.2M.
3. Pattern: Roof drain.
4. Body Material: Cast iron.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Flow-Control Weirs: 2” exterior water dam required.
7. Outlet: Bottom, No-hub.
8. Dome Material: Cast iron.
9. Adjustable Extension Collars: Required.
10. Underdeck Clamp: Required.
11. Sump Receiver: Required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 20 Section "Common Pipe, Valves, Fittings, and Hangers for Fire Suppression, Plumbing, and HVAC." 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 NPS 4. Use NPS 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 NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roof materials are specified in Division 07.

1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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 221423

BLANK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Water Softeners
2. Chemicals.
3. 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.

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.

B. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.

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, up to 2500 lb, as required to fill brine tank. 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 COMMERCIAL WATER SOFTENERS

A. Pressure-type water softener; WS-A:

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

   a. Aqua Systems*.
   b. Culligan International Company*.
   c. Marlo, Inc*.
   d. Process Solutions*.

   * All systems shall use Fleck control valves.

2. General:

   a. Comply with NSF 61, "Drinking Water System Components--Health Effects."
   b. Capacity: Size, location, capacity, and model as indicated on Drawings.
   c. Configuration: Twin alternating unit with two mineral tanks and one brine tank.

3. Mineral Tanks: Fiberglass reinforced polyester; pressure-vessel quality.

   a. Construction: The mineral tank shall be “polyglass” consisting of an inner shell of virgin polyethylene and an external shell of continuous fiberglass roving.
   b. Pressure Rating: 150 psig minimum.
   c. Wetted Components: Suitable for water temperatures from 40 to at least 120 deg F.
   d. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
   e. Support Legs or Skirt: Constructed of PVC, bonded to tank before testing and labeling.
   f. Upper Distribution System: Single, point type, fabricated from PVC pipe and fittings.
   g. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.

4. Controls: Fully automatic; factory mounted on unit and factory wired.

   a. Adjustable duration of various regeneration steps.
   b. Push-button start and complete manual operation.
   c. Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
   d. Pointer on pilot-control valve shall indicate cycle of operation.
   e. Means of manual operation of pilot-control valve if power fails.
   f. Main Operating Valves: Automatic, multiport, diaphragm type with the following features:

      1) Slow opening and closing, non-slam operation.
      2) Diaphragm guiding on full perimeter from fully open to fully closed.
      3) Isolated dissimilar metals within valve.
      4) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
      5) Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
      6) Sampling cocks for soft water.
      7) Special tools are not required for service.

g. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.

1) Demand-Initiated Control: Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tank. Set to repeat with other tank. Include electrical lockout to prevent simultaneous regeneration of both tanks.

5. Brine Tank: Combination measuring and wet-salt storing system.

a. Tank and Cover Material: Molded PE, 3/8 inch thick.
b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
c. Size: Large enough for at least four regenerations at full salting.

6. Factory-Installed Accessories:

a. Piping, valves, tubing, and drains.
b. Sampling cocks.
c. Main-operating-valve position indicators.
d. Water meters.

2.2 CHEMICALS

A. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.

1. Exchange Capacity: 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.

B. Salt for Brine Tanks: High-purity sodium chloride; free of dirt and foreign material. Rock and granulated forms are not acceptable.

1. Form: Processed, plain salt pellets.

2.3 WATER TESTING SETS

A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

PART 3 - EXECUTION

3.1 WATER SOFTENER INSTALLATION

A. 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.

B. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.

C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

D. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.2 CONNECTIONS

A. Refer to Division 20 Section "Pipe, Valves, Fittings, and Hangers for Fire Suppression, Plumbing, and HVAC" for piping joining materials, joint construction, and basic installation requirements. 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.

D. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.

E. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank.

F. Install valved bypass water piping around water softeners.

G. Install drains as indirect wastes to spill into open drains or over floor drains.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect 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. 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.

C. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

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

B. Add water to brine tanks and fill with salt.

1. Commercial Water Softeners: Plain salt pellets.

C. 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."

3.5 DEMONSTRATION

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

END OF SECTION 223100

BLANK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Light-commercial, storage electric water heaters.

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. 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.

C. 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. Commercial Electric Water Heaters: Three year limited tank warranty, One year limited parts warranty.

PART 2 - PRODUCTS

2.1 LIGHT COMMERCIAL ELECTRIC WATER HEATERS

A. Storage Electric Water Heaters; WH-B:

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

   a. Bradford White Corporation.
   b. Lochinvar Corporation.
   c. Smith, A. O. Water Products Company.
   d. State Industries, Inc.

2. General

   a. Comply with UL 174 requirements for storage-tank-type water heaters.
   b. Capacity: Size, location, capacity, and model as indicated on Drawings.

3. Storage-Tank Construction: Non-ASME-code steel, vertical arrangement.

   a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

      1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.

   b. Pressure Rating: 150 psig.
   c. Interior Finish: Glass-lined. Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

4. Factory-Installed Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   c. Insulation: Comply with ASHRAE/IESNA 90.1.
   d. Jacket: Steel with enameled finish.
   e. Heating Elements: Two, screw-in immersion type wired for non-simultaneous operation.
   f. Temperature Control: Adjustable surface thermostat for each element.
   g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

5. Special Requirements: NSF 5 construction.

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 20 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 20 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.

END OF SECTION 223300

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following fuel-fired water heaters:

1. Commercial, gas water heaters.

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. 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.

C. 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 fuel-fired 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. Commercial, Gas Water Heaters: Five year heat exchanger warranty, 1 year parts warranty.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS WATER HEATERS

A. Domestic Boiler and Storage Tank; WH-A, ST-A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

    a. Lochinvar Corporation.
    b. Approved equal.

2. General:

    a. Capacity: Size, location, capacity, and model as indicated on Drawings.
    b. Scope: Provide a packaged water heater assembly complete with domestic water boiler, storage tank, circulation pump, piping, controls, and interconnecting wiring.

3. Heat Exchanger

    a. Certification: ASME-code with 160 psig working pressure rating.
    b. Construction: Stainless steel heat exchanger building to ASME Section IV requirements. Direct vent, sealed combustion chamber.
    c. Firing: 5:1 turndown firing rate.
    d. Circulation Pump: Bronze fitted, sized of sufficient capacity to insure scale-free operation.
    e. Thermal Efficiency: Up to 98%.
    f. Jacket: Heavy gauge galvanized steel with acrylic enamel finish.
    g. Controls: 24-volt programmable digital controller with LCD display; built-in sequencing; BMS terminal strip; pump controls; PC connection port.
    h. Ignition: Direct spark type.
    i. Safety Controls: Inlet and outlet temperature sensors; ASME temperature and pressure relief valve; contacts on any failure; alarm contacts; runtime contacts; manual reset high limit; flow switch; low water flow indication.
    j. Temperature Gauges: Installed on inlet and outlet.
    k. Options:

        1) Condensate neutralization kit.

4. Storage Tank

    a. Certification: ASME-code with 125 psig working pressure rating.
    b. Construction: Vertical, round, glass lined high-carbon steel with enamel baked steel outer jacket.
    c. Tappings: Factory fabricated of materials compatible with tank for pipe connections, relief valve, pressure gauge, temperature gauge, drain, anode rod and controls as required. Attach tappings to tank before testing.
    d. Interior Finish: Glass-lined, including extending finish into and through tank fittings and outlets.
    e. Factory-Installed, Storage-Tank Appurtenances:

        1) Anode Rod: Replaceable magnesium.
        2) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
        3) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.

4) Jacket: Steel with enameled finish.
5) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

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 20 Section "Common Materials and Methods for Fire Suppression, Plumbing, and HVAC."

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 gas water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

D. 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.

E. Install thermometer on outlet piping of water heaters. Refer to Division 20 Section “Common Materials and Methods for Fire Suppression, Plumbing, and HVAC."

F. 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. Engage a factory-authorized service representative to inspect installation, including connections.

B. 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.

C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

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

END OF SECTION 223400

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Faucets.
2. Flushometers.
3. Toilet seats.
4. Fixture supports.
5. Water closets.
6. Urinals.
7. Lavatories.
8. Sinks.

B. Related Sections include the following:

1. Division 22 Section "Drinking Fountains and Water Coolers."

1.2 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and maintenance data.

1.3 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. Regulatory Requirements: Comply with requirements in ICC 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.

C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Vitreous-China Fixtures: ASME A112.19.2M.
2. Water-Closet, Flush Valve, Trim: ASME A112.19.5.

G. Comply with the following applicable standards and other requirements specified for lavatory/sink faucets:

1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
2. Faucets: ASME A112.18.1.
3. Hose-Connection Vacuum Breakers: ASSE 1011.
4. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
5. NSF Potable-Water Materials: NSF 61.
6. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

H. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Brass and Copper Supplies: ASME A112.18.1.
2. Manual-Operation Flushometers: ASSE 1037.
3. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Flexible Water Connectors: ASME A112.18.6.
2. Hose-Coupling Threads: ASME B1.20.7.
3. Off-Floor Fixture Supports: ASME A112.6.1M.
4. Plastic Toilet Seats: ANSI Z124.5.
5. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets; L-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler K-7515 or approved equal.

2. Description: Sensor-control mixing valve. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 0.5 gpm.
d. Centers: Single hole.
e. Mounting: Deck, exposed.
f. Inlet(s): NPS 3/8” tubing, with NPS 1/2” male adaptor, inlet supply check valves.
g. Spout Outlet: Aerator.
h. Operation: Dual beam sensor, on/off activation.
i. Power Source: 30-year hybrid energy cell (or equivalent).
j. Temperature Control: Internal mixer.
k. Construction: Above deck hermetically sealed electronics.

B. Lavatory Faucets; L-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago 895-317E35XKABCP or a comparable product by one of the following:

   a. T & S Brass and Bronze Works, Inc.
   b. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Manual-control mixing valve. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

   a. Body Material: Commercial, solid brass.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 1.5 gpm.
   d. Centers: 4-inch.
   e. Mounting: Deck, exposed.
   f. Valve Handles: 4” wristblades.
   g. Inlet(s): NPS 1/2 male shank.
   h. Spout Type: 3-1/2” rigid/swing gooseneck, tubular brass.
   i. Spout Outlet: Aerator.
   j. Operation: Quarter-turn ceramic, manual.

2.2 SINK FAUCETS

A. Mop Sink Faucets; MS-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago 897-RFC or a comparable product by one of the following:

   a. T & S Brass and Bronze Works, Inc.
   b. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot and cold water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

   a. Body Material: Commercial, solid brass.
   b. Finish: Rough chrome plate.
   c. Backflow Protection Device for Hose Outlet: Required.
   d. Centers: Adjustable.
   e. Mounting: Back/wall, exposed.
   f. Handle(s): Lever.
   g. Inlet(s): NPS 1/2 male shank.
   h. Spout Type: Rigid, solid brass with wall brace.
   i. Spout Outlet: Hose thread.
   j. Vacuum Breaker: Required.
   k. Operation: Quarter-turn compression, renewable, manual.

2.3 FLUSHOMETERS

A. Water Closet; WC-1, WC-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan 111-1.28-DFB or a comparable product by one of the following:

   a. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Flushometer for water-closet type fixture. Include brass body with corrosion and chlorine resistant internal components, non-clog synthetic rubber diaphragm assembly, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

   a. Internal Design: Diaphragm operation.
   b. Style: Exposed.
   c. Inlet Size: NPS 1.
   d. Trip Mechanism: Oscillating, lever-handle actuator.
   e. Consumption: 1.28 gal/flush.
   f. Tailpiece Size: NPS 1-1/2 and standard length to top of bowl.

B. Urinal; UR-1, UR-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan 186-0.5-DFB or a comparable product by one of the following:

   a. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Flushometer for urinal type fixture. Include brass body with corrosion and chlorine resistant internal components, non-clog synthetic rubber diaphragm assembly, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

   a. Internal Design: Diaphragm operation.
   b. Style: Exposed.
   c. Inlet Size: NPS 3/4.
   d. Trip Mechanism: Oscillating, lever-handle actuator.
   e. Consumption: 0.5 gal./flush.
   f. Tailpiece Size: NPS 3/4 and standard length to top of bowl.

2.4 TOILET SEATS

A. Toilet Seats; WC-1, WC-2:

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

   a. Bemis Manufacturing Company.
   b. Church Seats.
   c. Olsonite Corp.

2. Description: Toilet seat for water-closet-type fixture.

    a. Material: Molded, solid plastic.
    b. Configuration: Open front without cover.
    c. Size: Elongated.
    d. Hinge Type: Stainless steel, self-sustaining check hinge.
    e. Class: Extra heavy-duty commercial.
    f. Color: White.

2.5 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products 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 Supports; WC-1, WC-2:

1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-less waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

    a. Support Rating: Extra heavy duty.
    b. Support Loading: 750 pounds.

        1) Base support must be securely anchored to floor with 1/2” anchors able to withstand a pull-out force of 500 pounds. The rear anchor bar must be securely anchored to floor with 1/2” anchors able to withstand a pull-out force of 1000 pounds.

C. Urinal Supports; UR-1, UR-2:

1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports; L-2:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

2.6 WATER CLOSETS

A. Water Closets; WC-1, WC-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard "Afwall FloWise" 2257.001 or a comparable product by one of the following:

   a. Eljer.
   b. Kohler Co.

2. Description: Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.

   a. Style: Flushometer valve.
   b. Bowl Type: Elongated with siphon-jet design.
   c. Height: Refer to the plumbing fixture rough-in schedule on the Drawings.
   d. Design Consumption: 1.28 gal./flush.
   e. Color: White.

2.7 URINALS

A. Urinals; UR-1, UR-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard "Washbrook FloWise" 6590.001 or a comparable product by one of the following:

   a. Eljer.
   b. Kohler Co.

2. Description: Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.

   a. Type: Washout flush action.
   b. Trapway: Integral trap with removable strainer .
   c. Design Consumption: 0.5 gal./flush.
   d. Color: White.
   e. Supply Spud Size: NPS 3/4.
   f. Outlet Size: NPS 2.

2.8 LAVATORIES

A. Lavatories; L-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard "Ovalyn" 0497.221 or a comparable product by one of the following:

   a. Eljer.
   b. Kohler Co.

2. Description: Under-counter mounting, vitreous-china fixture.

   a. Size: 21-1/2 by 17-3/8 inches rim, 19 by 15-3/8 inches oval bowl.
   b. Color: White.

3. Subject to compliance with requirements, provide trim products by one of the following:

   a. McGuire Manufacturing Company.
   b. Engineered Brass Company.

4. Lavatory Trim

   a. Supplies: Chrome plated copper with 1/2" NPS x 3/8" OD loose key stops.
   b. Drain: Grid with ADA compliant offset waste.
   c. Drain Piping: NPS 1-1/4 chrome-plated cast-brass P-trap with cleanout; NPS 1-1/4 17 gauge tubular brass waste to wall; and wall escutcheon.

B. Lavatories; L-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard "Lucerne" 0356.421 or a comparable product by one of the following:

   a. Eljer.
   b. Kohler Co.

2. Description: Accessible, wall-mounting, vitreous-china fixture.

   a. Size: 20 by 18 inches rectangular.
   b. Faucet Hole Punching: Single center faucet hole.
   c. Color: White.

3. Subject to compliance with requirements, provide trim products by one of the following:

   a. McGuire Manufacturing Company.
   b. Engineered Brass Company.

4. Lavatory Trim

   a. Supplies: Chrome plated copper with 1/2" NPS x 3/8" OD loose key stops.
   b. Drain: Grid with ADA compliant offset waste.
   c. Drain Piping: NPS 1-1/4 chrome-plated cast-brass P-trap with cleanout; NPS 1-1/4 17 gauge tubular brass waste to wall; and wall escutcheon.

2.9 SINKS

A. Mop Sinks; MS-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Fiat MSB-2424 or a comparable product by one of the following:

a. Swan.
b. Stern-Williams.

2. Description: One-bowl, floor-mounting, molded stone utility sink.

a. Overall Dimensions: 24 by 24 by 10 inches.
b. Drain: 3-inch I.P.S. cast brass with 16 gauge stainless steel dome strainer and lint basket.
c. Accessories:

1) Hose and Bracket: Stainless steel hose bracket, spring-loaded rubber grip, 30” long flexible heavy duty 5/8-inch rubber hose.
2) Mop Hanger: Stainless steel mop hanger bracket, 24 by 3 inches, 3-spring loaded rubber grips.
3) Stainless steel wall guards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install wall-mounting fixtures with tubular waste piping attached to supports.

E. Install fixtures level and plumb according to roughing-in drawings.

F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

H. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

I. Install toilet seats on water closets.

J. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

K. 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 20 Section "Common Work Materials and Methods for Fire Suppression, Plumbing, and HVAC."

L. Set mop sinks in leveling bed of cement grout. Grout is specified in Division 20 Section "Common Work Materials and Methods for Fire Suppression, Plumbing, and HVAC."

M. 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 20 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.

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.

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 224000

BLANK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Wall-mounting water coolers.
2. Fixture supports.

1.2 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and maintenance data.

1.3 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. Regulatory Requirements: Comply with requirements in ICC 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 fixtures for people with disabilities.

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. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

E. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants" for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Water Coolers; EWC-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay LZSTL8WSLK or approved equal.
2. Description: Hi-lo water cooler with bottle filling station.

    a. Cabinet: Bi-level with two attached cabinets, stainless steel with stainless-steel top.
    b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
    c. Control: Push bar on front and sides.
    d. Filter: One installed water filter complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate. Provide additional cartridge for each installed unit.
    e. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

        1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
        2) Electrical Characteristics: 1/4 hp; 120-V ac; single phase; 60 Hz.

    f. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.
    g. Bottle Filler

        1) No-touch, sensor activation with automatic 30-second shut off timer.
        2) Anti-microbial protected components.
        3) Laminar flow output.
        4) 1.1 gpm quick fill rate.
        5) Visual user interface

            a) Filter monitor.
            b) Green ticker counter.

3. Subject to compliance with requirements, provide trim products by one of the following:

    a. McGuire Manufacturing Company.
    b. Engineered Brass Company.

4. Water Cooler Trim

    a. Supplies: Chrome plated copper with 1/2" NPS x 3/8” OD wheel handle stops.
    b. Drain: Grid with NPS 1-1/4 horizontal waste and trap complying with ASME A112.18.1.

2.2 FIXTURE SUPPORTS

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

1. Josam Co.
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. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view.

3.2 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 20 Section "Pipe, Valves, Fittings, and Hangers for Fire Suppression, Plumbing, and HVAC."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, traps, and risers, and with soil, waste, and vent piping. Use size fittings required to match fixtures.

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."

3.4 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

END OF SECTION 224700

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following natural gas piping specialties:

1. Gas regulators.

1.2 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 GAS REGULATORS

A. Gas Pressure Reducing Valves:

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

a. Cashco.
b. Equimeter
c. Fisher.
d. Rockwell.
e. Sensus.
f. Invensys.

2. Construction

a. Valve body: Cast iron.
b. Diaphragm case: Die-cast aluminum.
c. Diaphragm: Buna-N with nylon fabric reinforcement.
d. Orifices: Interchangeable brass.
e. Finish: Corrosion resistant protective finish.

3. Operation: Single stage diaphragm type.
4. Temperature limits: -20°F to 150°F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 20 Section "Pipe, Valves, Fittings, and Hangers for Fire Suppression, Plumbing, and HVAC." for piping joining materials, joint construction, and basic installation requirements.

B. Piping installation requirements are specified in other Division 20 Sections. Drawings indicate general arrangement of piping and specialties.

C. Install gas pressure reducing valves in accordance with manufacturer's installation recommendations.

D. Were gas pressure reducing valves are not located outdoors and away from building openings, relief vent shall be plumbed directly to outside. Multiple vents may be combined.

3.2 FIELD QUALITY CONTROL

A. Remove and replace malfunctioning natural gas piping specialties and retest as specified herein.

END OF SECTION 226315

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. Related Work Specified Elsewhere

1. Control Systems Equipment: Section 23 09 00
2. Sequences of Operation: Section 23 09 93

1.2 SUMMARY

A. This Section includes testing, adjusting and balancing of HVAC Systems to produce design objectives, including the following:

1. Adjusting blowers, fans and ducts to deliver or exhaust design air flow(including kitchen equipment)
2. Adjusting terminal units, diffusers, registers and grilles to supply, return or exhaust design air flow.
3. Adjusting relief dampers and vents.
4. Adjusting diffusers, registers and grilles to minimize drafts.
5. Adjusting all zones for design supply and return air flow.
6. Adjusting blowers and fans to design rpm.
7. Balancing of domestic hot water return loop.
8. Adjusting VAV terminal box controllers to design cfm and verify coil operation. (Heating and Cooling).
9. Sheet metal shop drawing review prior to ductwork installation, review the Sheet Metal Contractor's duct fabrication drawings and mark any additional balancing dampers, etc. that are required for proper balancing of the systems. This Contractor shall receive two copies from the Sheet Metal Contractor and shall return one copy to Sheet Metal Contractor.

1.3 SUBMITTALS

A. Bidding Documents

1. Submit name of the Test and Balance Agency to Architect/Engineer as a subcontractor on the Materials and Subcontractors Listing.
2. Submit name of the Test and Balance Agency to Architect/Engineer as a subcontractor on the Materials and Subcontractors Listing.
3. If the Contractor fails to submit name of selected Test and Balance Agency, the Architect/Engineer will select the agency of his choice and Contractor must then issue purchase order for this work as directed.

B. Certificate: Selected and approved agency shall submit certificate immediately upon receipt of test and balance contract.

C. Data Sheets

1. Submit type written data sheets on each item of testing equipment to be used.
2. Include name of device, manufacturer's name, model number, latest date of calibration and correction factors.

D. Report Forms

1. Submit specimen copies of the balance report set-up including addendums and alternates before starting work on site.
2. Submit 30, 60, 90 percent site visit reports on installation of HVAC systems.
3. Forms shall be 8-1/2" x 11" paper for looseleaf binding, with blanks for listing of the required test ratings and for certification of report.
4. Submit preliminary pencil copies of reports as A/E determines.

E. Final Report

1. Upon completion, all information shall be neatly typed and five copies submitted to the Architect/Engineer with accompanying schematic diagrams of systems tested.
2. All test reports shall be assembled, indexed and submitted in vinyl covered looseleaf notebooks with project name and Balancing Contractor's name permanently printed thereon.

1.4 QUALITY ASSURANCE

A. Test and Balance Agency

1. Obtain the services of an independent Test and Balance Agency that specializes in, and whose business is limited to, the testing and balancing of air conditioning systems.
2. The agency selected shall be fully certified by the NEBB and shall have at least one member of the agency qualified as a certified test and balance Engineer who has been issued this certification by the National Examining Board.
3. All work shall be done under the direct supervision of a full time member of the organization.
4. All final reports shall be signed and sealed by the certified test and balance Engineer.
5. Approved Test and Balance Contractors:

    a. Mechanical Systems Balancing

    b. Total Balance
    c. Fluid Dynamics

6. Agency Contract: Award the contract to the approved Balance Contractor in sufficient time to allow the Test and Balance Contractor to schedule this work in cooperation with other trades involved and comply with the completion date.

B. Instruments

1. The minimum instrumentation for testing, adjusting and balancing shall be the "NEBB Approved Minimum Field Instrumentation."
2. Instruments used for testing and balancing must have been calibrated within a period of six months and checked for accuracy prior to start of work.
3. Instruments must be maintained and carried in such manner to protect them from excessive vibration and moisture conditions.
4. Approval: all products and instrumentation used shall be subject to approval of the Engineer.

C. Procedure - Methodology: testing and balancing shall be performed in complete accordance with NEBB National Standards for Field Measurements and Instrumentation.

D. Conditions: System Operation - heating, ventilating, and air conditioning equipment including filters, shall be completely installed and in continuous operation as required to accomplish the adjusting and balance work specified. Test and Balance Agency shall give a Check List to the Mechanical and/or Sheet Metal Contractors which, when completed, and returned, will assure the systems are ready to be balanced. A/E shall receive a copy of check list from Mechanical and Sheet Metal Contractors when completed.

1.5 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, Commissioning Agent (if applicable) and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide seven (7) days advance notice for each test. Include scheduled test date and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

D. Measurements – Readjustments

1. Should corrective measures caused by faulty installation require retesting, adjusting and balancing, such work shall be at no additional expense.
2. Corrective measures other than the above shall be made only as directed by the Architect/Engineer. Such work shall be at no additional expense.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 PREPARATION

A. Air Systems - prior to system testing and balancing

1. Verify that the appropriate contractor has:

a. Checked all systems and placed them into a fully operational status.
b. Cleaned all air filters or installed new ones as required.
c. Checked temperature and system controls for proper operation.
d. Checked fan rotation for proper operation.

3.2 SYSTEM BALANCE

A. Air Systems - Perform the following minimum tests and balance:

1. Test and adjust supply, return and exhaust fans to design requirements. Change sheaves and belts as required to obtain design air quantities. Sheaves and belts to be furnished by respective equipment manufacturer. Sheaves shall be sized so that maximum CFM will be obtained with VFD at 100% speed. Slowing FVD is not an acceptable method to obtain maximum CFM.

2. Test and record motor electrical characteristics, RPM, service factor, measured voltage, full load amperes and connected load amperage. Check and record starter heaters, sizes and ratings, replacing belts sizes, etc.
3. Make pitot tube traverse (minimum of 16 points) of main supply ducts and obtain design CFM at fans. Seal all test holes with suitable hole plugs.
4. Test and record system static pressure, suction and discharge.
5. Test and adjust system for design CFM recirculated air.
6. Test and adjust system for design CFM outside air.
7. Adjust all main supply and return air ducts to proper design CFM.
8. Adjust all zones to proper design CFM, supply and return.
9. Test and adjust each diffuser, grille and register to within ±10% of design requirements.
10. Each grille, diffuser and register shall be identified as to location and area. Size, type, flow factor and manufacturer of diffusers, grilles, registers and all tested equipment shall be identified and listed.
11. Readings and tests of diffusers, grilles and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustments.
12. The Balance Contractor shall list all controls requiring adjustment by Temperature Control Contractor and assist Control Contractor with required settings.
13. All diffusers, grilles and registers shall be adjusted to minimize drafts in all areas.
14. Read and adjust the minimum and maximum settings on all variable air volume (VAV) boxes. See 23 09 93, Sequence of Operation for dual minimum applications. On dual minimum applications, set and confirm both minimums.

B. Record Data

1. Air Systems - record the following minimum data:

a. CFM delivery and RPM of blowers and fans

1) Static pressure at inlet and outlet of blowers and fans
2) All equipment nameplate data
3) Actual running current and voltage of fan motors and settings for solid state overload relays or heater sizes.

b. CFM delivered or exhausted at each diffuser, register, or grille.

C. Equipment Cards

1. Install at each piece of equipment a “check out” card showing all significant operating temperatures, pressures, amperes, voltages, brake horsepower, etc. Check out cards shall be standard 5” x 8” index cards enclosed in vinafilm card folders securely attached to equipment or wall in immediate area.

D. Owner's Instructions: Balancing Contractor shall arrange with the Owner at a time for the instruction of the Owner's personnel as to the proper operation and maintenance of the equipment.

3.3 OWNER ORIENTATION/COMMISSIONING

A. Reference Division 1.

3.4 ADDITIONAL TEST

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods

1. If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions, if so requested by Owner/Engineer.

END OF SECTION 230593

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PART 1 - GENERAL

1.1 WORK INCLUDED

A. Related Work Specified Elsewhere

1. Common Work Results for Fire Suppression, Plumbing and HVAC: Section 20 00 10
2. Common Materials and Methods for Fire Suppression, Plumbing and HVAC: Section 20 00 50
3. Common Pipe, Valves, Fittings and Hangers for Fire Suppression, Plumbing and HVAC: Section 20 00 60
4. Divisions 23 and 26 Specifications

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

C. Description of System: furnish and install complete an automatic temperature control system and Direct Digital Control System (DDCS) as shown or implied on the Contract Documents for the following:

1. Variable and Constant Volume Rooftop Units
2. VAV Terminal Units with Electric Heating Coil
3. Exhaust Fans
4. Kitchen Make-Up Air Fans
5. Kitchen Cooler/Freezer Temperature Monitoring

1.2 SCOPE OF WORK

A. Furnish all labor, materials, equipment and service necessary for a complete and operating Building Automation System (BAS), utilizing Direct Digital Controls a shown on the drawings and as described herein. Drawings are diagrammatic only. The BAS shall be capable of total integration of the facility infrastructure systems with user access to all system data either locally over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet. This shall include HVAC control, electrical, gas and water metering, energy management, alarm monitoring, and all trending, reporting and maintenance management functions related to normal building operations all as indicated on the drawings or elsewhere in this specification.

1. The Input/Output Summary Table on the Drawings identifies the minimum points that are to be addressed and incorporated into the Direct Digital Control (DDC) System. Any other points required to accomplish the sequences of operation specified shall be provided at no additional cost to the Owner.
2. All work performed under this Section of the Specifications shall comply with all codes, laws and governing bodies, and all direct digital controllers and BAS equipment installed shall be U.L. 916 approved.
3. The system shall comply with NFPA 90A Air Conditioning and 90B Warm Air Heating, Air conditioning.
4. System shall be designed and manufactured to ISO 9001 quality standard, and all electronic equipment shall conform to the requirements of FCC regulation Part 15. Section 15 governing radio frequency electromagnetic interference and be so labeled.
5. The unitary controllers, intelligent sensors and intelligent actuators shall be based upon LonMark or BacNet functional profile configurations.
6. Furnish and install control panels.

7. Furnish and install all control wiring that is a part of this contract unless otherwise noted.
8. Furnish all motorized temperature control dampers, valves and actuators.
9. Furnish and install all interlocking wiring between chillers and air cooled condensers and as herein specified.
10. Furnish and install all 120 volt, 24 volt, communication wiring, conduit and accessories to all control panels, actuators, control devices that are part of the temperature Control System.
11. Provide Owner training as described within these specifications.
12. Integrate building control system into the Owner's existing front end system for the campus.

B. Dynamic Color Graphic Displays

1. Color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units, 2-pipe heating/cooling systems, exhaust systems, building power, refrigerant monitoring, fan coil units, and zone controls shall be provided by the BAS contractor as indicated in the sequence of operation of this specification to optimize system performance analysis and speed alarm recognition. Graphic screen shall be provided showing the floor plan of this facility with temperatures, CO2 levels, humidity, and setpoints of each piece of HVAC equipment being controlled and any information included on the Drawings. The ability to change these setpoints shall be provided from this graphic. Multiple screens may be provided if required for display resolution. If multiple screens are provided, the top layer screen shall show entire facility with zone links to the sub-areas. CAD drawings of the building may be obtained from Engineer upon request.

2. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.

3. Equipment state can be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or setpoint.

4. Colors shall be used to indicate status and change as the status of the equipment changes. The status colors shall be user definable.

5. The windowing environment of the PC operator workstation or tablet device shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

6. A dynamic display of the site specific architecture showing the status of all controllers, operator workstations, and networks shall be provided.

   a. Graphical representation of all mechanical systems will be provided as part of the system.
   b. More detailed information about specific requirements should be reviewed with the facilities manager(s).
   c. The first page accessed after logging onto the system should be the home page. The home page should display the following information:

      1. Building name, and actual time and date being used by the system for trending etc.
      2. Either floor plans of the building or links to the floor plans.
      3. Outside air temperature and humidity.
      4. An indication that a point is in alarm for that building only:

A. Alarm management: provide a link directly to the alarm point or to an alarm page. The alarm page should allow an owner to link directly to the individual alarm points. There must be a link to the equipment that is associated with the alarm. The operator should not have to go through the navigation tree on any system to access the alarms for that building. All alarm management should be managed directly through the graphics pages.

B. Provide a link to silence the alarm so it will not keep alarming the central security system. Point will continue to show in alarm. Provide a separate link to reset the alarm after the alarm issue has been resolved.

d. Links to all major systems including the following as a minimum:

1. Rooftop Units
2. VAV Terminal Units
3. Exhaust Fans
4. Make-Up Air Fans

e. Links to the following shall also be shown as:

1. Trends.
2. Time of day schedules.
3. Contact information service.
4. PDF files of control system drawings showing system diagrams and sequence of operations as a minimum.
5. Power monitoring, gas and electric.
6. Secondary equipment summary pages Summary page to include the following at a minimum:
   A. Area served
   B. Actual CFM
   C. Space temperature
   D. Discharge air temperature
   E. Damper position
   F. Valve/Heater Status
7. Management of additional layers

f. Floor plan management:

1. Floor plans shall show terminal equipment as approximately located in the field. Show single line ductwork where appropriate for clarification of areas served.
2. Show space temperature for each sensor in the space.
3. Provide a link at each temperature to a graphics page for the secondary equipment serving that area.
4. Link back to home page.

g. Secondary equipment (such as VAV boxes, etc.) page management:

1. Show diagram reflecting configuration of terminal equipment.
2. Show entering air temperature (return where applicable).
3. Show discharge air temperature.
4. Show fan status (where applicable).
5. Show mode status, heating or cooling (where applicable).
6. Provide link to air handling equipment serving the piece of terminal equipment.
7. Provide link to hot water heating system.
8. Provide link to chilled water system.

9. Provide link to any other equipment whose operation could affect the terminal equipment being viewed.
10. Provide link back to home page.
11. Show outside air temperature and humidity.
12. Provide setpoint adjustment of points commonly requiring setpoint adjustment and as directed by the owner.
13. Provide summary page showing the following where applicable:
    A. Damper position
    B. Valve position
    C. Discharge temperature
    D. Air flow
    E. Space temperature
    F. Htg/clg mode

h. Major system page management such as air handling units, boiler and chiller systems, etc.

1. Show diagram reflecting configuration of equipment.
2. Show entering air temperature of any duct coming from another system (example: ERU serving OA to a, air handling unit).
3. Show all points listed in the points schedule and any others required to meet the sequence of operations.
4. Show fan status (where applicable).
5. Show mode status, heating or cooling (where applicable).
6. Provide link to hot water heating system.
7. Provide link to chilled water system.
8. Provide link to any other equipment whose operation could affect the equipment being viewed.
9. Show outside air temperature and humidity.
10. Provide setpoint adjustment of points commonly requiring setpoint adjustment and as directed by the owner.
11. Provide link to equipment schedules.
12. Show applicable points from open architecture connections such as chillers, boilers, VFD's, etc. A list of available points must be submitted to IPS HVAC Foreman or Energy Management Technician for approval. The approved point list must appear on the graphics.
13. Link back to home page.

i. Schedule Management

1. Provide zoning as approved by IPS HVAC Foreman or Energy Management Technician. As a minimum provide separate zones for each classroom wing or area separated by building structure or class level. Provide separate zones for gyms, auditoriums, cafeterias, kitchens and special use areas.

2. The scheduling graphic page will show all schedules. The operator must be able to click a schedule and have a window open that provides a monthly "live" calendar for easy access to future scheduling. Monthly calendar should indicate days where special events are scheduled.
3. The system will have a master schedule that overrides all other schedules.
4. Schedule changes can be made the day of the schedule change.
5. Link back to major equipment being scheduled.
6. Link back to home page.

j. Trend Management

1. The systems shall have the ability to store a minimum of 25 trends every three minutes for one year.
2. At least 25% of the system points shall be setup for trending.
3. Link back to the home page.

C. Work By Others

1. Sheetmetal Contractor will install all control dampers provided by Temperature Control Contractor. Temperature Control Contractor to verify size and location.

2. Mechanical Contractor will install all taps, control valves and thermo wells in piping for all temperature sensors, flow switches, pressure sensors and any other control device installed in piping.

3. Mechanical Contractor will install all differential pressure switches including isolation valves.

4. Mechanical Contractor shall install gas meter and water meter furnished by Temperature Control Contractor.

5. Electrical Contractor Provides:

   a. Wiring of all power feeds through all disconnects, starters and VFD's to electrical motors.
   b. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS manufacturer.
   c. Electrical Contractor will install and connect power wiring to variable frequency drives.
   d. Electrical Contractor furnish and install smoke detectors and wire to fan starters.
   e. Installation of Energy Meter in electrical switchgear. Temperature Control Contractor shall connect to the BAS.

6. Unit Ventilator manufacturer shall install DDC controller, 24V transformer, actuators, sensors, etc. provided by BAS manufacturer. BAS manufacturer shall ship control components as required for the sequence of operation to the Unit Ventilator manufacturer in a timely fashion so as not to compromise the specified completion date.

1.3 QUALITY ASSURANCE

A. All control items herein specified shall be the product of a single manufacturer and no mixing of suppliers will be permitted.

B. All engineering, project management, service and field labor shall be performed by trained employees in the regular full time employ of the Temperature Control Contractor. Electrical installation field labor may be subcontracted but must be done under regular supervision of the T.C.C. Systems provided by wholesalers, contractors or franchised dealers or any other firm whose principal business is not that of manufacturing and installing automatic temperature control systems, shall not be acceptable.

C. The Temperature Control Contractor shall submit proof of having installed five (5) projects of equal or greater size and complexity to this installation in a radius of 100 miles of the project.

D. T.C.C. shall submit proof of being able to provide company trained 24 hour service 365 days each year and such service must be able to respond in less than four (4) hours.

1.4 ACCEPTABLE MANUFACTURER/INSTALLATION

A. Acceptable Control System Manufacturer/Installers:

1. Alerton Controls / Open Control Systems

2. Owner Approved Equal

1.5 SUBMITTALS

A. Quantities prepared and submitted as noted in Division 01 “Submittals”.

B. Submit documentation in the following phased delivery schedule:

1. Valve and damper schedules.
2. Equipment data cut sheets.
3. System schematics, including:

   a. Sequence of operations
   b. Point names
   c. Point addresses
   d. Interface wiring diagrams
   e. Panel layouts
   f. System riser diagrams
   g. Auto-CAD compatible as-built drawings

C. Upon project completion, submit operation and maintenance manuals, consisting of the following:

1. Index sheet, listing contents in alphabetical order.
2. Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams.
3. Description of sequence of operations.
4. As-Built interconnection wiring diagrams.
5. Operator’s Manual.
6. Trunk cable schematic showing remote electronic panel locations, and all trunk data.
7. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.).
8. Conduit routing diagrams.
9. One set of software on CD rom.
10. All drawings, data sheets, etc., scanned to .pdf files and copied to a compact disk.

1.6 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the entire BAS system for a period of one year after substantial completion of entire project.

B. The adjustment, required testing, and repair of the system includes all computer equipment, transmission equipment and all sensors and control devices.

C. The on-line support services shall allow the local BAS Contractor to log on through a web browser to monitor and control the facility's building automation system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include

normal business hours, after business hours, weekends and holidays. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the BAS manufacturer shall dispatch the appropriate personnel to the job site to resolve the problem within 3 hours of the time that the problem is reported.

PART 2 - PRODUCTS

2.1 ARCHITECTURE OF DDC SYSTEM

A. Local system control shall be performed by field-programmable stand-alone Direct Digital Controllers, microprocessor based, consisting of one or more pieces of equipment and operator interface devices, functioning as an integrated system to provide all monitoring and control system functions specified hereinafter. The Digital Control System shall be user programmable utilizing English language providing menu and/or command prompts. The system shall provide the capability for the Digital Controllers to share point and calculated data for the purpose of developing complex and global strategies and common point sensing. Each Digital Controller shall perform its assigned control and energy management functions as a stand-alone unit regardless of the conditions of the system communications link.

B. Open, Interoperable, Integrated Architectures

1. The intent of this specification is to provide a peer-to-peer networked, stand-alone distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet (via Ethernet) and LonWorks technology communication protocols in one open, interoperable system. The system shall be capable of integrating Modbus protocol and exchanging data via Dynamic Data Exchange (DDE).

2. The supplied system 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/ASHRAEJ Standard 135-1995, BACnet and LonMark to assure interoperability between all system components is required. The system supplier must provide a PICS document showing the installed systems compliance level. Minimum compliance is Level 3.

3. 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.

4. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs. 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 for all database access. Systems requiring proprietary database or user interface programs shall not be acceptable.

C. This section shall describe the minimum hardware requirements for the Stand-alone Digital Controllers (SDC's), as well as the overall performance requirement for DDC System.

D. Systems which require the existing user-defined data base to be re-entered through the operator's terminal after a power failure shall not be acceptable.

E. Basic elements of the DDCS structure shall be built up of only standard components kept in inventory by TCC. Components shall not require customizing other than setting jumpers and switches, adding firmware modules or software programming to perform required functions.

F. The Digital Control System architecture shall provide expandability of both hardware and software.

G. The Digital Controllers supplied shall be the latest version available, including most recently updated software and hardware offered by the manufacturer.

H. T.C.C. shall supply a sufficient number of system and terminal control units to meet the input/output capacity requirements. There should be a minimum 20 percent extra input/output capability over initial requirements for future expansion.

I. The system control units will be enclosed in an all-steel enclosure with baked enamel finish, hinged access door and keyed latch. All terminal control units will be mounted within an Owner accepted Contractor supplied enclosure. Remaining components to complete the system will be mounted in the field interface panel as shown on drawings.

J. All digital controllers shall be protected from volatile memory loss with on-board battery back-up.

K. Digital controllers shall be capable of being downloaded with software both locally (with T.C.C.'s portable terminal) and remotely over Owners LAN.

L. Preprogrammed disc shall be given to the owner to restore software given the event of loss of data from hard drives.

2.2 NETWORKING COMMUNICATIONS

A. The design of the BAS shall network operator workstations and stand-alone DDC Controllers with Application Specific Controllers (ASCs). The network architecture shall consist of three levels, a campus-wide Management Level Ethernet network connecting Operator Workstations based on TCP/IP protocol, a high performance peer-to-peer Building Level Network connecting DDC Controllers, and Floor Level local area networks of ASCs. The multiple networks shall be totally transparent to the user when accessing data or developing control programs.

B. The design of BAS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.

1. Provide an Ethernet BACnet/IP connection to the building temperature control system.
2. There shall be only **one** connection to the owner's LAN. This connection shall be made at the boiler room or as directed by the owner. If more than one supervisory panel is used, the TCC shall run a parallel LAN between those panels. The owner will assign IP addresses as required.
3. Provide remote support to the building temperature control (TC) system using BACnet/IP through the Internet connection to the world wide web. Provide TC system automatic software reloading, where required, using the BACnet connection.
4. Contractor must provide the following to the Owner for coordination with IT:

    a. Identify firewall portal opening during the submittal phase of the project and deliver to Owner.
    b. Number of IP addresses required to make system operational
    c. Provide the necessary software for Owner to access all building information remotely.
    d. Provide fastest speed available for communications.
    e. Provide world wide web access for all BAS systems.
    f. Must allow for multiple users
    g. Hardware/Software

5. All annual licensing and upgrade fees must be included provided by the vendor in their bid.

6. System shall be accessible from a touch tablet device such as an iPad device of latest generation in addition to desktop computer.
7. Provide all necessary hardware, connection devices, software, etc. required for the owner to connect directly to the BAS system from a laptop for on site maintenance. A minimum of 13 copies of the hardware and any software required shall be provided with all licensing fees and upgrades through the warranty period.
8. Provide a login/password-protected method to limit access to the building TC system when directly connecting to the system. Provide unlimited owner access for service purposes.

2.3 NETWORK AREA CONTROLLER (NAC)

A. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:

1. Calendar Functions
2. Scheduling
3. Trending
4. Alarm Monitoring and Routing
5. Time Synchronization
6. Integration of LonWorks Controller Data and BACnet Controller Data
7. Network Management Functions for all LonWorks based devices

B. The Network Area Controller must provide the following hardware features as a minimum:

1. One Ethernet Port -10 / 100 Mbps
2. One RS-232 port
3. One LonWorks Interface Port B 78KB FTT-10A
4. Battery Backup
5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)

C. The NAC must be capable of operation over a temperature range of 0^{o} to 55^{o}C

D. The NAC must be capable of withstanding storage temperatures of between 0^{o} and 70^{o}C

E. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing.

F. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

G. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

2.4 INTEROPERABLE LON CONTROLLER (ILC)

A. HVAC control shall be accomplished using LonMark based devices where the application has a LonMark profile defined. Where LonMark devices are not available for a particular application, devices based on LonWorks shall be acceptable. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file for the device. Publicly available specifications for the Applications Programming Interface (API) must be provided for each LonWorks / LonMark controller

defining the programming or setup of each device. All programming, documentation and programming tools necessary to set up and configure the supplied devices per the specified sequences of operation shall be provided.

B. All ILCs shall be application programmable and shall at all time maintain their LonMark certification. All control sequences within or programmed into the ILC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

C. The ILCs shall communicate with the NAC at a baud rate of not less than 78.8K baud. The ILC shall provide LED indication of communication and controller performance to the technician, without cover removal.

D. The ILCs shall be operational as standalone devices configured to perform the sequences specified, and with I/O selected for the application. Controllers shall be tested and listed under UL916 for Energy Management computing devices. Each controller shall be provided with a face mounted LED type annunciation to continually display its operational mode: power, normal, or in an alarm state. The following integral and remote Inputs/Outputs shall be supported per each ILC:

1. Eight integral dry contact digital inputs.

    a. Any two digital inputs may be configured as pulse counters with a maximum pulse read rate of 15 Hz.

2. Eight integral analog inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC).
3. Six integral 4-20 ma analog outputs.
4. Eight integral 24 Vac Triac digital outputs, configurable as maintained, or floating motor control outputs.
5. One integral 20 Vdc, 65-mA power supply for auxiliary devices.

    a. If a 20 Vdc 65-mA power supply terminal is not integral to the ILC, provide at each ILC a separate, full isolated, enclosed, current limited and regulated UL listed auxiliary power supply for power to auxiliary devices.

6. Each ILC shall have expansion ability to support additional I/O requirements through the use of remote input/output modules. The minimum remote expansion capability per ILC shall be:

    a. Twenty remote four digital outputs
    b. Twelve remote digital inputs
    c. Eighteen remote analog inputs
    d. Remote I/O shall operate via direct peer-peer communication between the ILC and the remote I/O modules. No additional hardware or software shall be required to fully utilize remote I/O modules. ILC algorithms shall be able utilize remote I/O data points equivalent to integral I/O points.
    e. ILCs, which do not support direct expansion through remote I/O modules, shall provide the following additional integral inputs and outputs at each ILC.

        1) Twenty four additional, integral digital outputs
        2) Twelve additional, integral digital inputs
        3) Eighteen additional, integral analog inputs

E. ILC Controllers shall support the following control techniques:

1. Ten configurable general-purpose control loops that can incorporate Demand Limit Control strategies, Setpoint reset, adaptive intelligent recovery, and time of day bypass.

2. Ten general purpose, non-linear control loops.
3. Eight start/stop loops
4. Thirty-two If/Then/Else logic loops
5. Thirty six Math Function loops (MIN, MAX, AVG, SUM, SUB, SQRT, MUL, DIV, ENTHALPY).

F. The ILCs shall be configured for DIN rail mounting using industry standard clip on adapters or direct panel mounted. Each controller shall be designed with on-board jacks for quick commissioning and troubleshooting with a portable programming tool. This connection shall be extended to a space temperature port where indicated and shown on plans.

2.5 INTEROPERABLE BACnet CONTROLLER (IBC)

A. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the ANSI/ASHRAE Standard 135-1995. IBC's shall be provided for Air Handling Units, Unit Ventilators, Fan Coils, Heat Pumps, Variable Air Volume (VAV) Terminals and other applications as shown on the drawings. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The system supplier must provide a PICS document showing the installed systems compliance level to the ANSI/ASHRAE Standard 135-1995. Minimum compliance is Level 3.

B. The IBC's shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.

C. The IBC Sensor shall connect directly to the IBC and shall not utilize any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC Sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC Sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.

D. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the IBC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

2.6 WEB BROWSER CLIENTS

A. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable.

B. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

C. The Web browser client shall support at a minimum, the following functions:

1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

D. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

E. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

F. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

G. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.

H. User's shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

1. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
2. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
3. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
4. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
5. View logs and charts
6. View and acknowledge alarms

I. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

J. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.7 ALARM MANAGEMENT

A. Event Alarm Notification and Actions

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, wide-area network, local area network or pager.
3. Alarms directed to a browser (client) must minimally support alarm annunciation even if browser is not active.
4. Alarms to be able to be divided into three levels: Critical Alarms, Level 2 Alarms, Maintenance Alarms.

5. Contractor should be prepared to designate up to 25% (in addition to critical alarm points) of the total system points as alarm points.
6. Provide for the creation of an unlimited number of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
7. Provide timed (schedule) routing of alarms by object, group, or node.
8. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

B. Control equipment and network failures shall be treated as alarms and annunciated.

C. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text
2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:

    a. Day of week
    b. Time of day
    c. Recipient

3. Pagers via paging services that initiate a page on receipt of email message.
4. Graphic with flashing alarm object(s)
5. Printed message, routed directly to a dedicated alarm printer.
6. Audio messages

D. The following shall be recorded by the NAC for each alarm (at a minimum):

1. Time and date
2. Location (building, floor, zone, office number, etc.)
3. Equipment (air handler #, accessway, etc.)
4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

E. Alarm actions may be initiated by user defined programmable objects created for that purpose.

F. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

G. A log of all alarms shall be maintained by the server (if configured in the system) and shall be available for review by the user.

H. Provide a "query" feature to allow review of specific alarms by user defined parameters.

I. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

J. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.8 DATA COLLECTION & STORAGE

A. The NAC shall have the ability to collect data for any property of any object and store this data for future use.

B. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:

1. Designating the log as interval or deviation.
2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

C. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.

D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

E. All log data shall be available to the user in the following data formats:

1. HTML
2. XML
3. Plain Text
4. Comma or tab separated values

F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

G. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:

1. Archive on time of day
2. Archive on user-defined number of data stores in the log (buffer size)
3. Archive when log has reached its user-defined capacity of data stores
4. Provide ability to clear logs once archived.

2.9 DATABASE BACKUP AND STORAGE

A. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

B. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.

C. The NAC 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.

2.10 SYSTEM PROGRAMMING

A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface display shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.11 NETWORK COMMUNICATIONS

A. The Local Area Network (LAN) shall be either a 10 or 100 Megabits/sec. Ethernet network supporting BACnet, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NAC's) and user workstations.

B. Client access to the system shall be via the Internet from a remote location and from a local workstation by direct connection to the Ethernet LAN.

C. Internet access shall be by owner furnished high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or Internet Service Provider (ISP). The owner shall pay all Internet connection and access charges.

D. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE standard 802.3
2. Cable; 10 Base-T, UTP-8 wire, Category 5

2.12 FIELD BUS COMMUNICATIONS

A. The Field Bus communications network shall be based on industry standard LonWorks open protocol.

1. All communications shall be via twisted pairs wires, shielded where required and approved for use with LonWorks Free Topology Transceivers.

B. UC's and intelligent actuators and sensors shall reside directly on a peer-to-peer network utilizing LonMark configurations with selectable speed from 78K Baud up to 1 megabit. Bus speed shall be selected to maintain the required system response times. Physical media configurations shall be provided to support the LonWorks protocol.

C. The NAC shall support an optional Radio Frequency Interface for communication with electric, gas and water meters for remote readings. The interface shall be a standard 900 MHz Spread-Spectrum RF Interface which supports communications distances of up to one mile. This interface shall support a minimum of 400 meters of a mix of any type (gas, electric or water).

D. System Configuration & Definition

1. Network wide control strategies shall not be restricted to a single DDC Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.

2. Provide automatic backup and restore of all DDC controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity.

3. System configuration, programming, editing, graphics generation shall be performed on-line. If programming and system back-up must be done with the PC workstation off-line, the BAS contractor shall provide at least 2 operator workstations/servers.

2.13 FIELD DEVICES

A. ROOM THERMOSTATS AND SENSORS

1. Unless otherwise noted and except for DDC Terminal Unit Controller=s sensors, thermostats and temperature sensors located in conditioned spaces shall have locking covers which incorporate a thermometer. Room sensors for DDC Terminal Unit Controllers shall have exposed adjustment with locking-type covers and thermometers. Thermostats shall be Underwriters Laboratories listed under UL934 for use in air plenum applications. Finish shall be manufacturers standard. All thermostat locations shall be submitted for approval before installation. Unless otherwise indicated or specified, provide one thermostat for each zone shown on the drawings.

2. Thermostat temperature ranges shall comply with the Indiana Energy Code.

a. Protective cover provided on room temperature sensors to prevent accidental damage.
b. Space temperature sensor covers: durable, impact resistant material finished in acceptable color or acceptable metallic finish matching building hardware: utilize locking type cover screws and have thermometers.

3. Room thermostats and sensors shall be capable of being replaced without the need for controller re-calibration. Room thermostats and sensors shall accordingly have manufactured space temperature and setpoint signal precision tolerances of no greater than 1.0EF. DDC/BAS shall be able to limit space sensor integral adjustment through software commands.

4. Each room thermostat or sensor shall have an integral momentary push button, which can be depressed by the occupant during unoccupied mode of operation. This push button shall cause the DDC controller to bring the unitary air handler or building zone to occupied setpoints for a period of up to 2 hours (adjustable through BAS). Should occupant depress push button again later, DDC controller shall begin timing an additional override period; override operation shall be reported to appropriate DDC/BAS operator=s terminal to allow generation of custom reports.

5. Each room thermostat or sensor shall have a RJ11 type jack to allow communication to the laptop service tool.

6. Provide “Flatplate” temperature sensors in all Apublic areas@ (i.e. restrooms, gymnasiums, cafeterias, corridors, etc.) and where indicated on drawings.

B. DAMPER AND VALVE ACTUATORS

1. Actuators shall be direct coupled, brushless DC motor type, which require no crank arm and linkage. The actuator shall provide 0 - 10VDC, 0-2-V phased cut or 4 - 20 mA proportional control or two position control or pulse width modulation or Tri-State control as dictated by HVAC application and sequences of operation. Actuators shall be designed for either clockwise or counterclockwise fail-safe operation, have a manual positioning mechanism and control direction of rotation switch. Run time shall be constant and independent of torque. A 2 to 10VDC feedback signal shall be provided for position feedback or master-slave applications.

2. Actuators shall be UL listed and CSA certified, protected from overload at all angles of rotation and manufactured under ISO 9001 quality control standards.

3. All actuators on fresh air, return air and face and bypass dampers and valves shall be spring return to their normally open or closed position in the event of power failure.

4. Damper actuators: to be mounted outside the airstream and be able to be removed without taking damper apart. Extension shafts to be installed to mount actuators on outside of CSAC units.

5. All actuators shall be electric or electronic and designed to interface with the Direct Digital Control System.

6. All valve actuators shall be selected one size larger than minimum recommended size to assure tight valve close-off or a minimum of 50% over speed, whichever is greater. All valve actuators on 6" valves and larger shall have external handwheel.

7. Manufacturers:

a. Belimo
b. Johnson Controls
c. Honeywell

C. AIR STATIC PRESSURE TRANSMITTER

1. Transmitter shall have range of 0-1@ or 0.5@ WG and send a 4-20milliamp output signal. Zero set range and span set range +/- 5% of full range output. A combined static error (non-linearity, non-repeatability, and hysteresis) +/- 5% of full range output.

D. IAQ (CO_2) SENSOR

1. Measures CO_2 level only - 0 - 2,000 PPM $\pm$ 5% accuracy.

2. Duct mounted for large spaces where one AHU serves one zone.

3. Room mounted where one AHU serves multiple zones.

4. Complete with calibration kit.

5. Manufacturers:

   a. Valtronics Model 6289D
   b. MSA

E. ANALOG INPUT SENSORS

1. Analog sensing devices shall be available for the measurement of common variables such as temperature, static pressure, differential pressure, humidity, fluid flow, etc. All devices shall be standard manufactured for the purpose intended with an output range as specified. High impedance resistive temperature elements shall not be acceptable to reduce transient noise and voltage coupling and damage at the SDC or UDC.

2. All temperature measuring sensors shall have the capability of providing local indication at the sensing location and specifically at those locations shown on the point chart.

3. When thermowells are required, sensor and well shall be supplied as a complete assembly including well head. Thermal conductive compound shall be used in sensor/well assembly.

4. Thermowells constructed as to be compatible with the medium being measured.

5. All thermowells and sensors mounted to allow easy access to the sensor for repair or replacement; installed as part of the piping work.

6. Duct mount sensors mount through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. A seal shall be used on the sensor assembly to prevent air leaks.

7. Protective cover provided on room temperature sensors to prevent accidental damage.

   a. Space temperature sensor covers: durable, impact resistant material finished in acceptable color or acceptable metallic finish matching building hardware: utilize locking type cover screws and be with thermometers. All space sensors shall have a communications plug-in port (RJ-11) that are fully wired to the BAS so all points can be monitored by plugging the laptop into the temperature sensor port.

8. Outside air sensors designed to withstand the environmental conditions to which they will be exposed; equipped with solar shields.

9. Accuracies: as follows, including errors associated with sensor, leadwire and A to D convertor.

Point Type	Accuracy
Outside Air Temperature	1.0° F
Space Temperature	1.5° F
Duct Temperature	1.0° F
Sensors Used in Calibrations	0.5° F

F. PRESSURE SENSORS AND TRANSMITTERS

1. Pressure sensor construction compatible with the medium being measured.

2. All pressure sensors sized to withstand two times (2x) the average without damage and to hold calibrated accuracy when subject to a momentary forty percent (40%) overrange input.

3. Pressure measurement accuracy within 1 percent (1%) of the span overran ambient operating temperature of 30° F to 140° F.

4. Differential pressure sensors and transmitters used for flow measurement: sized to the flow sensing device and be supplied with the proper shutoff and bleed valves as required.

G. HUMIDITY SENSORS

1. Relative humidity sensors with sensing element rated for the relative humidity range designed into the building environment control system; have an overall accuracy of +/-5% over the range of 30% to 80% RH.

2. Humidity sensors shall be Vaisala 60/70 series.

H. RELAYS

1. Control relays shall be plug-in type rated for the application, equipped with form "C" contacts, in a dustproof enclosure.

2. Relay contacts: silver cadium with a minimum life span rating of one (1) million operations. Contacts shall be sized appropriately for intended use and amperage.

3. Relay coils equipped with coil transient suppression.

I. WIRE AND CABLE

1. General: provide wire and cable including communication media not included as part of the work of another contract.

2. Control Wiring

   a. Control wiring for Digital Functions: 22 AWG minimum with 600 volt insulation.
   b. Control wiring for Analog Functions: 22 AWG minimum with 600 volt insulation, shielded 2 or 3 wire to match analog function hardware.
   c. Control wire or cable: shall be installed in an acceptable raceway in accordance with Division 16 Specification.

d. All control wiring and cable shall be plenum rated.
e. All control wiring and cable shall be color coded “purple”.

J. FIELD EQUIPMENT PANELS

1. Panels shall be prewired and piped and house all controls, transducers, transformers, relays, switches, Din rails, etc., to coordinate BAS components to achieve specified Direct Digital Control (DDC) sequences.

2. Provide NEMA 1 type enclosures, factory fabricated steel or aluminum totally enclosed and equipped with a hinged front door having locking latch (plastic or composite enclosures are not acceptable). All cabinet locks shall be keyed alike. BAS contractor shall furnish required number of field equipment panels, located adjacent to SDC's or UDC's, as necessary to accommodate all panel mounted field equipment.

K. SMOKE DETECTORS

1. Furnished and installed by Division 26 Contractor. TCC shall supervise detector installation locations and wire into fan circuits; arranged to stop unit fan(s) upon alarm activation. Send an alarm to the BAS.

L. CURRENT SENSING RELAYS

1. Sensing relay shall be a solid state electronic device with split-core design to eliminate the need to remove power conductor for installation or servicing.

2. Amperage rating of 0-135 Amps for large loads and 0-10 Amps for small loads.

3. Trip set point shall be adjustable through a “trim potentiometer” built into the current sensor. Provide a trip LED.

4. Sensor supply current is induced from monitored conductor. Minimum conductor current required is 2 Amps. Provide a power LED to indicate that power is available at the current sensing relay.

5. Sensor shall have 600 VAC ms isolation.

6. Current sensor shall be Veris Hawkeye Model H722.

2.14 OUSTIDE AIR CO_2 SENSOR

A. Confirm outside air levels of CO_2 using Telaire 7001 unit. Install on north side of building adjacent to the master outdoor air temperature sensor.

2.15 AMBIENT AIR WATER VAPOR SENSOR (MASTER AMBIENT SENSOR)

A. Provide one ambient air water vapor sensor in suitable enclosure mounted on north wall of building to measure outside air wet bulb temperature.

B. Vapor sensor to have heated diffusion based sampling enclosure for low temperature (-20°F) operation.

C. Vapor sensor will be use to index all air handling units to economizer mode.

D. Vapor sensor shall be like Telair 1551 or equal.

E. Provide calibration kit like Telair 2075.

PART 3 - EXECUTION

3.1 GENERAL

A. Make all final adjustments to system as many times as necessary to achieve proper operation before turning over to Owner.

B. Check all instruments for proper location and operation. Final checkout shall be by qualified person other than installing personnel. He shall submit letter stating that he has checked out system and found it satisfactory.

C. Furnish installation instructions for equipment to be installed by others.

D. Provide wiring diagrams and check installation and furnish all controls and relays to accomplish electric control and interlocking of equipment when it is specified.

E. Location, size, capacity, mounting arrangement and electrical characteristics of equipment shall be as noted on drawings.

F. All wiring in connection with temperature control system shall be provided by Temperature Control Contractor. Term "wiring" shall be construed to include furnishing of wire, conduit, miscellaneous material and labor as required for mounting and connecting electrical control devices.

G. Dampers, valves, pressure taps, and separable sockets shall be set by others.

H. Mount instruments where they can be easily read and where readings will be truly representative.

3.2 PANEL INSTALLATION

A. Provide and install Control Panels (NEMA 1) for all primary HVAC equipment, DDC controllers and control components. Unitary controllers may be installed within the HVAC terminal equipment enclosures or controls sections.

B. Primary HVAC temperature control panels shall not be installed above ceilings or in non-accessible areas of the facility. Locate all panels in Mechanical Rooms, Storage Rooms as approved by the Owner and Engineer.

C. All BAS panels shall have din rails and plug-in relays (with indicator light). Relays-in-a-box (RIB’s are not acceptable).

D. All BAS panels shall have compartments and dividers to separate power wiring from communication wiring within the panels.

3.3 DIRECT DIGITAL WIRING INSTALLATION

A. All shield to be grounded at the DDC panel, shields at the sensors or transducers to be folded back and taped.

B. All digital input and output signal wiring between field devices and panel must be "continuous run". No splices will be permitted. Connections (including shield) must be soldered and taped. Signal integrity must be checked with an oscilloscope and appropriate signal generator and lines so tagged. Inform the Engineer of any such work before implementation.

C. All 24 volt and 120 volt wiring in boiler rooms, fan rooms and tunnels shall be run in galvanized rigid steel (GRS) conduit. All wiring in finished areas of existing building shall be routed concealed. If wiring is incorporated in concrete pours or block walls it will be installed in EMT or PVC raceway. Reference Division 16 for additional conduit and wiring requirements.

D. Control wiring shall be routed in cable trays or be supported from J-hooks. Do not route cable diagonally across the building.

E. Control wire and cable shall be run in continuous lengths from control point to control point with no splices allowed.

F. Control shall not be routed in the same conduit as power.

G. At Contractor's option, all wiring above accessible lay-in ceiling may be run with plenum rated cable, as permitted by code, properly supported from the building structure. If this option is selected, all cables in inaccessible areas, such as walls, floors and inaccessible ceilings and all wiring in Mechanical Equipment areas shall be in conduit.

H. Running bar wire above bare joist in roof/floor metal deck flutes is not permitted. Wire to be run above bottom chord of truss and supported with J-hooks and wire ties at maximum 4' o.c.

I. Provide all wire, conduit, fittings, miscellaneous materials and labor as required for mounting and connecting the electrical control devices furnished in this contract.

J. All wiring shall be continuous from point to point. No splicing between terminations allowed.

K. All temperature control wiring in boiler rooms, fan rooms and tunnels shall be in rigid conduit. Temperature control wiring run exposed in other rooms shall be installed in EMT conduit. Control wiring run in concealed accessible areas such as lay in ceiling can be plenum rated cable. Control wiring run in concealed inaccessible areas such as above a plaster or dry wall ceiling shall be run in conduit.

3.4 SUPERVISION AND ADJUSTMENT

A. The automatic temperature control shall supervise the installation of equipment which is furnished by him for installation by others. He shall check, calibrate and adjust the entire automatic control system, under this project and place it into satisfactory operating condition subject to the approval of the Owner, maintenance personnel and Engineer.

3.5 DIAGRAMS

A. Upon completion of work, provide complete, accurate and approved as-built diagrammatic blueprinted layouts of the automatic control system specified herein and as installed. Layouts shall show all control

equipment and the function of each system shall be indicated. One set of these drawings, layouts and descriptions shall be installed in each system control panel.

3.6 COMPLETION

A. Demonstration and Training

1. Reference Specification Section 01 79 00: Demonstration and Training

B. Temperature Control Contractor shall provide Owner with a video tape (VHS Format) of all training sessions.

C. From the date of substantial completion, the Temperature Control Contractor shall provide the Owner with a paid-up twelve month service contract to cover the entire temperature control system including full coverage of all labor and material. This will include visits to the job site to perform training sessions, routine maintenance on control components and other repairs as required. After each visit a written report shall be submitted. Schedule and coordinate all visits with the Owner's HVAC and Control Supervisor.

D. Prior to final inspection, this Contractor shall perform the following service work, including, but not limited to , the following items:

1. Check and/or oil all electric motors furnished under control system.
2. Lubricate all damper bearings as required.
3. Lubricate all damper bearings as required.
4. Lubricate valve stems, as required, check packing; repair as required.
5. Calibration of all instruments.
6. Checking and verifying all circuitry.
7. Calibrate and check out all controllers, fusing, etc.
8. Run software through program diagnostics and debug as required.

E. When the work is completed and a time directed by the Owner and/or Architect/Engineer, the Contractor shall carefully adjust all parts of the equipment and systems. This includes adjustment of automatic controls and safety devices, proper setting of adjustable devices, dampers and valves, and all other necessary operations so the systems are fully operable and automatic in operation. Upon completion of this work, notify the Owner and/or Architect/Engineer that system is ready for final tests and inspections.

F. At the time of final inspection, this Contractor shall be represented by a person of authority. He shall demonstrate, as directed by the Architect/Engineer, that his work fully complies with the purpose and intent of the specifications and drawings. All labor, services, instruments and tools necessary for demonstrations and tests shall be provided by the Contractor.

G. The Contractor shall test and adjust each instrument specialty and equipment, furnished by him, prior to final acceptance. The Contractor shall demonstrate that all subsystems operate as s coordinated and properly functioning integrated system to the approval of the Architect/Engineer.

H. The Contractor shall furnish all labor, provide all adjustments and incidentals necessary to obtain the desired and intended results.

3.7 AS-BUILT DRAWINGS

A. Include the Following:

1. AutoCad or Visio files updated to as-built conditions. PDF files of drawings on disk for Owner's use.
2. System schematics and wiring diagrams.
3. Programming disks for Owner's use (2 copies).
4. All product and equipment data cut sheets.
5. Valve, damper, VFD and motor schedules.

END OF SECTION 23 09 00

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Duct Liner.
3. Round ducts and fittings.
4. Dual wall insulated duct and fittings
5. Access doors
6. Sheet metal materials.
7. Sealants and gaskets.
8. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" 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" and performance requirements and design criteria indicated.

1. Static-Pressure Classes:

a. Supply Ducts (Upstream from Air Terminal Units): 2-inch wg.
b. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
c. Supply Ducts (Constant Volume Systems): 2-inch wg. (warehouse)
d. Return Ducts (Negative Pressure): 2-inch wg.
e. Exhaust Ducts (Negative Pressure): 1.5-inch wg.

2. Leakage Class:

a. Round Flat Over Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
b. Rectangular Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
c. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.

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"

1.3 SUBMITTALS

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

B. Shop Fabrication Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
13. The construction documents are not fabrication drawings and are not intended to show all offsets as required for proper ductwork installation. Contractor to field verify all existing conditions and prepare fabrication drawings based on existing conditions. All additional offsets shall be included in bid price.
14. Submit 2 copies of sheetmetal fabrication drawings to Testing and Balancing Contractor for his review prior to submitting to engineer.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

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

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels
    f. Piping
    g. Technology Devices

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DUCT LINER

A. Where noted on Drawings, this Contractor shall insulate inside of duct with liner.

B. All exposed leading edges and transverse joints shall be neatly butted without gaps. All edges shall be factory coated. All field cut edges shall be coated with approved coating/sealant. Manville Superseal Permacote or equal.

C. Nominal insulation thickness to be 1”

D. Insulation density shall be 1 ½ #/cu. ft.

E. Insulation shall have an air stream surface with an acrylic coating and a biocidal component, which satisfies the requirements of ASTM C1071 – “Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Liner Material).” The material must not support the growth of mold and fungi when tested in accordance with ASTM C665. NBFU approved. All components of duct liner insulation must not exceed 25 flame or 50 smoke developed ratings.

F. Manufacturers:

1. K-Flex USA Duct Liner Gray(Closed Cell)
2. Knauf Duct Liner EM
3. JohnsManville Linacoustic RC
4. Approved equal.

2.3 KITCHEN HOOD EXHAUST DUCTWORK

A. All kitchen hood exhaust ductwork serving Type I hoods shall be black welded steel. Fire rated spray coating as applied by Conquest FireSpray also acceptable. Submit duct fabrication drawings showing all elements of the grease duct system.

B. Provide code required duct slope, clearances to combustibles, and duct cleanouts for grease cleanout as required by the International Mechanical Code and NFPA. All cleanout shall be easily accessible.

2.4 ROUND DUCTS AND FITTINGS

A. See Floor Plans for dual wall duct requirements.

B. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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

a. Lindab Inc.
b. McGill AirFlow LLC.
c. SEMCO Incorporated.
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.
f. United Sheet Metal.
g. LaPine
h. Eastern Sheet Metal

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Dual-walled ductwork shall have “paint-grip” finish. Ductwork will be field painted.

2.5 DUAL WALL INSULATED DUCT AND FITTINGS

A. General

1. Construct to pressure classification as noted in Part 1 of this specification section.
2. Construction in general shall be comprised of an airtight, outer pressure shell, a 1" insulation layer and perforated metal inner liner that completely covers the insulation throughout the system.
3. Insulation shall have the following UL maximum rating: Flame Spread 25; Smoke Developed 50.
4. Outer pressure shell and inner liner shall be manufactured from galvanized steel, meeting ASTM A-527-67 in following minimum gauges:

NOMINAL DUCT SIZE	3-6"	7-20"	21-34"	35-48"	49"&UP
Duct-Outer Pressure Shell	26*	24*	22*	20*	16**
Duct-Inner Perforated Liner	24*	24*	24*	24*	20
Fitting-Outer Pressure Shell	20	20	20	18	16
Fitting-Inner Perforated Liner	20	20	20	20	20

* Gauges if made from spiral duct
** Longitudinal seam, continuous butt weld

5. Divided flow fittings are to be made as separate fittings, not tap collars into duct sections, with the following construction requirements:

   a. Sound airtight continuous welds at intersection of fitting body and tap.
   b. Tap liner securely welded to inner liner with weld spacing not to exceed 3”.
   c. Insulation to be packed around branch tap area for complete cavity filling.
   d. Branch connection is to be carefully fit to cut- out openings in inner liner without spaces for air erosion of insulation or sharp projections for noise and air flow disturbances.

6. All seams in pressure shell of fittings are to be continuous welded. Galvanized areas that have been damaged by welding shall be coated with corrosion resistant aluminum paint.
7. Perforations are not to exceed 3/32" diameter.
8. Inner liners of both duct and fittings are to be adequately supported by metal spacers welded in position to maintain spacing and concentricity.

B. Coupling: an inner coupling should be provided to align the inner lining to maintain good air flow conditions equivalent to standard round high pressure duct joints. Butt joints are not suitable for inner liner. This alignment may be accomplished by liner of fitting for slip-joint into pipe or by use of double, concentric coupling with two couplings held by spacers for rigidity and wall spacing. Above 34" I.D., a separate coupling should be provided for inner alignment with pressure shells joined by angle ring flanged connections.

C. Insulation Ends: at end of an insulated section or run, where internally insulated duct connects to uninsulated spiral duct or fitting, fire damper or flex, an insulation end fitting shall be installed to bring the outer pressure shell down to nominal size.

D. All dual wall duct to have mill phosphate finish for painting.

E. Flat Oval Dual Wall Duct and Fitting

1. Within available sizes, flat oval internally insulated duct shall be manufactured from spiral flat oval duct in the following U.S. Standard gauge galvanized steel:

NOMINAL DUCT WIDTH	TO 22”	23-46”	47-72”
Duct-Outer Pressure Shell	24 ga.	22 ga.	20 ga.
Inner Perforated	24 ga.	24 ga.	24 ga.

2. Bracing and reinforcement are to be as recommended by manufacturer for size and pressure conditions in duct. Joints shall be made by using an alignment coupling to connect liners. Pressure shells of ducts below 42" Major Axis dimensions shall be joined by reinforced 18 gauge couplings. Bolted angle flanges with neoprene gaskets shall be used to join pressure shells for ducts above 42" in width.
3. Dual wall flat oval ductwork for sizes not available in spiral construction shall be manufactured in 4' modular sections to the following minimum galvanized metal gauges:

NOMINAL DUCT WIDTH	TO 34”	35-38”	49”&UP
Duct-Outer Pressure Shell	20 ga.	18 ga.	16 ga.
Inner Perforated Liner	20 ga.	20 ga.	18 ga

4. When maximum width of oval duct exceeds 40" or when maximum height exceeds 26" angle iron companion flanges shall be welded to outer shell for stiffness and assembly. Alignment of inner lining shall be by reinforced slip-joint couplings of 18 gauge minimum. Flat oval duct below size limits shall be assembled by double slip-joint couplings formed from 18 gauge sheet metal secured together by welded spacers.
5. Manufacturers: Subject to compliance with requirements, provide products by on of the following:

    a. Lindab Inc.
    b. McGill Air Flow LLC.
    c. SEMCO Incorporated
    d. Sheet Metal Connectors, Inc.
    e. United Sheet Metal
    f. LaPine
    g. Eastern Sheet Metal

2.6 ACCESS DOORS (AD)

A. Construction - steel with 1/2" of fiberglass insulation between door and door pan. Sponge rubber gasketing to be on inside of door frame and between duct and door frame. Door metals to be of sufficient gauge for minimizing leakage at various duct pressures. Hinges not to exceed 12" apart and two handle-type latches to be used for sides exceeding 12".

1. Manufacturers:

    a. Ventfrabrics Ventlok Door
    b. Buensod Stacey Type F
    c. Approved equal

2.7 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.8 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.9 HANGERS AND SUPPORTS

A. Hanger Rods for Non-corrosive Environments: Cadmium-plated steel rods and nuts. Clean/degrease for painting where applicable.

B. 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."

C. 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.

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT 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 dual wall insulated duct in exposed areas at noted on Drawings.

C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

D. Install round ducts in maximum practical lengths.

E. Install ducts with fewest possible joints.

F. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a clearance that will allow for insulation thickness.

J. Route ducts so that they do not pass through transformer vaults, electrical equipment rooms, stairwell enclosures and elevator equipment rooms.

K. 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.

L. 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.

M. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

B. Seal Classes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements."

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
2. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
3. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: 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," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports. Clean/degrease where painting is to occur.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as follows:

B. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

C. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

   a. Velocity 1000 fpm or Lower:

      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.

   b. Velocity 1000 to 1500 fpm:

      1) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

   c. Velocity 1500 fpm or Higher:

      1) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

D. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

BLANK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Materials.
2. Counter balanced backdraft dampers.
3. Manual volume dampers.
4. Fire dampers.
5. Smoke dampers.
6. Flange connectors.
7. Turning vanes.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.

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 on ¼" = 1'-0" scale drawings.

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. Control damper installations.
d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.

2. The construction documents are <u>not</u> fabrication drawings and are not intended to show all offsets as required for proper ductwork installation. Contractor to field verify all existing conditions and prepare fabrication drawings based on existing conditions. All additional offsets shall be included in bid price.

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 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 COUNTER BALANCED BACKDRAFT DAMPERS

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

1. Greenheck EM
2. Ruskin CBD2.

B. Description: Gravity balanced with adjustable weights. Adjustable open from .01” to .15”.

C. Frame: 0.090-inch- thick 6063T5 extruded aluminum, with welded corners and 12 gauge brace at each corner.

D. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum with vinyl blade edge seals.

E. Blade Action: Parallel.

F. Blade Axles:

1. Material: Aluminum.
2. Diameter: 0.20 inch.

G. Tie Bars and Brackets: Aluminum.

H. Bearings: Synthetic pivot bushings.

I. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.

J. Sleeve: Minimum 20-gage thickness.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. Flexmaster U.S.A., Inc.
d. McGill AirFlow LLC.
e. METALAIRE, Inc.
f. Nailor Industries Inc.
g. Ruskin Company.
h. Greenheck.
i. Vent Products Company, Inc.

2. Suitable for horizontal or vertical applications.
3. Frames:

a. Hat-shaped, galvanized-steel channels, 16 ga. 0.064-inch minimum thickness.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

a. Multiple(min. 16 ga) or Single blade(min. 20 ga)
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized-steel

5. Blade Axles: Galvanized steel.
6. Bearings:

a. Oil-impregnated bronze.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:

1. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
2. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 1/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Airstream
3. Arrow United Industries; a division of Mestek, Inc.
4. Cesco Products; a division of Mestek, Inc.
5. Greenheck Fan Corporation.
6. METALAIRE, Inc.
7. Nailor Industries Inc.
8. American Warming & Ventilating.
9. Prefco; Perfect Air Control, Inc.
10. Ruskin Company.
11. Vent Products Company, Inc.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 14 gauge and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated fusible links.

2.5 SMOKE DAMPERS

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

1. Advanced Air
2. Air Balance Inc.; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. NCA Manufacturing.
7. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel.

F. Leakage: Class II.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 14 gauge, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: Two-position action mounted out of air stream. Motors to be 120V, power open, spring closed design.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections contained in these specifications.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 20 deg F.
6. Electrical Connection: 115 V, single phase, 60 Hz.

K. Accessories:

1. Auxiliary switches for signaling or position indication.
2. Test and reset switches, damper mounted.

2.6 FLANGE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.7 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. 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.

C. 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."

D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

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

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Flexmaster U.S.A., Inc.
5. Greenheck Fan Corporation.
6. McGill AirFlow LLC.
7. Nailor Industries Inc.
8. Buensod Stacey Type F.
9. Ventfabrics, Inc.
10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

    a. Double wall, rectangular.
    b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

    a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
    c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
    d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.9 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: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 20 to plus 200 deg 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. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 20 to plus 250 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.10 FLEXIBLE DUCTS

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

1. Wiremold Type 86-C.
2. Aircon-Duct.
3. Flexmaster U.S.A., Inc.
4. McGill AirFlow LLC.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 1-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.

C. Flexible Duct Connectors:

1. Clamps and Sheetmetal Screws: Nylon strap in sizes 3 through 18 inches with 3 sheetmetal screws to prevent blow-off of duct, to suit duct size.
2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

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 ducts and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at outlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and fire/smoke dampers according to UL listing.

H. 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. Downstream from manual volume dampers, control dampers and equipment.
3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
4. At each change in direction and at maximum 50-foot spacing.
5. Upstream of turning vanes.
6. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Section 20 00 50.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct rated at 10” static, strapped in place with 3 sheetmetal screwsto keep straps from blowing off ducts. Do not use flexible ducts to change directions.

O. Connect diffusers or light troffer boots to low-pressure ducts with maximum 36-inch lengths of flexible duct (rated at 4” static) strapped in place.

P. Connect flexible ducts to metal ducts with draw bands plus sheet metal screws.

Q. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Centrifugal roof ventilators.
2. Ceiling-mounting ventilators.
3. In-line centrifugal fans.
4. Motors.

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. Field quality-control test reports.

D. 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. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

C. UL Standard: Power ventilators shall comply with UL 705.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

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

1. Greenheck.
2. Loren Cook Company.

B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top or upblast arrangement with square, one-piece, aluminum base with venturi inlet cone.

1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance when scheduled on the Drawings.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.
5. Belt tensioner.

F. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. As scheduled on the Drawings.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in cant and mounting flange.
2. Overall Height: 20 inches or as scheduled on the Drawings.
3. Pitch Mounting: Manufacture curb for roof slope when required.
4. Metal Liner: Galvanized steel.
5. Provide welded curb adaptors as scheduled on the Drawings.

2.2 CEILING-MOUNTING VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck.
2. Loren Cook Company.

B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:

1. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link when scheduled on the Drawings.
2. Isolation: Rubber-in-shear vibration isolators.
3. Manufacturer's standard roof jack or wall cap, and transition fittings.
4. As scheduled on the Drawings.

2.3 IN-LINE CENTRIFUGAL FANS

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

.

1. Greenheck.
2. Loren Cook Company.

B. Description: In-line, direct or belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Housing: Square metal with inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Driven Units: Motor mounted in airstream.

E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

G. Accessories:

1. Backdraft damper in fan outlet.
2. Companion Flanges: For inlet and outlet duct connections.
3. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
4. Removable panels for access to internal parts.
5. Factory wired disconnect switch located on outside of fan housing.
6. As scheduled on the Drawings.

2.4 MOTORS

A. Comply with requirements in Division 20, Section 20 00 50.

B. Enclosure Type: Totally enclosed, fan cooled.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

C. Ceiling Units: Suspend units from structure; use all-thread rod or metal straps.

D. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 20, Section 20 00 50.

E. Install units with clearances for service and maintenance.

F. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

G. Install ducts adjacent to power ventilators to allow service and maintenance.

H. Ground equipment according to Division 26 Specifications.

I. Connect wiring according to Division 26 Specifications.

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 233423

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 the following:

1. Variable Air Volume Box with Electric Heating Coil (VAV).

1.3 SUBMITTALS

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

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data" include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.5 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 VARIABLE AIR VOLUME BOXES WITH HEATING COIL(VAV)

A. For capacity and size see Equipment Schedule on drawings.

B. Casing: 26 gauge dual wall galvanized steel. Provide factory installed dual wall access door in the bottom panel of each VAV box furnished with a heating coil.

C. Insulation of terminal units shall be ½" thick, 1-1/2# density fiberglass between dual walls. Insulation must be UL approved and meet NBFU and NFPA 90A requirements.

D. Air Control valve: shall seal against gasketed stops for minimum leakage. Maximum and minimum mechanical stops shall be provided. Total leakage of casing and valve shall not exceed 1% at 3" inlet static pressure.

E. VAV Control Options:

Air Flow Sensor: Integral multiple point air flow sensor to provide primary air flow within ±10% at 400 FPM air flow. Provide integral flow taps and calibration chart with each unit.
Damper Actuator and Controller shall be provided by Temperature Control Contractor and installed by the VAV box manufacturer. Actuator shall provide tight close off to 100% open. Coordinate exact requirements with Temperature Control Contractor (TCC).
Factory install controller as provided by and directed by TCC. Installation of TC's controller shall include, but not be limited to, mounting controller, damper actuator and pneumatic tubing to air flow sensor. Filter for pneumatic tubing will be provided by TCC.
Cost to install control components shall be born by VAV manufacturer.

Electric Heating Coil

a. Electric coils shall be supplied and installed on the terminal by the terminal manufacturer. Coils shall be ETL listed. Coils shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5 inches to prevent damage to elements during shipping and installation. Elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 3.5 inches apart, staggered for maximum thermal transfer and element life and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with hinged access door for access to all controls and safety devices.

b. Electric coils shall contain a primary automatic reset thermal cutout, a secondary manual reset thermal cutout, differential pressure airflow switch for proof of flow, and line terminal block. Unit shall include an optional integral door interlock type disconnect switch that will not allow the access door to be opened while power is on. Non-interlocking type disconnects are not acceptable. All individual components shall be UL listed
c. or recognized.

d. Optional Standard SCR Electric Heat
e. Proportional, modulating electric coils shall be supplied and installed on the terminal by the terminal manufacturer. Coils shall be ETL listed. Coils shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5 inches to prevent damage to elements during shipping and installation. Elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 3.5 inches apart, staggered for maximum thermal transfer and element life, and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with hinged access door for access to all controls and
f. safety devices.

g. Electric coils shall contain a primary automatic reset thermal cutout, a secondary manual reset thermal cutout, proportional electronic airflow sensor for proof of flow, and line terminal block.

F. Manufacturers:

1. Trane
2. Envirotec
3. Carrier
4. Titus
5. Price
6. Nailor Industries

2.2 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Connect ducts to air terminal units according to other Division 23 Sections.

D. Connect wiring according to Division 26 Specifications.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
2. Verify that controls and control enclosure are accessible.
3. Verify that control connections are complete.
4. Verify that nameplate and identification tag are visible.
5. Verify that controls respond to inputs as specified.

END OF SECTION 233600

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 ceiling- and wall-mounted diffusers, registers, and grilles.

This Section includes but is not limited to:

1. Grilles and Registers
2. Grilles – Aluminum Eggcrate Returns
3. Grilles – Filter Grille
4. Ceiling Diffuser Outlets
5. Louvers

B. Related Sections include the following:

1. Division 08 Section “Louvers and Vents” for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each 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 AND REGISTERS

A. Manufacturers:

1. Anemostat; a Mestek Company.
2. Carnes.
3. Krueger.
4. Nailor Industries of Texas Inc.
5. Price Industries.
6. Titus.

B. Capacity and size as noted on Drawings.

C. Constructed of heavy gauge steel or aluminum.

D. Finish to be factory white enamel paint.

E. Metal plaster frames: for grilles mounted on plaster, masonry, fiber or metal construction surfaces.

F. Volume Damper: Opposed blade operable through face of grill on supply registers only. Not required on return or exhaust.

G. Deflecting Blades: 3/4" deep, streamline. Single or double deflection as noted. Horizontal blades always mounted nearest grille face.

H. Supply Grilles: sponge rubber gasket, double deflection.

I. Return Grilles: single deflection blades fixed at 45° down.

J. Exhaust Grilles: single deflection blades fixed at 45° down.

2.2 GRILLES – ALUMINUM EGGCRATE RETURN

A. Manufacturers:

1. Titus
2. Price
3. Carnes
4. Anemostat
5. Krueger
6. Nailor

B. 1/2" x 1/2" x 1/2" louvers.

C. Finish to be factory white enamel paint.

D. Where grilles are mounted in exposed (inverted) T bar ceilings, the grille flange to be concealed leaving only the T bar exposed.

E. All other grilles to be complete with extruded aluminum border flange.

2.3 GRILLES – FILTER GRILLES

A. Manufacturers:

1. Price
2. Titus
3. Carnes
4. Anemostat
5. Krueger
6. Nailor

B. Construction

1. 45 or 38 degree fixed blades spaced on ½" centers.
2. Grill to drop down to change filter – hinged on one side with ¼ turn quick release fasteners on opposite side.
3. Designed for 1" filter media complete with holding frame.
4. Blades to run parallel to long dimension.
5. Provide filter media for filter changes as specified in 20 00 10
6. Fabricated from steel.

C. Installation

1. Filter grilles used to filter return air on terminal units such as Fan Coils.
2. When grilles installed in ceiling, install grilles so blades are angled toward wall to minimize visibility of filter.
3. When grilles installed in wall put hinge at bottom. Blades to angle up toward front of grill, so that when looking up at grill from floor, filter is not visible.
4. See details on drawings for additional information.

2.4 CEILING DIFFUSER OUTLETS

A. Round Ceiling Diffuser:

1. Manufacturers:

   a. Anemostat
   b. Carnes
   c. Nailor Industries of Texas Inc.
   d. Price Industries
   e. Titus
   f. Krueger

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Style: Three cone.
5. Pattern: Fully adjustable.
6. Dampers: Spiral type in neck of diffuser adjustable through face of diffuser.
7. Accessories:

   a. Plaster ring (when applicable).

B. Rectangular and Square Ceiling Diffusers:

1. Manufacturers:

   a. Anemostat
   b. Carnes
   c. Krueger
   d. Nailor Industries of Texas Inc.
   e. Price Industries
   f. Titus

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Size: As scheduled on the Drawings.
5. Mounting: Surface, T-bar or Snap in. Reference Architectural drawings for ceiling type.
6. Pattern: Adjustable.
7. Dampers: Spiral type in neck of diffuser adjustable through face of diffuser.
8. Accessories:

    a. Plaster ring (when applicable).

9. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

2.5 LOUVERS

A. 4" Extruded Aluminum Louvers 50% FA

1. Factory fabricated nominal 4" width frame for recess mounting (no flange overlap).
2. Blades: 6063T5 alloy minimum cross section .080", two weather stops. All blades longer than 36" to have concealed vertical bracing.
3. Frame: same material and thickness as blades.
4. Screen: ½" mesh, .047" wire. Located screen behind blades, screen permanently attached.
5. Louver and screen constructed of aluminum.
6. Louvers to have minimum of 50% free area.
7. Manufacturers:

    a. Greenheck
    b. Airflex Model SL Frame #2
    c. Carnes Model L-30
    d. Vent Products Type VSL-4
    e. Air Guide OL-4
    f. Ruskin

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

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PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Listed double-wall gas vents.

1.2 SUBMITTALS

A. Product Data: For the following:

1. Type B and BW vents.
2. Positive pressure special gas vents.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

PART 2 - PRODUCTS

2.1 GAS VENT – DUAL WALL POSITIVE PRESSURE

A. Provide type ‘B’ vent for water heater and positive pressure vent for boilers. Intake vents constructed of Schedule 40 CPVC piping.

B. Flue vents shall be a factory-built, all metal, pressure sealed chimney system using a combination of modular components for a complete installation.

C. For boilers, the vent pipe shall have an inner pipe constructed of type AL29-4C stainless steel with a 0.035" minimum wall thickness. The outer jacket shall be constructed of aluminized steel. The outer jacket surrounds the inner pipe with a one (1) inch insulating air space. Minimum wall thickness for outer jacket shall be 0.025". Provide special alloys as required by the boiler manufacturer.

D. The vent system shall be listed by UL and having passed UL tests for thermal shock, temperature tests and structural integrity. System shall be rated for use up to 1400^{o}F.

E. The vent system material shall be specifically designed to work with the boilers and water heater being provided.

F. The vent system shall be complete with guides at roof penetration for lateral support.

G. All flanged joints shall be sealed to prevent water leakage.

H. Provide a complete, dimensioned shop drawing with a complete parts list to the Engineer for review prior to fabrication.

I. Provide the following options:

1. Roof Curb or Roof Thimble.
2. Storm Collar.
3. Rain Cap.

J. Manufacturers:

1. Metalbestos
2. Metal Fab
3. Ampco
4. General Products Co., Inc.
5. Van Packer
6. Heat Fab

PART 3 - EXECUTION

3.1 APPLICATION

A. Listed Type B and BW Vents: Vents for certified gas appliances.

B. Listed Special Gas Vents: Condensing gas appliances.

3.2 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. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. Lap joints in direction of flow.

F. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

G. 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.

H. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 235100

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Gas fired heat exchanger.
3. Economizer outdoor- and return-air damper section.
4. Hot Gas/Hot Liquid Dehumidification Coil
5. Roof curbs.

1.2 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

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. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and maintenance data.

E. Warranty.

1.3 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTU’s.
2. Comply with ARI 270 for testing and rating sound performance for RTU’s.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigerant system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.

C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

D. UL Compliance: Comply with UL 1995.

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.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTU's that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: 5 year parts warranty for all compressors.
2. Warranty Period for Gas Furnace Heat Exchangers: 10 year parts warranty on all units from date of Substantial Completion.
3. Warranty Period for Entire Unit: 1 year parts and labor from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation.
2. Trane; American Standard Companies, Inc.
3. Lennox Industries Inc.
4. Bryant
5. York-Johnson Controls

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels shall be provided on units as indicated on the schedule. Double wall units shall have fiberglass insulation sandwiched between heavy gauge steel sheets to form a durable, rigid casing to withstand higher working pressures and impact forces. Double wall casing shall eliminate erosion of insulation material and contamination of the air stream.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

C. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 1/2 inch.
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

D. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple both sides of drain pan.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

2.3 FANS

A. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or

painted-steel wheels, and galvanized- or painted-steel fan scrolls. Fans housings shall be isolated from unit.

B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

C. Fan Motor: Comply with requirements in Division 20 Section "Common Materials and Methods for Fire Suppression, Plumbing and HVAC."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: As indicated on equipment schedule.

B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.

C. Refrigeration Specialties:

1. Refrigerant Charge: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. 2” Pleated: Minimum 30 percent arrestance, and MERV 7.

2.7 GAS FIRED HEAT EXCHANGER

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel with a minimum thermal efficiency of 80 percent.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

C. Heat-Exchanger and Drain Pan: Aluminized Steel.

D. Venting: Gravity vented with vertical extension flue shield.

E. Safety Controls:

1. Gas Control Valve: Minimum of Two stages.
2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 100 percent outdoor air, with damper filter.

B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit.

2.10 CONTROLS

A. Thermostats for single zone rooftop unit applications shall be for use with respective unit stage configuration. No substitutes. See drawings for locations.

B. DDC Controller:

1. Controller shall have volatile-memory backup.
2. Safety Control Operation:

   a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
   b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
   c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 28 Section "Fire Detection and Alarm."

3. Unoccupied Period:

   a. Heating Setback: 10 deg F.
   b. Cooling Setback: System off.
   c. Override Operation: Three hours.

4. Supply Fan Operation:

    a. Occupied Periods: Cycle fan to maintain occupied temperature.

    b. Unoccupied Periods: Cycle fan to maintain setback temperature.

5. Refrigerant Circuit Operation:

    a. Occupied Periods: Cycle or stage compressors to match compressor output to cooling load to maintain discharge temperature. Cycle condenser fans to maintain maximum hot-gas pressure.
    b. Unoccupied Periods: Compressors off.

6. Gas Furnace Operation:

    a. Occupied Periods: Modulate burner to maintain discharge temperature.
    b. Unoccupied Periods: Cycle burner to maintain setback temperature.

7. Fixed Minimum Outdoor-Air Damper Operation:

    a. Occupied Periods: Open to 25 percent or as scheduled.
    b. Unoccupied Periods: Close the outdoor-air damper.

8. Economizer Outdoor-Air Damper Operation:

    a. Occupied Periods: Open to 100 percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. During economizer cycle operation, lock out cooling.
    b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

2.11 ACCESSORIES

A. Powered 110 Volt Convenience Outlet: Outlet shall come from factory installed and powered by a stepdown transformer so it can be used whether or not the unit is operating.

B. Hinged access panels.

C. Unit mounted non-fused disconnect switch.

2.12 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards. Gas and electrical connections shall be through the curb.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

    a. Materials: ASTM C 1071, Type I or II.
    b. Thickness: 2 inches.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

a. Liner Adhesive: Comply with ASTM C 916, Type I.
b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
d. Liner Adhesive: Comply with ASTM C 916, Type I.

B. Curb Height: 14 inches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Roof Curb: Install on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

C. For horizontal discharge applications, provide flexible canvas duct connection to isolate ductwork from unit.

D. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain. Provide suitable pipe supports as required.

E. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply du cts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.
5. For horizontal discharge applications, manufacturer and mechanical must demonstrate that ductwork arrangement can be such that predetermined penetrations to the precast wall assemblies can be achieved. Sheet Metal Contractor to submit drawing to Engineer for review prior to installation. Close coordination with General Contractor will be required.

3.2 FIELD QUALITY CONTROL

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

B. 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. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.3 CLEANING AND ADJUSTING

A. 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 site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

END OF SECTION 237413

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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 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 SO.

1. Refer to Division 26 Section “Identification for Electrical Systems” for factory applied insulation color for service, feeders and branch circuit conductors.

C. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC and Type SO with ground wire.

2.2 CONNECTORS AND SPLICES

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

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway.

B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-2-THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway.

F. Exposed Branch Circuits: Type THHN-2-THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-2-THWN-2, single conductors in raceway.

I. Branch Circuits Installed below Raised Flooring: Metal-clad cable, Type MC.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and below floors, unless otherwise indicated.

B. 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.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. 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.

H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

END OF SECTION 260519

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. RS-485 cabling.
2. Low-voltage control cabling.
3. Control-circuit conductors.
4. Identification products.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with flat white latex paint. Comply with requirements in Section 099112 "Painting (Professional Line Products)."

2.4 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, one and two pair, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, one and two pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

2.5 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One-pair and multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One-pair and multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.6 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway; and power-limited cable, concealed in building finishes; complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway; and power-limited cable, concealed in building finishes; and Type TW or Type TF, in raceway; complying with UL 83.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
2. Flexible metal conduit shall not be used.

B. Install manufactured conduit sweeps and long-radius elbows if possible.

C. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the 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.

D. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70.

B. General Requirements for Cabling:

1. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
2. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. 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.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
7. Support: Do not allow cables to lay on removable ceiling tiles.
8. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

E. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.

3. 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 or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.

4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.5 FIRESTOPPING

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

3.6 GROUNDING

A. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

B. End-to-end cabling will be considered defective if it does not pass tests and inspections.

END OF SECTION 260523

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PART 1 - GENERAL

1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.

1.2 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Ground rods.
2. Ground rings.

B. Field quality-control reports.

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 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 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL 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.

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

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

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

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches below grade.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors.
3. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Pad-Mounted Transformers: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

C. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.5 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. 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 bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Installbonding jumper to bond across flexible duct connections to achieve continuity.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

G. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building's foundation.

H. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

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

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. 120/208 V Panelboards: 1 ohm(s).

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

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PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.4 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

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. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
2. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

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

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

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

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

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 scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

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

D. Use one-hole or two-hole straps to secure conduit and EMT.

1. 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 SLOTTED SUPPORT SYSTEM APPLICATION

A. Outdoors and Unconditioned Indoor Spaces: Use metallic coated steel slotted support system.

B. Conditioned, Interior Spaces: Use painted steel slotted support system, except in swimming pool and pool equipment rooms.

3.3 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

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

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

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

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

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Comply with requirements in Section 099112 "Painting (Professional Line Products)" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION 260529

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. See Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks and underground handholes, boxes, and utility construction.

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, compression type.

2.2 METAL WIREWAYS

A. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

B. Fittings and Accessories: Include 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.

C. Wireway Covers: Hinged type.

D. Finish: Manufacturer's standard enamel finish.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.

E. Nonmetallic Floor Boxes: Nonadjustable, round.

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

G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

H. 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.
2. Nonmetallic Enclosures: Plastic.

I. 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: Refer to Section 260543 “Underground Ducts and Raceways for Electrical Systems.”

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC. Includes raceways in the following locations:

    a. Mechanical rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: Rigid steel conduit.
6. Raceways for Optical Fiber or Communications Cable: EMT.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 1/2-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

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.

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.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

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

F. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

G. Raceways Embedded in Slabs: Not permitted.

H. 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.

I. Raceways for Optical Fiber and Communications Cable: Install as follows:

1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway 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.

J. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

K. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations.

L. 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.

M. Set metal floor boxes level and flush with finished floor surface.

N. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260533

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried duct banks, and in single duct runs.
2. Handholes and boxes.

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. Cover design.
2. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

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: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 DUCT ACCESSORIES

A. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.3 HANDHOLES AND BOXES

A. Description: Comply with SCTE 77.

1. Color: Green.
2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC" or "COMMUNICATIONS" as appropriate.
6. 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. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

3.2 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down away from buildings and equipment.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cables."

E. 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.

F. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

G. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during

backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.

3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

10. Warning Tape: Bury warning tape approximately 12 inches above ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank.

3.3 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: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, 36 inches below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.5 CLEANING

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

B. Clean internal surfaces of handholes. Remove foreign material.

END OF SECTION 260543

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

   a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

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

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

    a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

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

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

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 ACTION SUBMITTALS

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

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, 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.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 FLOOR MARKING TAPE

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

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. General Description:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored,compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft..
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.5 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. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.8 CABLE TIES

A. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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 signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Cable Ties: For attaching tags. Use plenum rated type.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trenchexceeds 16 inches overall.

H. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the system voltage and circuit identification.

B. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, 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.

C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, and handholes, use write-on tags with the conductor or cable designation, origin, and destination.

E. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes with the conductor designation.

F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

K. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

L. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

M. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
   b. Enclosures and electrical cabinets.
   c. Access doors and panels for concealed electrical items.
   d. Switchboards.
   e. Emergency system boxes and enclosures.
   f. Enclosed switches.
   g. Enclosed circuit breakers.
   h. Enclosed controllers.
   i. Push-button stations.
   j. Power transfer equipment.
   k. Contactors.
   l. Remote-controlled switches, dimmer modules, and control devices.
   m. Monitoring and control equipment.

END OF SECTION 260553

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:

1. Outdoor photoelectric switches.
2. Stand-alone indoor occupancy sensors with relay-packs.

B. See Division 26 Section "Relay-Based Lighting Controls" for low-voltage, manual and programmable lighting control systems.

C. See Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.

1.2 SUBMITTALS

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

B. Field quality-control test reports.

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 OUTDOOR PHOTOELECTRIC SWITCHES

A. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

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

1. Cooper Controls.
2. Crestron Electronics, Inc.
3. Hubbell Lighting.
4. Leviton Mfg. Company Inc.
5. Sensor Switch, Inc.
6. Watt Stopper (The).

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 15 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. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

C. PIR 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. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy .

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch- high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- high ceiling in a corridor not wider than 14 feet.

E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. 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., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS

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

1. Cooper Controls.
2. Crestron Electronics, Inc.
3. Hubbell Lighting.
4. Leviton Mfg. Company Inc.
5. Sensor Switch, Inc.
6. Watt Stopper (The).

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:

   a. When no daylight is present (target level).
   b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.

   a. Initial setup tool.
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

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

1. Cooper Controls.
2. Crestron Electronics, Inc.
3. Hubbell Lighting.
4. Leviton Mfg. Company Inc.
5. Sensor Switch, Inc.
6. Watt Stopper (The).

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor Tag $1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft..
2. Sensing Technology: PIR.
3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: Dual voltage, 120 and 277 V.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

D. Wall-Switch Sensor Tag $2:

1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..
2. Sensing Technology: PIR.
3. Switch Type: DP, individually field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: Dual voltage, 120 and 277 V.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.5 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 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

B. 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 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 and prepare test reports:

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 260923

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Lighting control panels using mechanically held relays for switching.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. IP: Internet protocol.

C. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

D. PC: Personal computer; sometimes plural as "PCs."

E. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.

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 control modules, power distribution components, relays, manual switches and plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each relay panel 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 wiring partition configuration, current, and voltage ratings.
4. Short-circuit current rating of relays.
5. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

1. Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

1.6 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. Lighting Control Relays: Equal to 10 percent of amount installed for each size indicated, but no fewer than 3.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panels for installation according to NECA 407.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Input signal from field-mounted manual switches, or digital signal sources, shall open or close one or more lighting control relays in the lighting control panels. Any combination of inputs shall be programmable to any number of control relays.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with UL 916.

2.2 PERFORMANCE REQUIREMENTS

A. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.

1. Hardwired Points:

a. Monitoring: On-off status.
b. Control: On-off operation.

2.3 LIGHTING CONTROL RELAY PANELS

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

1. Crestron Electronics, Inc.

B. Description: Standalone lighting control panel using mechanically latched relays to control lighting and appliances.

C. Lighting Control Panel:

1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
2. A vertical barrier separating branch circuits from control wiring.

D. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.

1. Timing Unit:

a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
c. Four independent schedules, each having 24 time periods.
d. Schedule periods settable to the minute.
e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
f. 10 special date periods.

2. Sequencing Control with Override:

a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
d. Override control "blink warning" shall warn occupants approximately five minutes before actuating the off sequence.

3. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation, including accurate time of day and date.

E. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 120-V tungsten, 30 A at 277-V ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA. Control shall be three-wire, 24-V ac.

F. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and photo sensors.

G. Operator Interface:

1. Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.
2. Log and display relay on-time.
3. Connect relays to one or more time and sequencing schemes.

2.4 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.

1. Match color and style specified in Section 262726 "Wiring Devices."
2. Integral green LED pilot light to indicate when circuit is on.
3. Internal white LED locator light to illuminate when circuit is off.

B. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."

C. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.5 FIELD-MOUNTED SIGNAL SOURCES

A. Daylight Harvesting Switching Controls: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

B. Indoor Occupancy Sensors: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Section 271500 "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panels according to NECA 407.

B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways 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 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 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 PANEL INSTALLATION

A. Comply with NECA 1.

B. Install panels and accessories according to NECA 407.

C. Mount top of trim 79 inches above finished floor unless otherwise indicated.

D. Mount panel cabinet plumb and rigid without distortion of box.

E. Install filler plates in unused spaces.

3.4 IDENTIFICATION

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

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Acceptance Testing Preparation:

1. Test continuity of each circuit.

D. Lighting control panel will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from 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.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 260943.23

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Identification.

1.2 SUBMITTALS

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

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
3. Include schematic and wiring diagrams for power, signal, and control wiring.

C. 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 2.

C. Comply with NFPA 70.

D. Comply with UL 891.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Nominal System Voltage: 208Y/120 V, unless otherwise indicated.

D. Main-Bus Continuous: 2000 A, unless otherwise indicated.

E. Enclosure: Steel, NEMA 250, Type 1.

1. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

F. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

G. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

H. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
3. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

I. Phase and Neutral Buses and Connections: Three phase, four wire unless otherwise indicated. Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.

1. Ground Bus: 1/4-by-2-inch- minimum size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors.
2. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
3. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables.

J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. LED indicator lights for power and protection status.
3. Audible alarm, with silencing switch, to indicate when protection has failed.
4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device.
5. Transient-event counter set to totalize transient surges.

B. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.

C. Withstand Capabilities: 5000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

D. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120-V, three-phase, four-wire circuits shall be as follows:

1. Line to Neutral: 800 V.
2. Line to Ground: 800 V.
3. Neutral to Ground: 1000 V.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time time adjustments.
c. Ground-fault pickup level, time delay, and I^2t response.

2.4 INSTRUMENTATION

A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Megawatts: Plus or minus 2 percent.
e. Megavars: Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.5 IDENTIFICATION

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Receive, inspect, handle, store and install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

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

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Install filler plates in unused spaces of panel-mounted sections.

E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

F. Comply with NECA 1.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Use engraved, laminated switchboard nameplates, attached with stainless-steel screws.

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Use engraved, laminated device nameplates, attached with stainless-steel screws.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

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

END OF SECTION 262413

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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. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include wiring diagrams for power, signal, and control wiring.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

C. Operation and maintenance data, including printed and electronic file of panelboard circuit directories.

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 surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Kitchen Areas: NEMA 250, Type 1 with stainless steel covers and trim.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Directory Card: Inside panelboard door, mounted in metal-frame card holder with clear transparent plastic protective window.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses: Tin-plated aluminum.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus Configured Terminators: Mechanical type.

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.

2.2 DISTRIBUTION PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Mains: Lugs only, unless otherwise indicated.

E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only as indicated.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

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 trim 79 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.

E. Install filler plates in unused spaces.

F. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

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. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a engraved, laminate, screw-attached 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. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

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

END OF SECTION 262416

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Weather-resistant receptacles.
4. Snap switches and wall-box dimmers.
5. Pendant cord-connector devices.
6. Floor service outlets.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. UTP: Unshielded twisted pair.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).

2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5361 (single), AH5362 (duplex).
b. Hubbell; HBL5361 (single), HBL5362 (duplex).
c. Leviton; 5891 (single), 5362 (duplex).
d. Pass & Seymour; 5361 (single), 5362-A (duplex).

B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; TR8300.
b. Hubbell; HBL8300SGA.
c. Leviton; 8300-SGG.
d. Pass & Seymour; TR63H.

2. Description: Labeled shall comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; VGF20.
b. Hubbell; GF20LA.
c. Pass & Seymour; 2095.
d. Leviton; 7899.

C. Weather- and Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; GFTR20.
b. Pass & Seymour; 2095TRWR.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; CWL520R.
b. Hubbell; HBL2310.
c. Leviton; 2310.
d. Pass & Seymour; L520-R.

2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.7 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Single Pole:

1) Cooper; AH1221.
2) Hubbell; HBL1221.
3) Leviton; 1221-2.
4) Pass & Seymour; PS20AC1.

b. Two Pole:

1) Cooper; AH1222.
2) Hubbell; HBL1222.
3) Leviton; 1222-2.
4) Pass & Seymour; PS20AC2.

c. Three Way:

1) Cooper; AH1223.
2) Hubbell; HBL1223.
3) Leviton; 1223-2.
4) Pass & Seymour; PS20AC3.

d. Four Way:

1) Cooper; AH1224.
2) Hubbell; HBL1224.
3) Leviton; 1224-2.
4) Pass & Seymour; PS20AC4.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; AH1221PL for 120 and 277 V.
b. Hubbell; HBL1201PL for 120 and 277 V.
c. Leviton; 1221-LH1.
d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; AH1221L.
b. Hubbell; HBL1221L.
c. Leviton; 1221-2L.
d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 1995.
b. Hubbell; HBL1557.
c. Leviton; 1257.
d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 1995L.
b. Hubbell; HBL1557L.
c. Leviton; 1257L.
d. Pass & Seymour; 1251L.

2.8 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable rotary knob; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

E. LED Luminaire Dimmer Switches: Modular; compatible with drivers; trim potentiometer to adjust low-end dimming; dimmer-driver combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.9 WALL PLATES

A. Single and combination types shall 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, Type 302 stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with while-in-use lockable cover.

2.10 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, and flap-type, and above-floor, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular and round, die-cast aluminum and solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Section 271500 "Communications Horizontal Cabling."

2.11 FINISHES

A. Devices:
1. Device Color: Gray unless otherwise indicated or required by NFPA 70 or device listing.
2. Wall Plate Color: Stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, 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. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

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

END OF SECTION 262726

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PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Cartridge fuses rated 600-V ac and less.
2. Spare-fuse cabinets.

1.2 ACTION SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper.
4. Coordination charts and tables and related data.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper.
4. Coordination charts and tables and related data.

1.4 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Feeders: Class J, time delay.
2. Motor Branch Circuits: Class RK1, time delay.
3. Other Branch Circuits: Class J, time delay.
4. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

1.5 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. 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. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. 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. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

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: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
6. Alarm Switch: One NO/NC contact that operates only when circuit breaker has tripped.
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Accessory Control Power Voltage: Integrally mounted, self-powered; 120-V ac.

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 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 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

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

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

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

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

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PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.

B. Related Section:

1. Division 23 Section "Instrumentation and Control for HVAC" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 hp.

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. N.C.: Normally closed.

D. N.O.: Normally open.

E. OCPD: Overcurrent protective device.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Show tabulations of the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Nameplate legends.
d. Short-circuit current rating of integrated unit.
e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

B. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and installed components.
2. Manufacturer's written instructions for setting field-adjustable overload relays.

1.6 MATERIALS MAINTENANCE 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. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

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

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
c. Rockwell Automation, Inc.; Allen-Bradley brand.
d. Siemens Energy & Automation, Inc.
e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.
3. Flush and surface mounting.
4. Red pilot light.

C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

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

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
c. Rockwell Automation, Inc.; Allen-Bradley brand.
d. Siemens Energy & Automation, Inc.
e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.

3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
4. Flush and surface mounting.
5. Red pilot light.

D. Magnetic Controllers: Full voltage, across the line, electrically held.

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

    a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    c. Rockwell Automation, Inc.; Allen-Bradley brand.
    d. Siemens Energy & Automation, Inc.
    e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.
3. Contactor Coils: Pressure-encapsulated type.

    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

    a. CPT Spare Capacity: 50 VA.

6. Solid-State Overload Relay:

    a. Switch or dial selectable for motor running overload protection.
    b. Sensors in each phase.
    c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

7. External overload reset push button.

E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

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

    a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    c. Rockwell Automation, Inc.; Allen-Bradley brand.
    d. Siemens Energy & Automation, Inc.
    e. Square D; a brand of Schneider Electric.

2. Fusible Disconnecting Means:

a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

3. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

2.2 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R.
3. Kitchen Areas: Type 4X, stainless steel.
4. Other Wet or Damp Indoor Locations: Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.3 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, type.

a. Push Buttons: Unguarded types; momentary as indicated.
b. Pilot Lights: LED types; colors as indicated; push to test.
c. Selector Switches: Rotary type.

B. Reversible N.C./N.O. auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Install fuses in each fusible-switch enclosed controller.

C. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

D. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

F. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

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

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches with enclosed-controller circuit in both manual 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. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation.
2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.

3. Test continuity of each circuit.
4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

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

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262913

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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 nonautomatic transfer switches rated 600 V and less.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 70.

D. Comply with NFPA 99.

E. Comply with NFPA 110.

F. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Contactor Transfer Switches:

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

a. Emerson; ASCO Power Technologies, LP.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

H. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

I. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 NONAUTOMATIC TRANSFER SWITCHES

A. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

B. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

C. Nonautomatic Transfer-Switch Accessories:

1. Pilot Lights: Indicate source to which load is connected.
2. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternate-source sensing circuits.

a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
b. Emergency Power Supervision: Red light with nameplate engraved "Alternate Source Available."

3. Unassigned Auxiliary Contacts: One set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identify components according to Section 260553 "Identification for Electrical Systems."

B. Set field-adjustable intervals and delays, and relays.

3.2 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Verify time-delay settings.
    b. Verify pickup and dropout voltages by data readout or inspection of control settings.
    c. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 017900 "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:

1. Section 262413 "Switchboards" for factory-installed SPDs.

1.2 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

2.2 PANEL SUPPRESSORS

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

1. Eaton Corporation; Electrical Sector; SPD series.
2. ERICO International Corporation; CRITEC TDXM series.
3. LEA International, Inc.; SP Plus series.
4. Liebert Corporation; a division of Emerson;AccuVar II series.
5. Thomas & Betts Power Solutions LLC; Current Technology Products; CurrentGuard Plus series.

B. SPDs: Comply with UL 1449, Type 1.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 160 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Comply with UL 1283.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.

2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

F. SCCR: Equal or exceed 100 kA.

G. Inominal Rating: 20 kA.

2.3 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Wiring:

1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

1.2 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. LER: Luminaire efficacy rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Ballast, including BF.
3. Energy-efficiency data.
4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
    b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Installation instructions.

1.4 INFORMATIONAL SUBMITTALS

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

1. Lighting fixtures.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches of the plane of the luminaires.
4. Ceiling-mounted projectors.
5. Structural members to which suspension systems for lighting fixtures will be attached.
6. Other items in finished ceiling including the following:

    a. Air outlets and inlets.
    b. Speakers.
    c. Sprinklers.
    d. Smoke and fire detectors.
    e. Occupancy sensors.
    f. Access panels.

7. Perimeter moldings.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Product Certificates: For each type of ballast and driver for bi-level and dimmer-controlled fixtures, from manufacturer.

D. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 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. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.

4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Diffusers 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 otherwise indicated.
    b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:

    a. "USE ONLY" and include specific lamp type.
    b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
    c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
    d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
    e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
    f. CCT and CRI for all luminaires.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than 10 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 42 kHz or higher.
8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.95 or higher.
10. Power Factor: 0.98 or higher.
11. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Electronic Programmed-Start Ballasts for T8, T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:

1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.

C. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

D. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.

   a. High-Level Operation: 100 percent of rated lamp lumens.
   b. Low-Level Operation: 50 percent of rated lamp lumens.

2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher unless otherwise indicated.
9. Power Factor: 0.98 or higher.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp continuously.
3. 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.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers

simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp in a remote fixture continuously.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type.
5. Housing: NEMA 250, Type 1 enclosure.
6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.6 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

a. Battery: Sealed, maintenance-free, nickel-cadmium type.
b. Charger: Fully automatic, solid-state type with sealed transfer relay.
c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.7 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: 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 lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps 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. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.8 FLUORESCENT LAMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. General Electric Co.; GE Lighting Division.
2. OSRAM SYLVANIA.
3. Philips Lighting Co.; a Division of Philips Electronics North America Corporation.

B. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

C. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 3100 initial lumens (minimum), CRI 80 (minimum), color temperature 3500 K, and average rated life 30,000 hours (12 hours per start) unless otherwise indicated.

D. T5HO rapid-start, high-output lamps, rated 49 W maximum, nominal length of 45.2 inches, 4800 initial lumens (minimum), CRI 84 (minimum), color temperature 3500 K, and average rated life of 36,000 hours (12 hours per start) unless otherwise indicated.

E. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start, and suitable for use with dimming ballasts unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).

7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

2.9 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.

1. Install ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

E. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265100

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior luminaires with lamps and ballasts.
2. Poles and accessories.

B. Related Sections:

1. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. Pole: Luminaire support structure, including tower used for large area illumination.

G. Standard: Same definition as "Pole" above.

1.3 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-5.

B. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-5 Ice Load Map.

C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-5.

1. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph.

a. Wind Importance Factor: 1.0.
b. Minimum Design Life: 25 years.
c. Velocity Conversion Factors: 1.0.

1.4 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

    a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Ballasts, including energy-efficiency data.
7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
8. Materials, dimensions, and finishes of poles.
9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
10. Anchor bolts for poles.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
3. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-5 and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: One for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.

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 IEEE C2, "National Electrical Safety Code."

E. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
1. Color: Match Architect's sample of custom color.

M. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:

a. "USES ONLY" and include specific lamp type.
b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
f. CCT and CRI for all luminaires.

2.3 FLUORESCENT BALLASTS AND LAMPS

A. Ballasts for Low-Temperature Environments:

1. Temperatures Minus 20 Deg F and Higher: Electromagnetic type designed for use with indicated lamp types.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: Class A.
3. Total Harmonic Distortion Rating: Less than 10 percent.
4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
6. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 20 deg F and higher.

2.4 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2.5 HID LAMPS

A. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.

B. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and CCT color temperature 4000 K.

2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-5.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

2.7 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.

1. Shape: Round, straight.
2. Mounting Provisions: Butt flange for bolted mounting on foundation.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
2. Finish: Same as luminaire.

F. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: Match Architect's sample.

2.8 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

C. Adjust luminaires that require field adjustment or aiming.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
2. Install base covers unless otherwise indicated.
3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

END OF SECTION 265600

PART 1 - GENERAL

The Contractor shall be held responsible to be familiar with the provisions contained herein and with other Sections of this Specification as applicable to the completion of the installation.

1.1 SCOPE OF WORK

A. This specification covers the furnishing and installation of materials for telecommunications system structured cabling, complete and in operating condition as indicated on drawings and/or as described herein.

1.2 QUALITY ASSURANCE

A. The following industry Standards are the basis for the structured cabling system described herein. The list is incorporated by this reference to them.

1. ANSI/TIA/EIA 568-B.1 - General Cabling Systems Requirements.
2. ANSI/TIA/EIA 568-B.2 - Balanced Twisted Pair Copper Cabling Systems.
3. ANSI/TIA/EIA 568-B.3 - Optical Fiber Cabling Systems.
4. ANSI/TIA/EIA 569B - Commercial Building Standard for Telecommunications Pathways and Spaces.
5. ANSI/TIA/EIA 606A - The Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.
6. ANSI-J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
7. TIA-758-A Customer - Owned Outside Plant Telecommunications Infrastructure Standard.
8. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant.
9. TIA-526-14-A - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant.
10. BICSI - Telecommunications Distribution Methods Manual (TDMM).
11. NEC - National Electric Code.
12. NFPA - National Fire Protection Association.
13. IEEE - Institute of Electrical and Electronics Engineers.
14. ISO - International Standards Organization.
15. UL - Underwriters Laboratories.

B. These Specifications, together with the Drawings accompanying them, are intended to depict the installation requirements necessary to support this Project. Contractor shall furnish materials shown and/or called for on the Drawings but not mentioned in the Specifications, or vice versa, that are necessary for the installation and support of communications cabling, whether or not specifically called for in both. In addition, Contractor shall provide incidental equipment and materials required for the completion of systems included in this contract whether or not specified or shown on the Drawings.

C. Contractor’s management team shall have demonstrated compliance with all applicable scopes of work. Contractor must demonstrate installation requirements as a Prime Contractor or Subcontractor on no less than three (3) Higher Education projects of similar size and scope.

1. The University may, at its discretion, require the names, previous project list, and references for the Contractor’s management team and field personnel assigned to this project prior to the start of the work.
2. The University maintains the right to ask for replacement of management or field staff at any time during the project.

D. All cabling shall meet ANSI/TIA/EIA-568.

E. The bidder must be an authorized Commscope Systimax Certified Vendor of the Systimax Solutions. The bidder must have successfully completed all Systimax design and installation training provided by Commscope.

F. Termination and testing of the telecommunication cabling shall be performed by qualified telecommunication installer with at least 3 years' experience that can assure the installation and testing parameters are met.

1. Experience with Category 6a installation is required.
2. Vendors and Contractors shall have on staff a Building Industry Consulting Service International (BICSI) Registered Communications Distribution Designer (RCDD).
3. The RCDD shall approve construction design and upon completion of installation, certify compliance with the standards and installation practices as specified by this document.

G. Prior to commencing the work of the project, the Contractor shall convene a meeting with the Construction Manager, University's Information Technology Services representative, and Engineering Services representative.

1. The meeting will cover Project Specifications, Addendum, Change orders, TR layouts, labeling, and other project work, documents and site conditions.
2. System testing procedures and requirements shall be confirmed at this time.
3. Test report forms and schedules shall be provided for University for review.
4. Inspection milestones will be set and notifications scheduled.
5. Meeting minutes will be distributed and will include agreements, action items and responsible party(s) for this meeting and for future meetings when required.

H. Store materials and equipment in dry, environmentally controlled space. Do not install equipment and materials until spaces are enclosed, watertight, and dry. Protect equipment from dust and other airborne materials.

I. Contractor's regular job progress meetings with the Construction Manager and other University representatives shall include a University Information Technology Services telecommunications representative.

J. University Inspection: Earlham University will provide advising as requested.

1. The University Technology Services may inspect the job as it progresses.
2. Prior to final acceptance of the work, the Contractor shall make arrangements with the appropriate authorized University personnel to inspect the construction areas, both to ensure satisfactory completion of the work and to ensure complete cleanup and restoration of areas affected by the work.
3. Temporary protection, coverings, and structures shall be removed at or before time of inspection.
4. Examine areas and conditions with the Installer present for compliance with requirements and other conditions affecting the performance of telecommunication transmission media.
5. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the appropriate University personnel.

1.3 INTENT OF DRAWINGS AND SPECIFICATIONS

A. The telecommunication systems herein specified provides for Information outlets and other low voltage signaling functions (such as for energy management and security systems) through twisted pair, fiber optic, and coaxial cable.

B. The system shall provide acceptable outlets for any telecommunication device, which requires connection to other devices, networks or information services serving general University needs.

1.4 DEFINITIONS

A. OUTSIDE PLANT: Transmission facilities used in the distribution of voice, data, or video from point where it leaves one building and enters another, including copper, coax, fiber optics, and microwave.

B. ENTRANCE CABLE: The outside plant cable(s) that enter the building from the campus outside plant communication distribution network.

C. MAIN BUILDING TELECOMMUNICATION EQUIPMENT ROOM (ER): The main telecommunication room located where the outside plant cabling and backbone cabling (risers) are interconnected. This room may also serve as a floor telecommunication equipment room (TR).

D. FLOOR TELECOMMUNICATION EQUIPMENT ROOM (TR): A telecommunication equipment room normally provided on every floor of the building. Floor equipment rooms must best spaced such

that the length of any horizontal cable run shall not exceed 295 feet, wire length, termination to termination.

E. BACKBONE CABLE (OSP): Cabling from outside or tunnel entrance of the Building to the Building Telecommunication Equipment Room (ER). Scope may include copper, coax, and fiber optics cabling.

F. RISER CABLE: Cabling from the Building Telecommunication Equipment Room (TR) to each Floor Telecommunication Equipment Room, including copper, coax, and fiber optics cabling.

G. STATION OUTLET BOX: The standard outlet box for telecommunications terminations shall be a double gang 4”x4”x2-1/8” minimum depth box, with mud ring sizes as required.

H. INFORMATION OUTLET: An assembly of interface ports for copper (data), fiber terminations (data), and various audio video connections; variations of arrangements are described elsewhere in this document.

1.5 SUBMITTALS

A. Submit shop drawings and/or manufacturer's product data for telecommunications equipment, including termination equipment, copper cables, fiber optic cables, cable routing devices, and associated equipment and materials.

1. Include cut sheets with rated capacities, operating characteristics, electrical characteristics and other measurements and descriptions which describe these items in detail.

B. Submit manufacturer's test reports and test data for each of the fiber optic cables installed.

1. The test reports must clearly identify which fiber corresponds with the respective test measurement data so that the results can be verified prior to installation of the cable.

C. Submit a schedule of material and an installation schedule based on the construction schedule and construction phasing, to the Architect/Engineer, within three (3) weeks after contract award.

D. Submit qualifications data for material installers, supervisors, and the project RCDD (Registered Communications Distribution Designer).

E. Submit completed cable records, including floor plans, riser diagrams, manhole diagrams, footages on any cable other than horizontal cabling, and jack id's by location.

F. Submit test reports to the Owner's Representative for approval.

1. Include in the test reports the test data taken and converted values.
2. Prior to submittal for approval, have test reports signed by authorized witnesses present at tests.
3. Submit two (2) final copies of approved test reports to the Owner's representative.
4. No services shall be installed until verified reports are submitted, reviewed, and found to be acceptable by the appropriate Owners representative.

1.6 RELATED SECTIONS

A. The following sections are related:

1. 27 05 26 - Grounding and Bonding for Communications Systems
2. 27 05 28 - Pathways for Communications Systems
3. 27 05 53 - Identification for Communication Systems
4. 27 11 00 - Communications Equipment Room Fittings
5. 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
6. 27 11 19 - Communications Termination Blocks and Patch Panels
7. 27 15 00.23 - Audio-Video Communications Horizontal Cabling
8. 27 15 13 - Communications Copper Horizontal Cabling
9. 27 15 43 - Communications Faceplates and Connectors
10. 28 23 00 – Video Surveillance
11. 28 30 00 – Access Control System

PART 2 - PRODUCTS

2.1 PRODUCT STANDARDS

A. Products shall be as listed in this section or as directed by the Owner.

B. All products shall be new.

PART 3 - EXECUTION

3.1 TELECOMMUNICATIONS INSTALLATION

A. Installation procedures shall be in accordance with industry acceptable practices, product manufacturers' recommendations, Federal, State and Local codes and standards, and shall include demolition and removal of materials as required to support the work.

B. This section includes tools, materials, equipment and labor necessary to complete a turnkey installation, including but not limited to the following items, which will be supplied by the Contractor unless otherwise noted by the University:

1. Cable trays, hangers, and mounting hardware
2. Conduit
3. Connecting blocks
4. Cross connect cable
5. Cross connect rings or spools
6. Equipment racks, mounting hardware and wire management
7. Labels for cables and receptacles
8. Modular station receptacles
9. Mounting brackets
10. Painted fire retardant plywood backboards
11. Riser cable
12. Station blocks
13. Station cables
14. Velcro tie wraps, bushings, and miscellaneous

3.2 DELIVERY, STORAGE AND HANDLING

A. Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.

B. Store wire and cable in clean dry space in original containers, following manufacturers' storage guidelines. Protect products from weather, damaging fumes, construction debris and traffic.

C. Handle wire and cable carefully to avoid abrading, puncturing, kinking, and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance and characteristic impedance integrity of transmission media are maintained.

3.3 SEQUENCING AND SCHEDULING

A. Coordinate with installation of wires/cables, electrical boxes and fittings, cable trays, and raceways.

B. Sequence installation of optical fiber cabling systems with other work to minimize possibility of damage during construction.

3.4 GENERAL INSTALLATION

A. No cable shall be installed in any facilities other than those intended for that use.

1. Gas pipe and water pipes must not be used for conduit under any circumstances.

B. Install telecommunication transmission media as indicated, in accordance with manufacturers' written instructions, in compliance with applicable requirements of the NEC, and in accordance with recognized industry practices.

C. CMP (Plenum) type cable will be used for all telecommunications cables.

D. Coordinate transmission media installation work as necessary to properly interface installation of media with other work.

E. Do not install compressed, kinked, scored, deformed or abraded cable, or allow such damage to occur.

1. Damaged materials shall be removed from the job site immediately.

F. Use extreme care in handling, fishing, and pulling-in transmission media to avoid damage to conductors, shielding and jacketing/cladding.

1. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips, which will not damage media or raceway.
2. If power equipment is used to pull cable, the pull speed must not exceed 30 meters per minute.
3. Use water based lubricant approved by the cable manufacturer to ensure manufacturers pulling tensions are not exceeded.
    a. Compound used must not deteriorate conductor or insulation.
4. Cable bending radii must not be exceeded.
5. Pulling methods must not cause cable to twist.
6. Cables pulled through pull boxes shall be hand assisted to prevent the cable from being crushed, kinked, or scraped.
7. Provide pull strings in telecommunication conduits.
    a. To facilitate future cable installations, install a nylon pull cord in each conduit simultaneously with the pull-in of cable.
8. Pull conductors simultaneously where more than one is being installed in same raceway.
9. Splices in building media runs are NOT permitted.
    a. Building wiring must be continuous and undamaged from outlet to connecting block or connecting block to connecting block.
10. Terminations shall be made with manufacturers' stated tools and in accordance with manufacturers' instructions and guidelines.
11. Tighten connectors and terminals, including screws and bolts, in accordance with manufacturers' published torque tightening values. Where manufacturers torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque specified in UL Standard.
12. When necessary within ER/TRs, horizontal station cables shall be secured with Velcro tie wraps. Both fiber and copper entrance and riser cable shall be secured with standard tie wraps. Observe the manufacturers' recommendations for distances between tie wraps and tightening tension from tie wraps and as specified in ANSI/TIA/EIA-568.
    a. Outside of ER/TRs horizontal cabling, entrance cables, and riser cables must be installed within industry standard pathways, such as cable tray, J hooks, and conduit.
13. Cables shall be permanently identified at each end with an industry approved label.
14. All wall penetrations for telecommunications cabling must be sleeved, with bushings at each end, and firestopped with removable/reusable material which has a minimum 2 hour rating, or in accordance with other architectural details, unless otherwise noted.
    a. Cables must not be installed through unsleeved holes drilled through walls.
    b. Comply with Division 07 requirements for Firestopping.
    c. Comply with TIA/EIA 569 on Firestopping.
    d. Comply with UL1479 or ASTM E814, and label with the UL1479 or ASTM E814 reference number.

3.5 TESTING AND DOCUMENTATION

A. General

1. Acceptance testing shall be completed and documentation provided to the University as soon as possible in order to permit the installation of networking equipment necessary to bring the building online for security and equipment monitoring systems.

B. Testing

1. Acceptance testing by the University shall not occur until all work in the ER/TR area is completed, including but not limited to mounting and installation of fiber OSP and riser cables, backboards, terminating boxes and cabinets, and grounding blocks, and termination of fiber riser cables, copper backbone cables, station wires, or any other work necessary for the completion of the installation.
2. The University shall have the right to schedule acceptance testing at its convenience.
3. A University representative, at the option of the University, shall be present during testing.
4. Such acceptance testing shall in no way reduce the Contractors' obligations regarding restoration, cleanup, or warranty.
5. Contractor shall perform tests necessary prior to acceptance testing to ensure that the installed cables will pass acceptance testing performed in conjunction with University representatives.
6. Contractor shall be responsible for performing, tracking, and recording the results of tests.
7. Contractor shall be responsible for providing equipment and materials necessary for as long a period of time as necessary to complete testing to the satisfaction of the University.
8. Test record forms shall be agreed to by the University prior to the commencement of acceptance testing.

C. Documentation

1. Provide record plant documentation, including jack type (information outlet), jack location, circuit length, fiber riser cable lengths, copper backbone cable lengths and any other information deemed to be useful.
2. The documentation format(s) will be agreed upon between the campus telecommunication coordinator and the Contractor.

    a. Provide all documentation in electronic format.
    b. If it is agreed to use proprietary software to provide testing results, the Contractor will be required to furnish licensed system software to run it unless the University already has a licensed version of the Contractor’s software.

3.6 RECORD DRAWINGS

A. Provide updated drawings of telecommunications systems in CAD format.

B. As a minimum, the data provided must include the following elements, where applicable:

1. Inside Plant

    a. Cable Routing.
    b. Riser and OSP cable, pair (count), locations, and final cable lengths.
    c. Supporting Structures.
    d. Terminal locations and IDs.
    e. Telecommunications Room and terminal details.
    f. Conduit and cable tray routing, installation heights and section lengths.
    g. Pull box locations, installation heights and sizes.
    h. Information Outlet locations, label IDs, types, and serving ER/TR.
    i. For each change reflected on the Record Drawings, the Change Order Request number shall be shown.

3.7 WARRANTY

A. The warranty on labor and material installed by the Contractor shall be in effect for minimum of five (5) years from the date of acceptance of the work.

B. Contractor shall repair, adjust, and/or replace, whichever the University determines to be in its best interests, any defective equipment, materials, or workmanship, as well as such parts of the work

damaged or destroyed by such defect, during the warranty period, at the Contractor's sole cost and expense.

C. In the event that any of the equipment specified, supplied, and/or installed as part of the work should fail to produce capacities or meet design specification as published or warranted by the manufacturer of the equipment involved or as specified in this document, the Contractor shall, in conjunction with the equipment manufacturer, remove and replace such equipment with equipment that will meet requirements without additional cost to the University.

D. In the event that the Contractor does not affect repair within seven (7) days from the date of notification of such defect, the University may secure repair services from other sources and charge the Contractor for such costs without voiding the warranty.

E. Guarantees of material, equipment, and workmanship running in favor of the Contractor shall be transferred and assigned to the University on completion of the work and acceptance of said work by the University.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TGB: Telecommunications grounding busbar.

D. TMGB: Telecommunications main grounding busbar.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

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

1. Ground rods.
2. Ground and roof rings.
3. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For installation supervisor, and field inspector.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.6 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

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

2.2 CONDUCTORS

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

1. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

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

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

D. Bare Copper Conductors:

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

2.3 CONNECTORS

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

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

1. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.

3. Harger Lightning and Grounding.
4. Panduit Corp.
5. Tyco Electronics Corp.

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

1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

2.4 GROUNDING BUSBARS

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

1. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.

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

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.

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

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

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inchesstainless-steel or copper-plated hardware for attachment to the rack.

2.5 LABELING

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

1. Brother International Corporation.
2. HellermannTyton.
3. Panduit Corp.

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

3.2 INSTALLATION

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

B. Comply with NECA 1.

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

3.3 APPLICATION

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

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

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

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

D. Conductor Support:

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

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.5 CONNECTIONS

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

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

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

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

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

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

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted rack grounding busbar

unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

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

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

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

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

3.6 IDENTIFICATION

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

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

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

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

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

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

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

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

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

E. Prepare test and inspection reports.

END OF SECTION 270526

BLANK

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes minimum requirements for the following:

1. Interior Horizontal Cabling Communications Pathways.

B. Minimum requirements and installation methods for the following pathways:

1. Conduit.
2. Cable Hangers.
3. Cable Tray.
4. In-Wall Boxes For Touch Panels.

C. Related work specified elsewhere:

1. Section 271513 - COPPER HORIZONTAL CABLING
2. Division 26 – ELECTRICAL
3. Division 28 – ELECTRONIC SAFETY AND SECURITY

1.2 QUALITY ASSURANCE

A. All pathways and associated 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 architect and Owners Project Manager. 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. Materials and work specified herein shall comply with the applicable requirements of:

1. National Electric Code (NFPA 70) including the following Articles:

a. 318 Cable Trays.
b. 331 Electrical Nonmetallic Tubing.
c. 348 Electrical metallic tubing.
d. 349 Flexible metallic tubing.
e. 350 Flexible metal conduit.
f. 351 Liquid-Tight Flexible metal conduit and Liquid-Tight flexible nonmetallic conduit.
g. 352A Surface Metal Raceways.
h. 352B Surface Nonmetallic raceways.
i. 353 Multioutlet Assembly.
j. 354 Underfloor raceways.
k. 362 Metal Wireways and nonmetallic Wireways.
l. 370 Outlet, Device, Pull and Junction Boxes, Conduit Bodies and Fittings.
m. 645 Information Technology Equipment.
n. 770 Optical Fiber Cables and Raceways.
o. 800 Communications Circuits.

2. The following American National Standards Institute (ANSI) standards:

a. ANSI-C80.3 Specification for Electrical Metallic Tubing, Zinc-coated.

3. The following Telecommunication Industry Association (TIA) standards:

a. ANSI/TIA/EIA – 568-B Commercial Building Telecommunications Cabling Standard.
b. ANSI/TIA/EIA – 569-A Commercial Building Standard for Telecommunications Pathways and Spaces.
c. EIA/TIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

d. EIA/TIA-607 Commercial Building Grounding and Bonding requirements for Telecommunications.

4. The following BICSI guidelines:

a. BICSI Telecommunications Distribution Design Manual (Most Recent Edition).
b. BICSI Telecommunications Cabling Installation Manual (Most Recent Edition).

5. The following UL Standards:

a. UL 1, 2000 Flexible Metal Electrical Conduit.
b. UL 3, 1999 Flexible Nonmetallic Tubing for Electric Wiring.
c. UL 5, 1996 Surface Metal Electrical Raceways and Fittings.
d. UL 360, 1996 Liquid-Tight Flexible Steel Conduit, Electrical.
e. UL 514B, 1996 Fittings for Conduit and Outlet Boxes.
f. UL 797, 1997 Electrical Metallic Tubing.
g. UL 870, 1995 Electrical Wireways, Auxiliary Gutters and Associated Fittings.

1.3 SUBMITTALS

A. Contractors' Bid shall include product data for the all the equipment specified herein.

PART 2 - PRODUCTS

2.1 CONDUIT

A. All conduit, junction boxes, and pull strings are provided under Division 26. Contractor shall refer to the appropriate specification section for this scope of work.

2.2 CABLE HANGERS

A. Provide prefabricated, zinc coated, carbon steel wide base hangers designed specifically for UTP and audio visual cable installations.

B. Hangers shall have open top, rolled edges and a 2" to 4" minimum diameter loop as required.

C. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.

D. Acceptable Manufacturer:

1. Erico Caddy
2. Or equal

2.3 WALL BOXES FOR TOUCH PANELS

A. Provide in wall box for wireless Crestron TPS-6xWALL touch screen control panels in the Banquet Halls

B. Acceptable products:
1. Crestron PMK-6X-DSW Pre-Construction Wall Mount Kit

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. The intent of the telecommunications pathways is to provide a route between ER and TR rooms, routes from the TR's throughout building floors to hallways, and routes from hallway distribution systems into rooms to individual drop locations for telecommunications cabling.

B. Installation of new pathways shall not interfere with existing pathways in such a way that installation of new cables within the existing pathway is made more difficult.

C. Support raceways from building construction. Do not support raceways from ductwork, piping, or equipment hangers.

D. Support outlet, pull, and junction boxes independently from building construction. Do not support from raceways.

E. Coordinate all raceway runs with other trades.

F. All open raceways shall be installed a minimum of 6 in. away from any light fixture or other source of EMI (Electro-magnetic interference).

G. All horizontal pathways shall be bonded and grounded per the NEC Article 250.

H. In all cases, horizontal pathways shall be sized for a minimum of 60% future growth.

I. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

3.2 CONDUIT

A. Electrical Metallic Tubing, Rigid Metal Conduit and Rigid PVC are allowed conduit types. Flexible metal conduit is not allowed.

B. Conduit runs to work areas shall serve no more than one (1) communication outlet.

C. Conduits shall be sized to accept maximum 40% fill ratio; sizing shall account for fire code capacity restrictions.

D. Identification: Clearly label conduit at exposed ends indicating closet or outlet where conduit terminates.

E. Fire stop all pathways as previously specified in the Construction Documents and Project Manual.

F. All backbone conduits shall be marked with 1” reflective tape every 25 feet.

G. Bush all conduit ends not bushed by Electrical Contractor.

3.3 CONDUIT SLEEVES

A. Install a 4” Conduit Waterfall on all 4” conduit sleeves containing cables that transition more than 6” vertically from the sleeve down to another raceway (conduit or cable tray).

B. Install Nylon Cable Protectors in conduits where large amounts of cables enter/exit the conduit system creating pressure on the cables on the leading conduit edge. These protectors would not be used on 4” conduits where the Panduit Waterfall is required (more than 6” of vertical drop).

C. Install EZ Path sleeves where cables must penetrate fire-rated walls between sections of skeletal conduit or cable tray sections.

3.4 STATION CONDUITS

A. Provide station conduits from each telecommunications outlet location to the horizontal distribution systems. Conduit may be stubbed above accessible ceiling space and use cable hangers until it reaches the nearest conduit sleeve or cable tray. Conduit shall be 1” EMT minimum or appropriate size as shown on the Drawings or as specified herein for installation of telecommunications cables.

B. Provide an insulating press fit bushing on all telecommunications conduits including interconnecting nipples and stub to distribution system. To prevent conflicts with other cables conduits to the cable tray shall not be stubbed less than 6" above or below the cable tray center line. Every effort shall be made to bend station conduits down such that the flow of installed cables promotes the minimum length back to the nearest telecommunications room and the least amount of bends in the cables. Bushings must be rated to be used in an environmental air handling space (Plenum).

C. Provide nylon pull cord in each conduit to horizontal distribution system.

D. 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° of total bends, installation of an appropriate sized junction box is required. See attachment at end of this section for junction box requirements.

E. Place an appropriate sized junction box in each individual station conduit run that exceeds 100ft in length.

F. Conduits shall be anchored so that they are rigid to movement.

3.5 CABLE HANGERS

A. Provide cable hangers a maximum of 3’ on center wherever cable tray or conduit is not present.

B. Ceiling ties and rods shall not be used to hang cable or cable supports without the approval of the Architect.

C. Load hangers as recommended by the manufacturer. Provide hangers side by side on a common bracket where cable quantities require.

D. Do not install cables loose above lock-in type, drywall or plaster ceilings.

E. Cables shall be installed at least six (6) inches above the ceiling tiles and shall not touch the ceiling.

F. Do not support cable from ceiling system tie wires or grid in fire rated systems.

G. Utilize Erico Caddy Cablecat adjustable Cable Support when cable trays are not available.

3.6 SUPPORTING DEVICES

A. Provide steel angles, channels and other materials necessary for the proper support of wall-mounted cabinets, racks, panels, etc.

B. Cabinets, large pull boxes, and cable support boxes shall be secured to ceiling and floor slab and not supported from conduits. Small equipment boxes, etc., as approved by the Architect and Project Manager, may be supported on walls.

C. Racks for support of conduit and heavy equipment shall be secured to building construction by substantial structural supports.

3.7 FIRE STOPS

A. Contractor shall provide firestopping for all telecommunications conduits according to the AHJ.

B. Communication pathways requiring fire stopping shall utilize removable/re-usable fire stopping putties for ease of Moves, Adds, and Changes.

C. 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.

D. Contact Architect to identify walls which are fire-rated construction. Walls must be sealed with a 2-hour fire stop assembly at a minimum.

E. All fire stopping penetrations shall conform to the recommended practices listed in UL1479 or ASTM E814 and must be labeled with the UL1479 or ASTM E814 reference number, dated, and signed by the technician who installed the fire stopping material.

3.8 WALL BOXES FOR TOUCH PANELS

A. Contractor shall install wall boxes for touch panels according to manufacturer instructions at the locations as shown on the T-Series drawings.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

   a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

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

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

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

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

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

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and 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.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual 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 annular clear space between pipe and sleeve for installing mechanical sleeve seals.

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

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes the minimum requirements for the installation, termination, and labeling of all faceplates and connectors as depicted on the Technology Drawings and required by these specifications.

B. Related Sections include the following:

1. 27 05 26 - Grounding and Bonding for Communications Systems
2. 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
3. 27 11 19 - Communications Termination Blocks and Patch Panels
4. 27 15 13 - Communications Copper Horizontal Cabling
5. 27 15 43 - Communications Faceplates and Connectors

PART 2 - PRODUCTS

2.1 LABELS

A. Products shall provide labeling options that comply with the TIA/EIA-606-A Standard. All products shall be clearly identified. Products shall include faceplates, surface mount boxes, patch panels, marker ties, printers and accessories.

B. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.

C. Shall be preprinted or laser printed type.

D. Where used for cable marking provide vinyl substrate with a white printing area and a clear “tail” that self laminates the printed area when wrapped around the cable.

E. Where insert type labels are used, provide clear plastic cover over label.

F. A standard style, size 10, bold font type shall be used when making faceplate labels. All label heights shall be the same to allow for consistent labeling. A Cable Management Inventory Record shall be used to record all installation details.

G. Acceptable Manufacturers:

1. Brady LAT-176-124(2) 0.375x1.90 (No Exceptions)

PART 3 - EXECUTION

3.1 IDENTIFICATION AND LABELING

A. The telecommunications Contractor’s onsite representative(s) shall schedule a meeting with the University Information Technology representative through the appropriate Project Manager prior to the permanent labeling of Information Outlets and TR patch panels.

B. Label all horizontal cabling specifically corresponding to where the cable terminates in the ER/TR. Label both ends of each horizontal cable as shown on the drawings. Numbers shall be sequential and Contractor shall confirm labeling with Owner prior to installation.

C. Faceplates and Patch Panels:

1. Label faceplates at the Information Outlets specifically corresponding to the horizontal cable labeling scheme.
2. Labels shall be mounted in a manner which permits easy access and viewing.

D. Information Outlet receptacles, cables, and terminations shall be labeled with a standard identification tag at both the Information Outlet and on the patch panels/wiring blocks in the ER/TR.

E. Tags shall be preprinted or computer printed with indelible water proof ink and mechanically secured in a permanent fashion; for example, such as using an appropriate label maker with 3/8” tape.

F. Handwritten labels are NOT acceptable.

G. Labeling scheme:

1. The station cable serving each receptacle must be labeled at the room receptacle and the TR rack.
2. Information Outlet receptacles in rooms are to be labeled -A through -ZZ in each room beginning with the first receptacle to the left of the main entrance to the room and continuing clockwise around the room.
3. All labeling will be done in all capital letters.
4. For example, a jack labeled 246A-A would be labeled such because:

    a. Room 246A is the room number
    b. The Information Outlet designation is “A” (first receptacle in room from the left of the door)
    c. Station cables from a given room shall be terminated in sequential order, i.e. – 246A-A, 246A-B,246A-C, 246A-D, etc. If more than 26 are needed, the progression would be – 246A-X, 246A-Y, 246A-Z, 246A-AA, 246A-AB, 246A-AC, … 246A-AZ, 246A-BA, 246A-BB, etc.

H. Information Outlets for special purposes shall have a unique identifier listed with the jack ID.

I. The identifier shall be inserted into the Outlet ID, between the room number and the Outlet designator as indicated in the drawings.

J. Common identifiers are listed below:

1. Wireless access point (WAP) "100+WD-A"
2. Elevator jack "100+EL-A"
3. Card Reader "100+CR-A"
4. Fire Alarm "100+FA-A"
5. Security Camera “100+SC-A”

K. All labeling shall be coordinated with and approved by an appropriate University representative.

1. Schedule a meeting with the University Information Technology representative through the Project Manager prior to the permanent labeling of Information Outlets and ER/TR patch panels.

3.2 RECORD COPY AND AS - BUILT DRAWINGS

A. Provide record copy drawings (in CAD format) periodically throughout the project as requested by the Project Manager and also at end of the project. Record copy drawings shall include notations reflecting the as-built conditions of any additions to or variation from the drawings provided.

B. Provide hard copy and electronic copy of cable inventory which includes all circuit numbers for UTP cabling.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Grounding.

B. Related Requirements:

1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Section 271500 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.
3. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

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 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. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

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.
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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."

2.3 EQUIPMENT FRAMES

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

1. ADC.
2. Belden Inc.
3. Cooper B-Line.
4. Emerson Network Power Connectivity Solutions.
5. Hubbell Premise Wiring.
6. Leviton Commercial Networks Division.
7. Middle Atlantic Products, Inc.
8. Ortronics, Inc.
9. Panduit Corp.
10. Siemon Co. (The).
11. Tyco Electronics Corporation; AMP Products.

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Racks: Modular-type, steel or aluminum construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
2. Baked-polyester powder coat finish.

D. Modular Freestanding Cabinets:

1. Removable and lockable side panels.
2. Hinged and lockable front and rear doors.
3. Adjustable feet for leveling.
4. Screened ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.
6. Grounding bus bar.
7. Rack-mounted, 550-cfm fan with filter.
8. Power strip.
9. Baked-polyester powder coat finish.
10. All cabinets keyed alike.

E. Modular Wall Cabinets:

1. Wall mounting.
2. Steel or aluminum construction.
3. Treated to resist corrosion.
4. Lockable front and rear doors.
5. Louvered side panels.
6. Cable access provisions top and bottom.
7. Grounding lug.
8. Rack-mounted, 250-cfm fan.
9. Power strip.
10. All cabinets keyed alike.

F. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.4 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, 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R 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: When protection is lost, circuit opens and cannot be reset.
7. Cord connected with 15-foot line cord.
8. Rocker-type on-off switch, illuminated when in on position.
9. Peak Single-Impulse Surge Current Rating: 13 kA 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.

2.5 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 with 9/32-inch holes spaced 1-1/8 inches 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 J-STD-607-A.

2.6 LABELING

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

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 260543 "Underground Ducts and Raceways for Electrical Systems" for materials and installation requirements for underground pathways.

3.2 INSTALLATION

A. Comply with NECA 1.

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

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

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

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

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

3.3 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."

3.4 FIRESTOPPING

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

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

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

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

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

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch 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.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

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 for Class 2 level of administration including optional identification requirements of this standard.

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

END OF SECTION 271100

BLANK

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, and materials unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, and labeling of all telecommunications infrastructure as described on the Drawings and/or required by these specifications.

1.2 RELATED SECTIONS

A. Related sections include the following:

1. 27 05 26 - Grounding and Bonding for Communications Systems
2. 27 05 53 - Identification for Communication Systems
3. 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
4. 27 11 19 - Communications Termination Blocks and Patch Panels
5. 27 15 13 - Communications Copper Horizontal Cabling
6. 27 15 43 - Communications Faceplates and Connectors

1.3 INTENT OF DRAWINGS AND SPECIFICATIONS

A. These Specifications, together with the Drawings accompanying them, are intended to depict the installation requirements necessary to support this Project. Contractor shall furnish materials shown and/or called for on the Drawings but not mentioned in the Specifications, or vice versa, that are necessary for the installation and support of communications cabling, whether or not specifically called for in both. In addition, Contractor shall provide incidental equipment and materials required for the completion of systems included in this Contract whether or not specified or shown on the Drawings.

PART 2 - PRODUCTS

2.1 PRODUCT STANDARDS

A. All materials shall conform with the current applicable industry standards including, but not limited to:

1. NEMA (National Electrical Manufacturers' Association)
2. ANSI (American National Standards Institute)
3. ASTM (American Society for Testing and Materials)
4. ICEA (Insulated Cable Engineers Association)
5. National Electrical Safety Code

B. In addition, all Material shall be Underwriters Laboratories Listed unless otherwise indicated.

C. All products must be new.

2.2 TELECOMMUNICATIONS ROOM PLYWOOD

A. Provided by Division 26. Refer to appropriate section for product specifications.

2.3 TELECOMMUNICATIONS ROOM CABLE TRAY

A. Black powder coated tubular steel runway.

B. Shall include Runway elevation kit if needed.

C. Include all splice kits, ground straps, and support kits as required.

D. Provide all other associated parts as needed.

E. Acceptable Manufacturers:

1. Cooper B-Line

2. Chatsworth Products
3. Panduit
4. Or Equivalent

PART 3 - EXECUTION

3.1 EQUIPMENT ROOM FITTINGS

A. New ER/TRs must be free from dust, dirt, and other foreign materials before the installation of any termination hardware or the termination of copper or fiber optic cables. The door to the telecommunication rooms must be permanently installed and closed during termination.

B. Each Contractor shall be knowledgeable of work to be performed by other trades and take necessary steps to integrate and coordinate their work with other trades.

C. The Contractor shall be responsible for furnishing all materials on the drawings or as specified herein for a complete telecommunications system.

D. All telecommunications infrastructure shall be installed utilizing BICSI installation practices in an aesthetically pleasing and organized fashion. All surface raceway in new buildings must be approved by the Architect and/or University Information Technology Services Representative.

E. All telecommunications infrastructure shall be installed for optimal performance.

F. All telecommunications infrastructure shall be installed to accommodate future moves, adds, and changes.

G. All work performed in occupied spaces shall be in a manner that allows the owner to operate the existing facilities on a continuous basis.

3.2 TELECOMMUNICATIONS ROOM PLYWOOD

A. Install according to Division 26 Specifications and requirements.

3.3 TELECOMMUNICAITONS ROOM CABLE TRAY

A. Install cable tray in telecommunications room as shown on drawings. Shall be supported at a minimum of every 5’.

B. Install cable tray above all equipment frames and securely attach both ends of cable tray. Cable tray and equipment frame shall be secured so that the top of the equipment frame cannot move. Ladder rack also shall be installed perpendicular to and secured to the outward end of the equipment rack(s).

C. Install horizontal cable tray at a minimum of 7' 2" AFF to the bottom of the tray.

D. Install additional horizontal and vertical sections of cable tray on walls where OSP cables, and large bundles of horizontal cables route from conduits entering/exiting the room.

E. Horizontal cable tray routed within the ER shall be installed in such a way that the route for future "unprotected" OSP cabling does not pass through, on, or in front of the cable tray containing "unprotected" UTP cabling.

3.4 ELECTRICAL OUTLETS

A. Affix thermal label to all electrical outlet covers indicating circuit number and panel of origin.

B. Electrical outlets designated for UPS units located behind equipment frames shall have thermal label indicating reading “UPS only” and contain the circuit number and panel of origin.

C. Electrical outlets designated for service use shall have thermal label indicating reading “Service Use” and contain the circuit number and panel of origin.

D. Each circuit serving the telecommunication room shall have a critical circuit tag affixed adjacent to breaker/switch. Panel schedules/directories shall be labeled to indicate the outlets within the telecommunications room.

3.5 WIRE MANAGEMENT

A. Install D-rings on plywood as specified herein or shown on drawings.

B. Install D-rings horizontally and vertically on plywood backboard to manage horizontal cables that enter the telecommunications room from below up to the cable tray. Route these horizontal cables to the nearest corner of the room to maximize wall space.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section describes the minimum requirements for the cabinets, racks, frames, and enclosures for Phase II of the Stanley Hall Science Building. The Contractor shall provide racks and enclosures as needed for each system within the project.

B. This section includes the minimum installation requirements for equipment and cabling infrastructure in Equipment Rooms and Telecommunication Rooms, and includes the following:

1. Floor mounted Equipment Racks
2. Rack Mounted Power Outlet Units

C. Related Sections include the following:

1. 27 05 26 - Grounding and Bonding for Communications Systems
2. 27 05 53 - Identification for Communication Systems
3. 27 11 19 - Communications Termination Blocks and Patch Panels
4. 27 15 13 - Communications Copper Horizontal Cabling
5. 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures

1.2 QUALITY ASSURANCE

A. All telecommunications 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 approval of the Architect and Owners Representative. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based on the acceptable manufacturers listed. Where "Or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and work specified herein shall comply with the requirements of the local Authority Having Jurisdiction. Refer to Section 27 00 00 for all applicable standards and codes.

1.3 SUBMITTALS

A. Contractors' Bid shall include product data for the all the equipment specified herein.

Contractor shall submit shop drawings for the final location and layout of all cabinets and equipment frames before installation.

PART 2 - PRODUCTS

2.1 FLOOR MOUNTED 2 POST EQUIPMENT RACKS

A. Contractor shall provide data equipment racks as shown on the drawings or as specified herein.

B. Specifications:

1. Minimum 7' (45U).
2. Standard 19" rack width with 12-24 tapped rails
3. Aluminum or Steel Construction with Bolted or Welded connections
4. Powder Coated Black
5. Marked and numbered rack mount spaces
6. Capable of integrated the grounding and bonding system

C. Acceptable Manufacturers:

1. Chatsworth
2. Commscope

3. Cooper B-Line
4. Middle Atlantic
5. Panduit
6. Or Equivalent

D. Vertical Wire Management

1. Provide vertical wire management for each rack as shown on the contract drawings and as required herein.
2. Minimum of 84”H x 6”W , doubled sided, with doors
3. Color: Black
4. Acceptable Manufacturers:
   a. Commscope (No Exceptions)

2.2 RACK MOUNTED POWER OUTLET UNITS

A. Provide two (2) power strips per cabinet and rack. Each shall meet the following specifications:

1. 20 amp, 120V.
2. Rack mounted, rear facing, and plugged into each AC Power.
3. Non-switched.
4. Surge suppressed.
5. Minimum 6 outlets – transformer spaced.
6. Power cord shall be minimum 8' in length.
7. Shall meet UL 1363 and 1449 requirements.

B. Acceptable Manufacturers:

1. APC
2. Geist
3. Isobar
4. Interlink
5. Or equal

PART 3 - EXECUTION

3.1 FLOOR MOUNTED EQUIPMENT RACKS

A. The equipment racks shall be installed in the ER/TRs according to layout and communication media requirements. Placement of cabinets shall be done in accordance with the T-Series drawings and/or the approved shop drawing of the room layout. All questions regarding cabinet placement or room layout shall be directed in writing to the Owner.

B. The rack shall be anchored to the floor and braced overhead with ladder racking, and grounded to the ground bus bar location in the ER/TR with a #4 solid or stranded ground wire. All cabinets and racks shall be anchored to the wall.

C. Provide vertical and horizontal cable management as required by this specification or requested by the owner.

3.2 RACK MOUNTED POWER OUTLET UNITS

A. Provide and install each power strip per location as noted on the contract drawings.

B. Contractor shall label each power outlet per owner requirements to identify all power connections required by owner provided equipment.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. All horizontal cabling shall be terminated in the new ER or TR.

B. This section includes the minimum installation requirements for termination blocks and patch panels in Telecommunication Rooms, and includes the following:

1. Category 6a Patch Panels
2. Category 6a Patch Cords
3. Optical Fiber Patch Cords

C. Related Sections include the following:

1. 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
2. 27 15 13 - Communications Copper Horizontal Cabling
3. 27 15 43 - Communications Faceplates and Connectors

1.2 QUALITY ASSURANCE

A. All telecommunications 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 approval of the Architect and Owners Representative. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based on the acceptable manufacturers listed. Where "Or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and work specified herein shall comply with the requirements of the local Authority Having Jurisdiction. Refer to Section 270000 for all applicable standards and codes.

1.3 SUBMITTALS

A. Contractors’ Bid shall include product data for the all the equipment specified herein.

PART 2 - PRODUCTS

2.1 CATEGORY 6a PATCH PANELS

A. Contractor shall provide patch panels as shown on the T-Series drawings or as required to complete the project scope.

B. Acceptable Manufacturers:
1. Commscope Systimax M2000A-48 2U Angled (No Exceptions)

2.2 CATEGORY 6a PATCH CORDS

A. Contractor shall provide a Category 6a patch cords for each terminated data port within the scope of the project. Contractor shall provide Pigtail style cables as required to cross connect each phone location in the project.

B. Length shall be a minimum of 4' and color shall match horizontal cabling. Pigtail cables shall be a minimum of 15'.

C. Acceptable Manufacturers:

1. Commscope Systimax X10D Patch Cords (No Exceptions)

2.3 OPTICAL FIBER PATCH CORDS

A. Contractor shall provide duplex single mode OS2 optical fiber patch cords for installation by the Owner.

B. Contractor shall provide two (2) optical fiber patch cords, Terminated SC/LC

C. Length shall be a minimum of 2 meters and color shall match the type and grade of optical fiber installed.

D. Acceptable Manufacturers:

1. Commscope Systimax (No Exceptions)

PART 3 - EXECUTION

3.1 COPPER EQUIPMENT

A. Horizontal Cabling Patch Panels

1. Use Systimax modular angled patch panels filled with appropriate Category 6a modules.
2. Use a Pigtail modular patch cord from the patch panel installed in the rack to the 110 block mounted on the wall for establishing a connection for each phone/voice only locations.
3. All patch panels, termination panels, and cable managers should be installed so that their fronts, and the front of the networking equipment later provided by owner, shall be visible from the telecommunications room open doorway.

B. Category 6a Patch Cords

1. Contractor shall provide Category 6a patch cords for each horizontal data outlet within the project. Patch cords shall be 5’ for installation in the TR and a minimum of 8’ for each work area information outlet.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cable.
3. 50/125-micrometer, optical fiber cabling.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Cabling identification products.

B. Related Sections:

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.2 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.

1.3 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.

1.4 PERFORMANCE REQUIREMENTS

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

1.5 ACTION SUBMITTALS

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

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
5. 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.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.

1.8 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.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. 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.

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. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

E. Grounding: Comply with ANSI-J-STD-607-A.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

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

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. 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.

C. 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 wide, 3 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated,3/4 by 48 by 96 inches. Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

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

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Draka USA.
5. Genesis Cable Products; Honeywell International, Inc.
6. KRONE Incorporated.
7. Mohawk; a division of Belden CDT.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope Inc. brand.
11. 3M.
12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, 100-pair UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 5e.
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, General Purpose: Type CM or CMG.
    b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    c. Communications, Riser Rated: Type CMR, complying with UL 1666.
    d. Communications, Limited Purpose: Type CMX.
    e. Multipurpose: Type MP or MPG.
    f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.4 UTP CABLE HARDWARE

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

1. American Technology Systems Industries, Inc.
2. Dynacom Corporation.
3. Hubbell Premise Wiring.
4. KRONE Incorporated.
5. Leviton Voice & Data Division.
6. Molex Premise Networks; a division of Molex, Inc.
7. Nordex/CDT; a subsidiary of Cable Design Technologies.
8. Panduit Corp.
9. Siemon Co. (The).
10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, 4-pair cables in 36-inchlengths; terminated with 8-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

2.5 OPTICAL FIBER CABLE

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

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Corning Cable Systems.
4. General Cable Technologies Corporation.
5. Mohawk; a division of Belden CDT.
6. Nordex/CDT; a subsidiary of Cable Design Technologies.
7. Optical Connectivity Solutions Division; Emerson Network Power.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope Inc. brand.
10. 3M.
11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: Multimode, 50/125-micrometer, 24-fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA/EIA-492AAAA-B for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. General Purpose, Nonconductive: Type OFN or OFNG.
    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    c. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
    d. General Purpose, Conductive: Type OFC or OFCG.
    e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
    f. Riser Rated, Conductive: Type OFCR, complying with UL 1666.

5. Conductive cable shall be steel or aluminum armored type.
6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

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

1. ADC.
2. American Technology Systems Industries, Inc.
3. Berk-Tek; a Nexans company.
4. Corning Cable Systems.
5. Dynacom Corporation.
6. Hubbell Premise Wiring.
7. Molex Premise Networks; a division of Molex, Inc.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Optical Connectivity Solutions Division; Emerson Network Power.
10. Siemon Co. (The).

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. 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 TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

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

2.8 IDENTIFICATION PRODUCTS

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

2.9 SOURCE QUALITY CONTROL

A. Factory test cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

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

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

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

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

1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

B. 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.

3.3 INSTALLATION OF PATHWAYS

A. 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.

B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

E. 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.

F. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. 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.
8. 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.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. 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 long not less than 12 inches in diameter below each feed point.

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

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A 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.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables 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.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

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

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

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

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

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

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch 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.

3.7 IDENTIFICATION

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

1. Administration Class: 2.
2. 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 TIA/EIA-606-A 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, 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 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. 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 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 TIA/EIA 606-A, for the following:

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

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

C. 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.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 271300

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. UTP cabling.
2. 50/125-micrometer, optical fiber 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 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.2 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. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

G. RCDD: Registered Communications Distribution Designer.

H. UTP: Unshielded twisted pair.

1.3 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.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. 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.

1.8 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.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set .
2. Test each pair of UTP cable for open and short circuits.

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-B.1 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., 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. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

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 J-STD-607-A.

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.4 UTP CABLE

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

1. ADC.
2. Belden Inc.
3. Berk-Tek; a Nexans company.
4. CommScope, Inc.
5. Draka Cableteq USA.
6. Genesis Cable Products; Honeywell International, Inc.
7. Mohawk; a division of Belden Networking, Inc.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope, Inc. brand.
10. 3M Communication Markets Division.
11. Tyco Electronics Corporation; AMP Products.

B. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6A.
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, General Purpose: Type CM or CMG.
    b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    c. Communications, Riser Rated: Type CMR, complying with UL 1666.
    d. Communications, Limited Purpose: Type CMX.
    e. Multipurpose: Type MP or MPG.
    f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.5 UTP CABLE HARDWARE

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

1. ADC.
2. American Technology Systems Industries, Inc.
3. Belden Inc.
4. Dynacom Inc.
5. Hubbell Premise Wiring.
6. Leviton Commercial Networks Division.
7. Molex Premise Networks; a division of Molex, Inc.
8. Panduit Corp.

9. Siemon Co. (The).
10. Tyco Electronics Corporation; AMP Products.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6A. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6A performance. Patch cords shall have latch guards to protect against snagging.

2.6 OPTICAL FIBER CABLE

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

1. Belden Inc.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Corning Cable Systems.
5. CSI Technologies Inc.
6. General Cable Technologies Corporation.
7. Mohawk; a division of Belden Networking, Inc.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope, Inc. brand.
10. 3M Communication Markets Division.
11. Tyco Electronics Corporation; AMP Products.

B. Description: Multimode, 50/125-micrometer, 24-fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA-492AAAB for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

a. General Purpose, Nonconductive: Type OFN or OFNG.
b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
c. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
d. General Purpose, Conductive: Type OFC or OFCG.
e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.

f. Riser Rated, Conductive: Type OFCR, complying with UL 1666.

5. Conductive cable shall be steel or aluminum armored type.
6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.7 OPTICAL FIBER CABLE HARDWARE

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

1. ADC.
2. American Technology Systems Industries, Inc.
3. Belden Inc.
4. Berk-Tek; a Nexans company.
5. Corning Cable Systems.
6. CSI Technologies Inc.
7. Dynacom Inc.
8. Hubbell Premise Wiring.
9. Molex Premise Networks; a division of Molex, Inc.
10. Siemon Co. (The).

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.8 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Four-port-connector assemblies mounted in single faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.9 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

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

2.10 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A 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."

2.11 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

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

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

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Install cables in pathways 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.

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.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. 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 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 and not more than 6 inches 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- 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 TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. 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 long not less than 12 inches in diameter below each feed point.

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

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables 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.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

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

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

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

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

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

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch 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.

3.6 IDENTIFICATION

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

1. Administration Class: 2.
2. Color-code cross-connect fields. 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 TIA/EIA-606-A for Class 2 level of administration, including optional identification requirements of this standard.

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, 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 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. 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 jacks and plugs are used for both voice and data communication cabling, use a different color for jacks 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 jacket color but still complies with requirements in TIA/EIA-606-A.

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

3.7 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visually inspect UTP and optical fiber cable 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 TIA/EIA-568-B.1.
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 TIA/EIA-568-B.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. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

6. UTP Performance Tests:

a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.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.

7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
8. Final Verification Tests: Perform verification tests for UTP and optical fiber 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.

C. 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.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to 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.

END OF SECTION 271500

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Contractor to Provide all work as detailed in the Contract Drawings and Specifications as a turn-key installation, including all material, labor, programming, as-built documentation, warranties, taxes, freight and permits. Only items and requirements specifically stated to be provided under another section shall not be a requirement for this section of the work.
2. Electrical Contractor to provide and install:

a. HDMI Cabling
b. VGA Cabling
c. Composite Video Cabling
d. Stereo Audio Cabling
e. Speaker Cabling
f. Microphone XLR Cabling
g. Shielded UTP Cabling
h. RS232-Control Cabling
i. IR Control Cabling
j. Dry Contact Cabling

1.2 RELATED DOCUMENTS

A. Related Sections:

1. Section 27 41 16 “Integrated Audio Video Systems”

1.3 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this contract shall be applicable to this contract.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the Contract Documents.

1.4 SUBMITTALS

A. Refer to Section 01 for submittal requirements.

1.5 QUALITY ASSURANCE

A. All cable 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 Architect. Equipment and materials shall be of the quality and manufacture indicated. The Equipment specified is based on the acceptable manufacturers listed.

B. The Contractor shall provide in-house engineering and project management capabilities consistent with the requirements of the work. The Contractor shall have a project manager and field supervisor in place which oversees the entire project until completion of the project. The assigned project manager will be responsible for coordination, scheduling, manpower, commissioning etc. of the project. The Contractor’s field supervisor shall be present during the full duration of the project to oversee field installations and to coordinate with other trades to ensure progress on the project.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Electrical contractor shall confirm all faceplate colors, configurations, and labeling prior to installation.

2.2 HDMI CABLING

A. Electrical Contractor shall provide HDMI cabling meeting the following specifications:

1. Minimum 24 AWG construction
2. Cabling shall be NEC, CMP rated.
3. Male connector on each end
4. Minimum resolution of 1920 x 1200 @ 60 Hz
5. Max refresh rate of 120 Hz
6. Minimum data rate of 4.95 Gbps
7. 24 bit color depth
8. Acceptable Manufacturers:

    a. Cable-comm
    b. FSR
    c. Comprehensive
    d. Crestron
    e. Hubbell
    f. C2G

2.3 VGA CABLING

A. Electrical Contractor shall provide and install VGA cabling meeting the following specifications:

1. Cabling shall be NEC, CMP rated.
2. Minimum 28 AWG construction
3. Cabling shall meet or exceed UXGA performance at length provided.
4. Connectors shall be designed for wall box or surface box bulkhead installation.
5. Acceptable Manufacturers:

    a. Conquest
    b. C2G
    c. Comprehensive
    d. Crestron
    e. Hubbell

2.4 COMPOSITE VIDEO CABLING

A. Electrical Contractor shall provide and install composite video cabling meeting the following specifications:

1. Cabling shall be NEC, CMP rated.
2. Minimum 24 AWG construction
3. Cabling shall contain a copper clad steel center conductor with a foam dielectric, aluminum braid and foil shield that meets the standards of the Underwriters Laboratory.
4. Nominal impedance of 75 ohms with braid coverage rating of 92% or an effective RFI shielding greater than 110dB is required.
5. Acceptable Manufacturers:

    a. Conquest
    b. C2G

c. Comprehensive
d. Crestron

2.5 STEREO AUDIO CABLING

A. Electrical Contractor shall provide and install stereo audio cabling meeting the following specifications:

1. Cabling shall be minimum 22 AWG, stranded one (1) pair copper.
2. Cabling shall be Cabling shall be NEC, CMP rated.
3. 3.5mm stereo mini p lug (male) or RCA connectors on each end.
4. Cabling shall carry a balanced audio signal.
5. Acceptable Manufacturers:

a. Hosa
b. Belden
c. Pro Co
d. C2G

2.6 SPEAKER CABLING

A. Electrical Contractor shall provide and install speaker cabling and appropriate connectors meeting the following specifications:

1. Cabling shall be NEC, CMP rated.
2. Cabling shall be minimum 14 AWG, stranded one (1) pair copper.
3. Plenum rated.
4. Acceptable manufacturers

a. Hosa
b. C2G
c. Crestron
d. Belden

2.7 MICROPHONE XLR CABLING

A. Electrical Contractor shall provide and install microphone cabling and appropriate connectors meeting the following specifications:

1. Cabling shall be NEC, CMP rated.
2. Cabling shall be minimum 20 AWG, stranded one (1) pair copper.
3. Overall shield: 100% coverage of aluminum polyester foil with drain wire
4. Balanced audio.
5. Acceptable Manufacturers:

a. Pro Co
b. C2G
c. Hosa
d. Shure

2.8 SHIELDED UTP CABLING

A. Electrical Contractor shall provide and install shielded UTP cabling and appropriate connectors meeting the following specifications:

1. Cabling shall be NEC, CMP rated.
2. 24 AWG x8 copper conductors.
3. Insulation minimum .007 inch thick FEP
4. Cabling shall be plenum rated.
5. Overall shield: 100% coverage of Mylar tape with aluminum on the outside with drain wire
6. Acceptable Manufacturers:
   a. Belden
   b. Comprehensive

c. Hubbell
d. Crestron

2.9 RS-232 CONTROL CABLING

A. Electrical Contractor shall provide and install RS-232 control cabling and appropriate connectors meeting the following specifications:
1. Cabling shall be NEC, CMP rated.
2. Cabling shall be minimum AWG 20, stranded one (1) pair copper.
3. Cabling shall be Plenum rated
4. Acceptable manufacturers:
a. Belden
b. Comprehensive
c. Conquest
d. Crestron

2.10 IR CONTROL CABLING

A. Electrical Contractor shall provide and install infrared control cabling and appropriate connectors meeting the following specifications:
1. Cabling shall be NEC, CMP rated.
2. Plenum rated.
3. Cabling shall be minimum AWG 20, stranded one (1) pair copper.
4. Acceptable manufacturers:
a. Belden
b. Comprehensive
c. Conquest
d. Crestron

2.11 DRY CONTACT CABLING

A. Electrical Contractor shall provide and install microphone cabling and appropriate connectors meeting the following specifications:
1. Cabling shall be NEC, CMP rated.
2. Plenum rated.
3. Minimum
4. Acceptable manufacturers
a. APC
b. Belden
c. Hubbell

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with Manufacturer’s specifications and published standard’s recommendations.

C. Wiring:

1. Run wire with conduit, exposed above accessible ceilings, below accessible floors, in cable trays and in riser rooms.
2. Utilize cable trays whenever possible.
3. All cabling shall be installed per Using Agency’s requirements.
4. Provide plenum rated cable when routed through plenum areas.

5. Provide code compliant fire proofing techniques for all penetrations of fire rated partitions and slabs.
6. Fasten cables securely to building structure every 5 feet at minimum throughout cable paths.
7. Cable runs shall be continuous from device location to the final point of termination.
8. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on wire and cable.
9. Skyfold Wall shall be connected through dry contact cabling to the control system in the equipment rack. Install according to Manufacturer's specifications

D. Component Connections:

1. Prepare wire ends for attachment to components in accordance with Manufacturer recommendations.
2. Wire nuts shall not be an acceptable means of connecting wire and cable. All connections shall be made by crimp connection only.

3.2 AUDIO VIDEO CABLING

A. General Requirements

1. Cables are to be installed in flush mounted boxes located at location as shown on the drawings. All patch cords shall be bundled together using hook and loop style cable ties. No zip ties are permitted on patch cord cable management.
2. All cables are to be terminated into snap in faceplate inserts and fully connected to all Audio/Visual equipment provided by the Contractor.
3. All faceplates and cabling shall be labeled with appropriate labels as to the source and destination of cabling.

3.3 SYSTEM ACCEPTANCE

A. An authorized representative of the Owner along with the Architect and the Owner's Representative shall review all audio visual technology components to assure they are properly installed, functional and integrated into the Owner's existing technology infrastructure.

B. All devices shall be reviewed prior to final system acceptance.

1. The Contractor shall provide two (2) weeks advance notification to the Architect and Using Agency's Representative for scheduling of the final system acceptance.
2. The Contractor shall provide two copies of recorded drawings and two copies of completed testing/as built documents.
3. The Contractor shall provide in AutoCAD an electronic version of the recorded documents.

C. Punch list is developed and distributed by the Architect:

1. The Contractor shall produce documentation to demonstrate the punch list has been completed and the installation is at Final Completion.

D. Once the system has been accepted by the Owner, that date will be noted as the start of the warranty period.

E. The Owner reserves the right to suspend and/or terminate testing at any time when the system fails to perform as specified.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Horizontal cabling is the portion of the UTP cabling system that extends from the work areas to the Equipment Room (ER) or Telecommunications Room (TR). The horizontal cabling shall be configured in a star topology, and include the horizontal cables, the mechanically terminated jacks/inserts and the faceplates in the work areas.

B. Locations of user drops are shown on T-Series Technology Drawings.

C. This section includes minimum requirements for the following:

1. Category 6a UTP Cable from TR to Workstation.
2. Installation, Termination, and Testing Methods.

D. Related Sections include the following:

1. 27 05 53 - Identification for Communication Systems
2. 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
3. 27 11 19 - Communications Termination Blocks and Patch Panels
4. 27 15 43 - Communications Faceplates and Connectors

1.2 QUALITY ASSURANCE

A. All telecommunications equipment and cabling 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 approval of the Architect and Owners Representative. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based on the acceptable manufacturers listed. Where "Or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and work specified herein shall comply with the requirements of the local Authority Having Jurisdiction. Refer to Section 270000 for all applicable standards and codes.

C. Strictly adhere to all Category 6a installation practices when installing UTP data cabling.

PART 2 - PRODUCTS

2.1 CATEGORY 6A CABLING

A. Contractor shall provide data cabling from each required outlet location to the ER/TR.

B. All cabling shall be plenum rated. Jacket color shall be blue unless otherwise noted.

C. Acceptable Manufacturers:

1. Commscope Systimax GigaSPEED XD10, #2019B

2. Or Equivalent

2.2 EMERGENCY BLUE PHONE TOWER UTP CABLING

A. Contractor shall provide Category 6 UTP cabling from emergency phone locations to the ER/TR.

B. All cabling shall be rated for underground burial. Jacket color shall be black unless otherwise noted.

C. Acceptable Manufacturers:

1. Commscope Systimax GigaSPEED XL, #1571A

PART 3 - EXECUTION

3.1 SCOPE OF WORK

A. Before the installation of Horizontal Cabling will be allowed to begin, the telecommunications Contractor must provide a mock-up of the labeling and wiring to a sample faceplate and patch panel.

1. The mock-ups must be reviewed by an appropriate representative of the University and approved prior to performing any final wiring required by the project documents.

B. Installation of Horizontal Copper Cabling

1. 4-pair UTP cables should withstand 25 foot-pounds of pulling pressure. This number shall be verified by the wire manufacturer.
    a. Maximum cable length is limited to 90 meters (295 feet) from the jack to the patch panels.
    b. Comply with ANSI/TIA/EIA-569 standard regarding the requirements and recommendations for separation of copper telecommunication cabling from sources of electromagnetic interference.
    c. The Contractor shall replace any damaged cable at no expense to the University. No repair will be allowed on damaged cables.
2. Cabling shall be terminated at the station jack and at the equipment room as indicated in ANSI-TIA- EIA-568, wiring configuration T568B.
    a. The modular faceplate at the user end shall be equipped with inserts for communication services as indicated on plans.
    b. Station cable in the TR shall be terminated on Category 6a patch panel located in the equipment racks.
    c. The minimum bend radius of Category 6a UTP cable shall not be smaller than four (4) times the diameter of the jacketed cable, and shall not cause the cable jacket to buckle.
    d. Route cables from the back of the patch panel through its coupler openings and loosely attach them to the wire manager with Velcro cable ties, leaving enough slack for re-termination at a future date.
    e. Remove only as much jacketing as needed to terminate properly to the connecting hardware, keeping the amount of jacketing removed to an absolute minimum.
    f. Do not untwist pairs more than 0.5 inches.
    g. Visually inspect cable pairs for bare wire and other defects before terminating wires.
    h. Once all of the cables have been terminated, dress the cable slack behind the panel with Velcro tie wraps tightened to a snug but not compressing fit.

C. Testing of Horizontal Copper Cabling

1. Perform visual inspection to ensure that all cables are terminated on the eight position station jacks on both ends in proper color code order.
2. All terminated cabling runs shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements found in the TIA/EIA-568-C series of standards. All pairs in each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation, including (but not limited to) cables, connectors, patch panels, and cordage shall be repaired or replaced in order to ensure 100% usability of all installed runs.
3. All balanced twisted-pair cable links shall be tested for basic continuity and length, as indicated below. Of the parameters listed, it is understood that PSANEXT cannot be tested using current field test equipment.
4. Continuity – Each pair in every installed cabling run shall be tested using a test set that detects and identifies opens, shorts, polarity and pair reversals, crossed pairs, and split pairs. The results shall be recorded as Pass/Fail (as indicated by the test set) and referenced to the appropriate cable identification number and circuit/pair number. Any fault shall be corrected and the run re-tested prior to final acceptance.
5. Length – Every installed cabling run shall be tested for installed length using a time domain reflectometer (TDR) device. The cable length shall not exceed 90m (295 ft). The cable length shall be recorded, referencing the cable identification number and circuit/pair number.
6. Category 6a performance testing shall be done according to the published standards.
7. The approved handheld tester will have the capability to be programmed with current Category 6a requirements as specified in ANSI/TIA/EIA-568 standards.

8. Documentation will include cable ID (same as jack ID) to be marked on the punch down blocks and patch panels in the telecommunication closet, station jack ID to be marked on the station jack and results of the testing done with the cable analyzer.
9. Analyzer documentation will also need to be in the "csv" or "dat" format.
    a. Results must be labeled using the information outlet labeling scheme for the project.
10. Test results shall be stored on a CD and delivered to the University's Information Technology Services representative.
11. Test results shall be verified by the designated University personnel as part of the inspection and acceptance procedure.

D. Warranty and Certification

1. In order to facilitate quicker turn-around for ordering and activating new information outlets in the building, the telecommunications Subcontractor shall submit partial jack lists that are tested and approved rather than submitting the lists and test results of the entire building.
2. The contractor shall provide a minimum Commscope Systimax fifteen (15) year warranty for all passive components used in the installed Category 6a system. Defective and/or improperly installed products shall be replaced and/or reinstalled at no cost to the owner of the system.
3. The Vendor shall provide a User Manual to the owner of the System. This document describes essential system elements and specifies the Owner's responsibilities for maintaining the integrity of the installed cabling system over time. The User Manual shall contain guidelines for cabling system modifications (e.g., relocations, additions, changes to services), in addition to labeling and record-keeping maintenance requirements.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes the minimum requirements for the installation, termination, and labeling of the faceplates and connectors as depicted on the Drawings and required by these specifications.

B. This section includes minimum requirements for the following:

1. Category 6a Jacks
2. Information Outlet Faceplates and Inserts
3. Audio Visual Outlet Faceplates and Inserts

C. Related Sections include the following:

1. 27 05 28 - Pathways for Communications Systems
2. 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
3. 27 11 19 - Communications Termination Blocks and Patch Panels
4. 27 15 00.23 - Audio-Video Communications Horizontal Cabling
5. 27 15 13 - Communications Copper Horizontal Cabling

1.2 QUALITY ASSURANCE

A. All telecommunications and audio visual equipment and cabling 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 approval of the Architect and Owners Representative. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based on the acceptable manufacturers listed. Where "Or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and work specified herein shall comply with the requirements of the local Authority Having Jurisdiction. Refer to Section 270000 for all applicable standards and codes.

1.3 SUBMITTALS

A. Manufacturers catalog sheets, specifications and installation instructions for all products to be installed within the scope of work included under this contract shall be submitted for approval.

PART 2 - PRODUCTS

2.1 CATEGORY 6A JACKS

A. Contractor shall provide the quantity of Category 6a jacks required by the contract drawings for the project. Provide jacks in faceplates in work areas as well as ER and TR locations as needed.

B. Acceptable Manufacturers:

1. Commscope Systimax GigaSPEED X10D MGS600 (No Exceptions)
2. Contractor shall confirm all information outlet colors with the Owner prior to installation

2.2 STANDARD INFORMATION OUTLET FACEPLATES AND INSERTS

A. Contractor shall provide the quantity of faceplates and inserts required by the contract drawings for the project.

B. Faceplate colors shall be confirmed with the Architect prior to submittal information

C. The following are the standard faceplates and inserts for the project.

1. Commscope Systimax M-Series Faceplates (No Exceptions)

2.3 STANDARD AUDIO VISUAL FACEPLATES AND INSERTS

A. Contractor shall provide the quantity of faceplates and inserts required by the contract drawings for the project. Refer the T-Series drawings for typical layout of audio video input/output locations.

B. Faceplate inserts for audio and video signals shall include but are not limited to HDMI, HD15 (VGA), RCA, and 3.5mm TRS.

C. Faceplate colors shall be confirmed with the Architect prior to submittal information

D. Acceptable Manufacturers:

1. Crestron
2. Extron
3. Or Equivalent

2.4 GROMMET FACEPLATES

A. Contractor shall provide grommet faceplates as needed for audio and video locations throughout the project.

B. Grommet faceplates shall provide a minimum of 1.5” Diameter opening for cable pass through.

C. Faceplates shall be provided to match all other device faceplate locations.

PART 3 - EXECUTION

3.1 GENERAL

A. All cables shall be terminated with high density modular jacks that snap into a faceplate mounted on a wall outlet box or surface raceways.

B. Outlet boxes shall be secured to the building with mechanical fasteners. Adhesive fasteners are not allowed.

C. All openings not used shall be filled with appropriate blank inserts.

D. All locations including Audio Video connectors shall be labeled as to its purpose and/or destination. Confirm labeling with Architect and Owner before final installation.

3.2 INFORMATION OUTLET AND AUDIO VISUAL ROUGH-IN

A. Standard Information Outlets (single gang or double gang) shall be located at the same height as 120 volt AC outlets (normally 18" above finished floor).

B. Wall mounted telephones require a double gang box with a single gang plaster ring, positioned 54" A.F.F. to the center of the outlet box.

C. Information Outlets above countertops should be installed so that the center of the outlet box will be a minimum of 12" above the countertop.

1. A countertop with a backsplash may require different outlet box locations.

D. No Information Outlet will be installed such that workstations or devices served from it cannot be reasonably reached by a 16ft cord.

3.3 LABELING

A. Contractor shall complete labeling according to section 27 05 53 - Identification for Communications Systems.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes minimum requirements for the following:

1. Emergency Blue Light Phone Towers.

B. Related work specified elsewhere:

1. Section 271513 COPPER HORIZONTAL CABLING
2. Division 26 – ELECTRICAL
3. Division 28 – ELECTRONIC SAFETY AND SECURITY

1.2 QUALITY ASSURANCE

A. All pathways and associated 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 architect and Owners Project Manager. 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. Materials and work specified herein shall comply with the applicable requirements of:

1. National Electric Code (NFPA 70) including the following Articles:

a. 318 Cable Trays.
b. 331 Electrical Nonmetallic Tubing.
c. 348 Electrical metallic tubing.
d. 349 Flexible metallic tubing.
e. 350 Flexible metal conduit.
f. 351 Liquid-Tight Flexible metal conduit and Liquid-Tight flexible nonmetallic conduit.
g. 352A Surface Metal Raceways.
h. 352B Surface Nonmetallic raceways.
i. 353 Multioutlet Assembly.
j. 354 Underfloor raceways.
k. 362 Metal Wireways and nonmetallic Wireways.
l. 370 Outlet, Device, Pull and Junction Boxes, Conduit Bodies and Fittings.
m. 645 Information Technology Equipment.
n. 770 Optical Fiber Cables and Raceways.
o. 800 Communications Circuits.

2. The following American National Standards Institute (ANSI) standards:

a. ANSI-C80.3 Specification for Electrical Metallic Tubing, Zinc-coated.

3. The following Telecommunication Industry Association (TIA) standards:

a. ANSI/TIA/EIA – 568-B Commercial Building Telecommunications Cabling Standard.
b. ANSI/TIA/EIA – 569-A Commercial Building Standard for Telecommunications Pathways and Spaces.
c. EIA/TIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
d. EIA/TIA-607 Commercial Building Grounding and Bonding requirements for Telecommunications.

4. The following BICSI guidelines:

a. BICSI Telecommunications Distribution Design Manual (Most Recent Edition).
b. BICSI Telecommunications Cabling Installation Manual (Most Recent Edition).

5. The following UL Standards:

a. UL 1, 2000 Flexible Metal Electrical Conduit.
b. UL 3, 1999 Flexible Nonmetallic Tubing for Electric Wiring.
c. UL 5, 1996 Surface Metal Electrical Raceways and Fittings.
d. UL 360, 1996 Liquid-Tight Flexible Steel Conduit, Electrical.
e. UL 514B, 1996 Fittings for Conduit and Outlet Boxes.
f. UL 797, 1997 Electrical Metallic Tubing.
g. UL 870, 1995 Electrical Wireways, Auxiliary Gutters and Associated Fittings.

1.3 SUBMITTALS

A. Contractors' Bid shall include product data for the all the equipment specified herein.

PART 2 - PRODUCTS

2.1 EMERGENCY BLUE PHONE TOWER

A. General Description

1. The Emergency Phone Tower shall be rectangular in appearance and made of continuous steel construction. It shall stand 9' from the base to the top of tower. The word "EMERGENCY" with bright reflective lettering shall be located on all four sides and each letter shall be a minimum of 3" in height. The phone shall be compliant with the American with Disabilities Act (ADA) and be powered with 120 VAC.
2. The Emergency communication component shall comply with the ADA. The phone shall have the ability to be programmed with up to 5 emergency phone numbers. Upon activation of the emergency push button; a call will be automatically placed, the strobe shall instantaneously flash until the call has been disconnected by the called party.

B. Construction

1. The Tower shall be constructed of hot rolled steel that is weatherproof and manufactured with a weather and corrosion resistant finish.
2. The Tower is to stand 9' tall from base to top, 10 ¾" wide and 6" deep and all aspects of its construction will be vandal resistant.
3. The emergency phone plate shall be made of 12 gauge Stainless Steel and be 11 ¼" inches high and 8 ¼" inches wide and will attach to the tower using 6 stainless steel screws.
4. The emergency phone button shall be located approximately 36" above the base to ensure conformance with the ADA requirements.
5. The Tower must have a Braille faceplate located approx. 36" above the base to ensure conformance with the ADA requirements.
6. The base of the Tower shall be 5/8" in thickness, welded to body of tower with 4 built in 1" mounting holes to attach to a concrete mounting pad.
7. The strobe and beacon light shall be mounted directly to the top of the Tower.
8. The strobe electronics access opening shall be 7 ¼" high and 6 ¾" wide and located on the back of the tower.
9. Phone electronics and most electrical connections must be housed in a NEMA enclosure within the Tower.
10. The Tower shall have a rear access panel located on the back of the tower, directly behind the phone plate. The panel provides access to the electrical and phone connections.

C. Mounting

1. The Tower is constructed of steel that is of one continuous piece with a welded internal base 5/8" thick containing four built in mounting holes. A template for installing the anchor bolts is to be included. The unit shall be mounted on a concrete pad with 3/4" galvanized anchor bolts, galvanized nuts and washers.

D. Electrical

1. The phone shall be powered by 120 VAC. Power must be supplied to the tower through conduit that extends up into the base of the tower.

2. The power consumption cannot exceed 7 amps with a fully active phone, strobe, beacon, faceplate LED, wide-area speakers, wide-area lighting and camera.
3. The phone line must be supplied via cable that is run through conduit that extends up into the base of the tower.

E. Lights

1. The dual element light shall be located at the top of the Emergency Phone Tower. The light shall contain a strobe and a constant-on beacon.
2. The strobe shall be activated upon pushing of the emergency phone button. It shall have an output of approx. 150 to 500 candelas and flash at a rate of a minimum of 60 flashes per minute.
3. The beacon shall provide continuous, steady illumination and will utilize an LED cluster as its light source.
4. A Photocell shall be offered as an option to allow for the deactivation of the beacon during daylight hours.
5. A single element strobe shall be offered as an option. The strobe shall be activated upon pushing of the emergency phone button.
6. Strobes must also be available in red and amber.

F. Communications

1. The unit shall have an ADA compliant and vandal resistant speaker phone.
2. The phone shall be a push once to talk phone. Once the button has been pushed, the phone will call programmed emergency numbers. The phone must be capable of being programmed with up to 5 emergency numbers.
3. The phone shall have Location Message capability. Phone must have a minimum 18 second recordable message capability programmable to play 1 or 2 times or play continuously until * is pressed by called party. Phone shall notify called party of the location of the call upon being received at the emergency dispatch center.
4. Phone shall be capable of allowing the called party to replay the phone location message if necessary to ensure an understanding of the location of phone tower.
5. Once call has been made (button pushed), the call can only be terminated by the called party.
6. Phone plate must have a red LED that will light up upon push of the button. The light shall be a solid color when the phone is activated and will flash when call has been answered.
7. The speakerphone must be capable of being programmed and reprogrammed on-site and remotely.
8. Line powered phones and Dip Switch programming are not acceptable.
9. Standard Phone features:

    a. Programmable with up to 5 emergency phone numbers
    b. Weatherproof speaker
    c. Weatherproof microphone
    d. Operating Temperature of between -40˚F to +150˚F (-40˚ to + 65˚C)
    e. Programmable passwords
    f. On-Site or Remote Programmable
    g. EEPROM memory to protect programming
    h. Adjustable speaker and microphones levels
    i. Programmable location message with human voice recognition
    j. Programmable conversation time
    k. 2 Button – 2 Number capability
    l. Remote and on-site diagnostic testing
    m. Ability to control additional accessories (cameras, speakers)

G. Finish

1. Unit shall be powder coated white with a weatherproof and corrosion resistant finish. End user must be capable of requesting custom colors. Confirm final colors of unit with the Owner prior to ordering.
2. Unit must be UV resistant.

H. Graphics

1. All wording shall be made of highly reflective vinyl lettering.
2. The standard text such as “EMERGENCY” shall be available in blue with each letter to be a minimum of 3” in height.
3. Text shall be available in white for towers painted with custom colors.

I. Options

1. There shall be custom paint options for the Emergency Phone Tower.
2. System must allow for custom school or company logo on the tower similar to how the word “Emergency” is affixed.
3. System must allow for custom tower notification lettering in place of “Emergency” if requested.
4. Wireless Communication options shall be available. These options shall consist of cellular, two-way radio, and 900 MHz communications.
5. Voice over IP (VoIP) communication option shall be available.
6. A Wide-Area Broadcast Speaker option shall be offered. The system would consist of the standard Tower with an audio amplifier and weather resistant speakers.
7. A Wide-Area Lighting option shall be offered. The system consists of a weather and vandal resistant light attached to a steel mounting pole. The pole is attached to the back of the tower using an integral mounting plate.
8. All options shall be confirmed with the Owner prior to placing an order.

J. Warranty

1. The unit shall be warranted for a period of two years.

K. Acceptable manufacturer:

1. Rath Security (No exceptions)

2.2 CONDUIT

A. Contractor shall provide conduit for electrical and communications cabling as shown in detail on Contract drawings. Refer to Section 270528 - Pathways for Communications for conduit requirements.

2.3 UTP CABLE

A. Contractor shall provide and install Outdoor Rated UTP cabling from emergency phone locations to the ER/TR. Refer to Section 271513 - Copper Horizontal Cabling for cabling requirements.

PART 3 - EXECUTION

3.1 EMERGENCY BLUE PHONE TOWER

A. Locations of emergency phone towers shall be as shown on the Contract Drawings.

B. A concrete pad measuring no less than 3' x 3' with a minimum thickness of 8" shall be installed for the purpose of mounting the emergency phone tower.

C. Contractor shall follow all manufacturer requirements and recommendations for installation of the tower.

3.2 CONDUIT

A. Conduit to tower shall be a minimum of 30" below finish grade and shall extend through the concrete pad into the base of the tower.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. RS-232 cabling.
2. RS-485 cabling.
3. Low-voltage control cabling.
4. Control-circuit conductors.
5. Fire alarm wire and cable.
6. Identification products.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

E. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

F. RCDD: Registered Communications Distribution Designer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. 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.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

2.3 RS-232 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.4 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.5 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.6 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway; and power-limited cable, complying with UL 83, concealed in building finishes.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.7 FIRE ALARM WIRE AND CABLE

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

1. Comtran Corporation.
2. Draka Cableteq USA.
3. Genesis Cable Products; Honeywell International, Inc.
4. Rockbestos-Suprenant Cable Corp.
5. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

2.8 IDENTIFICATION PRODUCTS

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

1. Brady Worldwide, Inc.
2. HellermannTyton North America.
3. Kroy LLC.
4. Panduit Corp.

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

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

2.9 SOURCE QUALITY CONTROL

A. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

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 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

3.2 WIRING METHOD

A. Install wiring in metal pathways and wireways.

1. Minimum conduit size shall be 3/4 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Install cable, concealed in accessible ceilings, walls, and floors when 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. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
4. Install conductors parallel with or at right angles to sides and back of enclosure.
5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
6. Mark each terminal according to system's wiring diagrams.
7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. 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.
6. 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.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B 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.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between 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.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Section 260533 "Raceways and Boxes for Electrical Systems."

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

G. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.6 CONNECTIONS

A. Comply with requirements in Division 08 Section "Door Hardware" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Section 281300 "Access Control" for connecting, terminating, and identifying wires and cables.

C. Comply with requirements in Section 282300 "Video Surveillance" for connecting, terminating, and identifying wires and cables.

D. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System for connecting, terminating, and identifying wires and cables.

3.7 FIRESTOPPING

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

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

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

3.8 GROUNDING

A. For communications wiring, comply with J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 IDENTIFICATION

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

3.10 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 280513

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

   a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

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

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

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

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

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

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

   a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
   b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and 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.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual 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 annular clear space between pipe and sleeve for installing mechanical sleeve seals.

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

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 280544

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Security access central-control station.
2. One or more security access networked workstations.
3. Security access operating system and application software.
4. Security access controllers connected to high-speed electronic-data transmission network.

1.2 DEFINITIONS

A. CCTV: Closed-circuit television.

B. CPU: Central processing unit.

C. Credential: Data assigned to an entity and used to identify that entity.

D. dpi: Dots per inch.

E. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

F. GFI: Ground fault interrupter.

G. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

H. I/O: Input/Output.

I. LAN: Local area network.

J. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

K. PC: Personal computer. Applies to the central station, workstations, and file servers.

L. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.

M. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.

N. RAS: Remote access services.

O. RF: Radio frequency.

P. ROM: Read-only memory. ROM data are maintained through losses of power.

Q. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

R. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

S. UPS: Uninterruptible power supply.

T. USB: Universal serial bus.

U. WAN: Wide area network.

V. WAV: The digital audio format used in Microsoft Windows.

W. WMP: Windows media player.

X. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

Y. Windows: Operating system by Microsoft Corporation.

Z. Workstation: A PC with software that is configured for specific, limited security-system functions.

AA. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

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

1. Diagrams for cable management system.
2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:

    a. Workstation outlets, jacks, and jack assemblies.
    b. Patch cords.
    c. Patch panels.

4. Cable Administration Drawings: As specified in "Identification" Article.
5. Battery and charger calculations for central station, workstations, and controllers.

C. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

D. Other Action Submittals:

1. Project planning documents as specified in Part 3.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Microsoft Windows software documentation.
2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
4. System installation and setup guides with data forms to plan and record options and setup decisions.

1.6 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. Alarm Printer Black/Red Ribbons: Package of 12.
2. Laser Printers: Three toner cassettes and one replacement drum unit.
3. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.
4. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70, "National Electrical Code."

E. Comply withSIA DC-03 and SIA DC-07.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Central Station, Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in air-conditioned indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Outdoor Environment: NEMA 250, NEMA 250, Type 3R enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph.
4. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X enclosures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Lenel Systems International Inc.

2.2 DESCRIPTION

A. Security Access System: PC-based central station and field-installed controllers, connected by a high-speed electronic-data transmission network.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

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

3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for guard tours and key control.
11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.3 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."

C. Wiring Method: Install wiring in raceway and cable tray 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. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

D. Install LAN cables using techniques, practices, and methods that are consistent with Category 6A rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.

E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

F. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.4 CABLE APPLICATION

A. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 232-F Cabling: Install at a maximum distance of 50 ft..

D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft..

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft..
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft..

G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft..

3.5 GROUNDING

A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

A. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch- high text and symbols as required. Push-button switches shall be connected to the controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.

B. Install card readers.

3.7 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with TIA/EIA 606-A.

B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

3.8 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. Tests and Inspections:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.11 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.

2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION 281300

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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. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

A. Provide all work as detailed in the Contract Drawings as a turn-key installation including integration into the existing facility systems, all material, labor, programming, as-built documentation, warranties, taxes, freight and permits. Only items and requirements specifically stated to be provided under another section shall not be a requirement for this section of the work.

B. The end product which the contractor is to produce shall be a complete, operational and functional integrated observation camera system.

C. Provide the following Systems and Equipment:

1. Closed Circuit Television (CCTV) System.
2. Wire and Cable.

D. Coordinate all installation and integration of the security system with the following related systems:

1. Division 27 - Communications
2. Wire and Cable

1.3 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the Contract Documents.

1.4 QUALITY ASSURANCE

A. Contractor Qualifications:

1. All work specified herein shall be the responsibility of the single prime technology package provider. Contractors shall document a minimum of five years' experience in the fabrication, assembly and installation of system of similar complexity as specified herein. The documentation shall include the names, locations and points of contact for at least three installations of the type and complexity specified herein. The contractors shall provide a brief overview of each system detailing what CCTV system was used; the amount of equipment installed; and certify that the system has been in operation for a minimum of 24 months.
2. The Contractor shall have a service facility and organization with staffing capable of providing comprehensive maintenance and service to the specified systems within 4 hours after being called, 24 hours per day and 7 days per week.
3. The Contractor shall provide in-house engineering and project management capabilities consistent with the requirements of the work. The Contractor shall have a project manager and field supervisor in place which oversees the entire project till completion of the project. The assigned project manager will be responsible for coordination, scheduling, manpower, commissioning etc. of the project. The Contractor's field supervisor shall be present during the full duration of the project to oversee field installations and to coordinate with other trades to ensure progress on the project.

4. The Contractor must be familiar with local codes and contract conditions pertaining to this project.

B. Product Standards:

1. All materials installed on this or any other project must be new and the latest specification and version from the manufacturer.
2. All products installed shall be what is depicted in these specifications with no exceptions.

1.5 SUBMITTALS

A. General:

1. All submitted data shall be specific to this project and identified as such. Generic submittal data will not be accepted.
2. Submit transformer and amplifier locations (if used) for review.

B. Product Data:

1. Manufacturers' descriptive literature, illustrations and installation instructions for all components included within this project indicating compliance with applicable referenced standards, size, dimensions, model number, electrical characteristics, support requirements, connection requirements and all applicable information verifying that submitted components comply with Contract Documents.

C. Record Documents:

1. Identify component locations on the record drawings.
2. Manufacturer's warranty form in which manufacturer agrees to repair or replace components that fail, in materials or workmanship, within specified warranty period.

D. Operation and Maintenance Data:

1. Operation Data:

a. Include manufacturer’s installation and operating instructions.

2. Maintenance Data:

a. Servicing requirements, inspection data, preventative maintenance schedule, exploded assembly views, replacement part numbers and availability, location and contact numbers of service depot.

1.6 DELIVERY, STORAGE and HANDLING

A. Equipment and components shall arrive onsite properly protected and undamaged with containers, packaging and labels intact.

B. Store, handle and protect materials and equipment in accordance with Manufacturer's recommendations.

C. Provide additional protection during handling as necessary to prevent breaking scraping, marring, or otherwise damaging products or surrounding areas.

D. Protect all equipment and components that are to be installed within this project from theft, vandalism, and exposure to rain, freezing temperatures and direct sunlight.

E. Protect installed equipment and components from damage and prevent use by unauthorized persons.

1.7 EXTRA MATERIALS

A. Spare Parts:

1. The Contractor will maintain a spare parts inventory to resolve any critical component failure the day of the incident. Critical components shall be:

a. CCTV Cameras

1.8 WARRANTY AND SERVICE

A. Warranty:

1. The Contractor shall warrantee the completed work for a period of one year, from the date of commissioning, to be free of defect in design, workmanship or material.

B. Warranty Service:

1. In the event that defects in the materials and/or workmanship are identified during the warranty period, the contractor shall provide all labor and materials to correct the deficiency.
2. All service work shall be performed by manufacturer certified technicians.
3. All warranty service shall include the replacement of all parts and or components as required to restore normal system operation. If parts or components need to be repaired, then a loaner will be supplied and installed until the part or component can be repaired and reinstalled.
4. Immediately following a warranty service request, the Contractor shall provide written documentation to the owner which details the service work completed, cause of trouble and any outstanding work required to restore a complete and normal system.

C. Repair or Replacement Service:

1. Service on defective cameras shall be completed within the following schedule:

a. 8am to 5pm on business days

2. All repairs shall be completed within 48 hours from site arrival. If the failure exceeds 48 hours, the Owner reserves the right to require the Contractor to provide onsite manufacturer support at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of Authorities Having Jurisdiction.

2.2 Closed Circuit Television (CCTV) System:

A. General

1. The CCTV system shall be Internet Protocol (IP) based utilizing interior and exterior megapixel cameras mounted at specific locations identified in the T-Series Drawings.
2. Existing Network Video Recorders are located in the University Data Center and the Evan Center and shall be used as the central recording device for all cameras within the building.
3. Each CCTV camera location shall require ceiling or wall mounting. Contractor shall include all ceiling or wall mounting hardware as needed for a complete and functional camera location.
4. Video from each camera shall be transmitted on the building local area network. Owner provided network switches shall provide PoE to each camera location.

B. Network Video Recorders (Existing):

1. Network Video Recorder

a. NVRs are currently integrated with the existing Lenel OnGuard system for viewing live video and recorded video through a single interface.

2. Contractor shall provide adequate and appropriate licenses for all camera locations to ensure they are recorded on the existing NVRs.
3. Contractor shall provide all cameras and client viewing licenses.
4. Contractor shall ensure that each new camera location is fully integrated with the existing LenelOnGuard system. Contractor shall coordinate with the Owner to ensure the work is completed according to Owner's requirements.

C. CCTV Cameras, Housings and Mounts:

1. CCTV Cameras shall be 1/3 or 1/4 inch progressive scan CCD or CMOS, high resolution color, IP transmission based.
2. Provide backlight compensation for interior cameras with views that include exterior glass.
3. Provide cameras with super-dynamic or wide dynamic range technology where extreme light level changes may occur.
4. Exposed wiring of any kind shall not be acceptable.
5. Field verify the exact camera location, position and mounting with the Project Manager and Owner prior to installation.
6. Field verify and confirm camera views with the Project Manager and Owner prior to final installation and adjust camera positions and lens requirements as required.
7. All Cameras installed shall have a minimum three (3) year manufacturer warranty (No Exceptions).
8. Interior Fixed Miniature Dome CCTV Camera:
    a. Built-in H.264 and MJPEG digital signal output at 1280x1024 image resolution with up to 30 fps.
    b. MPEG-4/MJPEG dual stream output for simultaneous live monitoring and high resolution recording.
    c. Image refresh rate: 0.1 fps - 30 fps.
    d. All lenses to be vari-focal.
    e. All cameras and lenses to be color.
    f. All lenses to be auto iris.
    g. Cameras shall feature built-in IR (Infrared) illuminators.
    h. Camera shall be powered by the data transmission cable and conform to the IEEE 802.3af standard for Power over Ethernet.
    i. Contractor to provide gooseneck adapter for wall mounting where necessary.
    j. Wall mounted cameras shall be installed at a height of 14' above finished floor.
    k. Acceptable Manufacturers and Models:
        1) Sony SNC-DH180 (No exceptions)
9. Exterior Fixed Dome CCTV Camera:
    a. Built-in H.264 and MJPEG digital signal output at 1280x1024 image resolution with up to 30 fps.
    b. MPEG-4/MJPEG dual stream output for simultaneous live monitoring and high resolution recording.
    c. Image refresh rate: 0.1 fps - 30 fps.
    d. All lenses to be vari-focal.
    e. All cameras and lenses to be color.
    f. All lenses to be auto iris.
    g. Cameras shall feature built-in IR (Infrared) illuminators.
    h. Cameras shall feature a built-in heater.
    i. Cameras shall have a start temperature range of -20°C to +50°C (-4°F to +122°F) and an operating temperature range of -30°C to +50°C (-22°F to +122°F)
    j. Exterior cameras shall be installed at a height of 14' above finish grade.
    k. Cameras shall be wall mounted utilizing appropriate gooseneck wall mount adapters.
    l. Cameras shall be powered by the data transmission cable and conform to the IEEE 802.3af standard for Power over Ethernet.
    m. Acceptable Manufacturers and Models:
        1) Sony SNC-DH160 (No Exceptions)

2.3 WIRE AND CABLE

A. All wire and cable shall be Underwriter’s Laboratories (UL) approved for its intended application, shall meet all national, state and local code requirements for its application, and shall meet or exceed manufacturers’ recommendations for the components connected.

B. Provide outdoor or plenum rated cable as required by code.

C. All wire and cable shall meet individual system or subsystem manufacturer specifications.

D. Wire and cable shall comply with the applicable requirements of the National Electrical Code (NEC), latest edition, in regards to cable construction and usage.

E. Provide plenum rated category 6a UTP cabling from camera locations to ER/TR.

F. Patch Cables:

1. All patch cables shall be pre-manufactured.
2. The length of all patch cables shall be long enough to route neatly through cable management systems and to be dressed in neatly.
3. All patch cables shall have owner standard ends.

G. Acceptable Manufacturers:

1. Belden
2. West Penn Wire

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of Authorities Having Jurisdiction.

B. All installation shall be in accordance with manufacturers' specifications and published recommendations.

C. Run wire with conduit, exposed above accessible ceilings, below accessible floors, cable trays and in riser rooms.

D. Utilize cable trays whenever possible.

E. All cabling shall be installed per Owner's requirements.

F. Provide Plenum cable when ran through Plenum areas.

G. Provide code compliant fire proofing techniques for all penetrations of fire rated partitions and slabs.

H. Fasten cables throughout cable paths securely to building structure every 10 feet at minimum.

I. Cable runs shall be continuous from device location to the final point of termination.

J. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on wire and cable.

K. Prepare wire ends for attachment to components in accordance with manufacturer recommendations.

L. Wire nuts shall not be an acceptable means of connecting wire and cable. All connections shall be made by crimp connection only.

3.2 SYSTEM ACCEPTANCE

A. An authorized representative of the Owner along with the Architect shall review all security technology components to assure they are properly installed, functional, and integrated into the Owner's technology infrastructure.

B. Upon notification of project completion by the Contractor to the Project Manager, a final, on site review of the system shall be conducted by representatives of the Contractor, Owner, and the Architect. All components and systems must be deemed by all parties to be acceptable prior to final system commissioning.

C. Contractor shall coordinate with the existing Lenel OnGuard access control system and manufacturer to ensure the new camera locations are fully integrated with the existing system. System at a minimum will log events as needed to coordinate with the access control system.

D. The Contractor shall provide two weeks advance notification to the Owner for scheduling of the final system acceptance.

E. The Contractor shall provide two copies of recorded drawings and in electronic format and two copies of completed testing/as built documents.

F. The Contractor shall provide in AutoCAD an electronic version of the recorded documents.

G. The Contractor shall provide the Project Manager, Field Supervisor and a Support Technician during the final system acceptance process for adequate support during the testing process.

H. The Contractor shall staff the Owners Monitoring Station to acknowledge alarms during the testing.

I. The Contractor shall accompany the Owner’s Staff in the field to assist in the functional demonstration of security devices.

J. Punch list is developed and distributed by Architect and the Owner's Representative.

K. The Contractor shall produce documentation to demonstrate the punch list has been completed and the installation is at Final Completion.

L. Once the system has been accepted by the Owner, that date will be noted as the start of the warranty period. The owner reserves the right to suspend and/or terminate testing at any time when the system fails to perform as specified.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work required under this section consists of providing labor, equipment, supplies, materials, testing unless otherwise specified, and to perform the following operations recognized as necessary for the installation, termination, labeling, of conduits, boxes, raceways, etc., and the wiring of the Access control system. Access control wiring includes cables for doors, card readers, door contacts, door latches, and electric strikes.

1.2 RELATED SECTIONS

A. Related sections include the following:

1. 08 70 00 - Door Hardware
2. 26 00 00 - Electrical
3. 27 00 00 - Communications

1.3 INTENT OF DRAWINGS AND SPECIFICATIONS

A. These Specifications, together with the Drawings accompanying them, are intended to depict the installation requirements necessary to support this Project. Contractor shall furnish materials shown and/or called for on the Drawings but not mentioned in the Specifications, or vice versa, that are necessary for the installation and support of communications cabling, whether or not specifically called for in both. In addition, Contractor shall provide incidental equipment and materials required for the completion of systems included in this contract whether or not specified or shown on the Drawings.

1.4 DEFINITIONS

A. Door Switch – Flush mounted magnetic switch installed at the top of the door frame near the side opposite to the hinges that is connected back to card reader control board.

B. Controlled Door– Any door consisting of at least (1) door switch that is being monitored with central Lenel system board but without a card reader near the monitored door

C. Card Reader Door- Any door consisting of at least (1) card reader and that is monitored by the central Lenel system board.

D. LX Switch – Switch located in panic bar mounted on door or inside a mortise type latch to monitor position of the latch.

E. RX Switch – Switch located in magnetic lock panic bar mounted on door to monitor position of the panic bar (Request to Exit).

F. Power Transfer – Device connected to the door, on hinged side, and to the door frame for the purpose of transferring wires from the door frame to the door for monitoring and controlling the latches.

1.5 SUBMITTALS

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

B. Shop Drawings: Detail the system including the following:

1. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment.
2. Wiring Diagrams: Detail power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals.
3. Equipment Cabinet Drawings: Dimensioned and to scale.

C. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements. On request, submit evidence of experience and of relationship with equipment manufacturer.

D. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.

E. Field Tests Reports and Observations: Include record of final adjustments certified by Installer.

F. Maintenance Data: Include the following in maintenance manuals specified in Division 1:

1. Operating instructions
2. Troubleshooting guide
3. Wiring terminal identification
4. Equipment parts list

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of the product manufacturer for both installation and maintenance of units required for this Project. The installer shall have a minimum of three (3) years documented experience installing and servicing access control systems.

B. Manufacturer Qualifications: A firm experienced in manufacturing equipment similar to that indicated for this Project and that maintains technical support services capable of providing user with training, parts, and emergency maintenance and repair with a 24-hour- maximum response time. The manufacturer of the product specified in this section shall have a minimum of five (5) years of documented experience in the manufacture and design of access control systems.

C. Source Limitations: Obtain security equipment components through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. The access control system shall conform to all local and state jurisdiction requirements.

1.7 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. Card Readers: Furnish quantity equal to 10 percent of amount installed, but not less than 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products that are fully compatible with the existing Lenel OnGuard system.

2.2 SYSTEM REQUIREMENTS

A. Coordinate the features of materials and equipment to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Resistance to Electrostatic Discharge: System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to electrostatic discharges of up to 25,000 V in an environment with a relative humidity of 20 percent or less.

C. Equipment: Solid state, modular.

D. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.

2.3 ACCESS CONTROL SOFTWARE

A. Marian University has existing Lenel OnGuard access control software in use and all new access control locations shall integrate with existing software. Contractor shall provide appropriate licenses for each access control or monitoring location as needed.

2.4 ACCESS CONTROL SYSTEM CONTROLLER

A. Contractor shall provide a new Lenel Intelligent System Controller to be mounted in the main enclosure within the ER/TR.

1. Controller shall be connected to the University network and fully integrated into the existing Lenel OnGuard system.

2.5 INPUT/OUTPUT INTERFACE MODULES

A. Contractor shall provide input/output modules as required to fully integrate all new card readers and door monitoring hardware into Lenel system controller.

B. Acceptable Manufacturers and models:

1. Single Reader Interface Modules

a. Lenel LNL-1300

2. Dual Reader Interface Modules

a. Lenel LNL-1320

3. Input Control Modules

a. Lenel LNL-1100

4. Output Control Modules

a. Lenel LNL-1200

2.6 ACCESS CONTROL ENCLOSURE

A. Contractor shall provide and install an enclosure to house access control interface modules. Enclosure shall be mounted in the ER/TR as shown on the T-series drawings.

B. Enclosure shall accommodate a minimum of six (6) interface modules.

C. Enclosure shall be lockable.

D. Acceptable Manufacturers:

1. Lenel LNL-CTX6
2. Or approved equal

2.7 ACCESS CONTROL CARD READERS

A. Contractor shall provide access control card readers as required by the contract drawings.

B. Reader shall be capable of reading both a magnetic stripe and proximity card credential.

C. Reader shall be capable of RS-485

D. Acceptable Manufacturers:

1. AptiQ (No exceptions)

2.8 DOOR POSITION SWITCH (DPS)

A. Refer to Section 087100 - Door Hardware for requirements on door position switches.

2.9 REX MOTION SENSORS

A. The Request to Exit Motion Detector specified herein shall provide a means of shunting the Door Monitor Switch and/or the unlocking of the controlled door upon exiting.

B. The REX motion sensor shall be a single device capable of controlling single or dual leaf doors. The unit shall be ceiling or wall mountable and have adjustable patterns. The unit shall have an LED activity indicator. The device shall have two (2) Form-C relays for outputs.

C. Approved Manufacturers:

1. Bosch

2. GE
3. Schlage
4. Or approved equal

2.10 CABLES

A. RS485 Communication Wire - Provide communication cables from Main Access Control Cabinet to each card reader and controlled device.

1. Each RS485 cable shall be a 2-pair, individually shielded, 22 gauge, stranded polypropylene insulated conductors, with (1) 24 gauge stranded tinned copper drain wire and overall chrome PVC jacket, UL CM rated.

2. Acceptable Manufacturers:

a. Belden
b. Or approved equal

B. Power Supply Cable - Provide power cable from power supply to solenoid in the panic bar.

1. Each power supply cable shall be a 2 conductor, unshielded twisted pair, 18 gauge polyolefin insulated stranded conductors, with overall chrome PVC jacket, UL CMG rated.
2. Acceptable Manufacturers:

a. Belden
b. Or approved equal

C. Card Reader Communications Cable - Provide communication cable from Card Reader to the control board in the main access control cabinet.

1. Each card reader cable shall be a 3-pair, individually shielded, 22 gauge, stranded fluorinated ethylene propylene, with (1) 22 gauge stranded tinned copper drain wire and overall chrome FEP jacket, UL CM rated.
2. Acceptable Manufacturers:

a. Belden
b. Or approved equal

D. Electric Strike Cable

1. Acceptable Manufacturers:

a. Belden
b. Or approved equal

E. Door Contact Cable

1. Acceptable Manufacturers:

a. Belden
b. Or approved equal

2.11 ELECTRONIC LOCKING TECHNOLOGY – PROVIDED BY DIVISION 8

A. The security Contractor shall coordinate with the door hardware Contractor on the placement of required electronic locking hardware. The door Contractor will provide and install all electric locking hardware with the associated line voltage power supplies. The security Contractor will provide all necessary wire and cable, low voltage power supplies, terminate all connections, and shall interface this equipment with the integrated security system.

B. Power supplies for delayed egress panic devices and electric latch retraction type locks shall be provided by the door hardware Contractor. This required device has been specified under Division 8.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method: Install wiring in raceway except within consoles, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

B. Wiring Method: All wiring is to be installed in conduit except as mentioned in part 3.1A above.

C. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150mm) from cabinets, boxes, or fittings.

D. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train conductors to terminal points with no excess. Provide and use lacing bars in cabinets.

E. Separation of Wires: Run in separate raceways or, if exposed or in same enclosure, provide 12-inch (300 mm) minimum separation between conductors adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.

F. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets, and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.

G. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.

H. Identification of Conductors and Cables: Retain color-coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams. Label stations, controls, and indications using approved consistent nomenclature.

3.2 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.

C. Grounding Provisions: Comply with requirements in Division 26 Section "Grounding".

3.3 CONTROLLED DOORS

A. Controlled door consists of a 6" square by 4" deep box with a (1) 1 1/4" EMT continuous from the box to within 18" to 24" from the hallway distribution system. Location of box should be on wall and not be in front of or above the door.

B. If door is equipped with ADA Auto Door Opener install 1/2" EMT to control for interface.

C. New Construction Wooden or Aluminum Doors

1. From the 6" x 6" x 4" box to each door, one (1) 3/4" EMT shall be installed inside the door frame to a box located at the top of the door frame, opposite of the hinged side for the magnetic door switch.

D. With Electrified Panic Hardware or Mortise Type Electrified Lock.

1. From the 6" x 6" x 4" box to each door, one (1) 3/4" EMT shall be installed inside the door frame to a box located inside the door frame, on the hinged side of the door, approximately 6" above the middle hinge for the power transfer.

E. With Electrified Door Strike.

1. From the 6" x 6" x 4" box to each door, one (1) 3/4" EMT shall be installed inside the door frame to a box located inside the door frame, opposite the hinged side of the door, directly across from the latch in the door for an electrified door strike.

3.4 CARD READER DOORS

A. New Construction Wooden or Aluminum Doors

1. Controlled door consists of a 6" square by 4" deep box with one (1) 1 1/4" EMT continuous from the box to within 18" to 24" from the hallway distribution system. Location of box should be on wall and not be in front of or above the door.
2. Card Reader door consists of one (1) 3/4" EMT continuous from the card reader back box to the 6" x 6" x 4" junction box above the accessible ceiling which is connected to the main access control cabinet. Card reader shall be located 42" A.F.F. and located as shown on the drawings.
3. From the 6" x 6" x 4" junction box to each door, one (1) 3/4" EMT shall be installed inside the door frame to a box located at the top of the door frame, opposite of the hinged side for the door switch.
4. With Electrified Panic Hardware
    a. One (1) door power supply shall be installed and connected to the junction box by one (1) 3/4" EMT for communication. Electrical connections shall be made in accordance with Division 26 Specifications and drawings.
    b. From the junction box to each door, one (1) 3/4" EMT shall be installed inside the door frame to a box located inside the door frame, on the hinged side of the door, approximately 6" above the middle hinge for the power transfer.
    c. From the reader board box to the magnetic card reader located outside of the door, one (1) 1/2" EMT shall be installed inside the wall to a flush mount box located 42" A.F.F. outside of the door, opposite of the hinged side for the card reader. Refer to construction drawings for card reader locations.
    d. If door is equipped with ADA Auto Door Opener install 1/2" EMT to control for interface if required.
5. With Mortise Type Electrified Lock.
    a. From the junction box to each door, one (1) 1/2" EMT shall be installed inside the door frame to a box located inside the door frame, on the hinged side of the door, approximately 6" above the middle hinge for the power transfer.
    b. From the reader board box to the card reader located on the unsecured side of the door, one (1) 3/4" EMT shall be installed inside the wall to a flush mount single gang box located 42" A.F.F. outside of the door, opposite of the hinged side for the card reader.
6. With Electrified Door Strike.
    a. From the junction box to each door, one (1) 1/2" EMT shall be installed inside the door frame to a box located inside the door frame, opposite the hinged side of the door, directly across from the latch in the door for an electrified door strike.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field assembled components and testing and adjusting of system.

B. Test Procedure: Comply with the following:

1. Schedule tests a minimum of seven days in advance of performance of tests.
2. Report: Submit a written record of test results.
3. Operational Test: Perform an operational system test to verify compliance of system with these Specifications.

C. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets these Specifications and complies with applicable standards. Report results in writing.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

E. System Testing:

1. All Controlled doors shall be tested for proper operation as follows:

   a. With door(s) closed and locked, verify all switches are closed, zero resistance, and multiplexer board is indicating inactive status, green LED (on) for the particular point.
   b. With door(s) closed and locked, push each panic bar or handle without opening door to verify LX switches open, infinite resistance, and board is indicating active status, green LED (off) for the particular point. Release bar or handle to verify status changes back to inactive and LX switch(s) close, zero resistance.
   c. With door(s) closed and locked, open each door individually to verify door switches open, infinite resistance, and board is indicating active status, green LED (off) for particular point. Close door to verify status changes back to inactive.
   d. Contact Owner's representative to verify computer control of door location.

2. All Card Reader doors shall be tested for proper operation as follows:

   a. With door(s) closed and locked, verify all switches are closed, zero resistance.
   b. With door(s) closed and locked, push each panic bar or handle without opening door to verify LX switches are opening, infinite resistance. Release bar or handle to verify LX changes back to a closed state, zero resistance.
   c. Contact Owner's representative to verify computer control door location and confirm unit is online.
   d. Swipe valid card through read-head to verify door unlocks, opens, and closes.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Notification appliances.
5. Device guards.
6. Remote annunciator.
7. Addressable interface device.
8. Digital alarm communicator transmitter.
9. Fire alarm wire and cable.
10. Identification products.

1.2 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.

9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Locate detectors according to manufacturer's written recommendations.
    d. Show air-sampling detector pipe routing.

12. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

    a. Trained and certified by manufacturer in fire-alarm system design.
    b. NICET-certified, fire-alarm technician; Level III minimum.
    c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.
e. Device addresses.
f. Record copy of site-specific software.
g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

    1) Equipment tested.
    2) Frequency of testing of installed components.
    3) Frequency of inspection of installed components.
    4) Requirements and recommendations related to results of maintenance.
    5) Manufacturer's user training manuals.

h. Manufacturer's required maintenance related to system warranty requirements.
i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

1.6 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. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

1.8 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. 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.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Smoke detectors.
3. Automatic sprinkler system water flow.
4. Fire-extinguishing system operation.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
5. Activate emergency shutoffs for gas and fuel supplies.

6. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Duct smoke detectors.
2. Valve supervisory switch.
3. Independent fire-detection and -suppression systems.
4. User disabling of zones or individual devices.
5. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. Record the event on system printer.
4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
5. Transmit system status to building management system.

2.3 FIRE-ALARM CONTROL UNIT

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

1. Siemens Industry, Inc.; Fire Safety Division.
2. SimplexGrinnell LP.

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

    a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.
    c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
    d. The FACP shall be listed for connection to a central-station signaling system service.
    e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.
2. Pathway Survivability: Level 0.
3. Install no more than 50 addressable devices on each signaling-line circuit.
4. Serial Interfaces:

    a. One dedicated RS 485 port for central-station operation using point ID DACT.
    b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
    c. One USB port for PC configuration.

E. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

J. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, breaking-glass or plastic-rod type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

    a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
    b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
    c. Multiple levels of detection sensitivity for each sensor.
    d. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.

d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.6 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.

1. Rated Light Output:

a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.

2.7 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.8 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.9 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture [**one**] [**two**] telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.

4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.10 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by device manufacturer.
2. Finish: Paint of color to match the protected device.

2.11 FIRE ALARM WIRE AND CABLE

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

1. Comtran Corporation.
2. Draka Cableteq USA.
3. Genesis Cable Products; Honeywell International, Inc.
4. Rockbestos-Suprenant Cable Corp.
5. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. 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.

D. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.

E. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

2.12 IDENTIFICATION PRODUCTS

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

1. Brady Worldwide, Inc.
2. HellermannTyton North America.
3. Kroy LLC.
4. Panduit Corp.

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 79 inches above the finished floor.

C. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

D. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
4. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

H. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.

1. Exposed pathways shall be installed in EMT.
2. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
2. Supervisory connections at valve supervisory switches.

3.5 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Section 260533 "Raceways and Boxes for Electrical Systems."

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

G. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.6 IDENTIFICATION

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

B. Install framed instructions in a location visible from fire-alarm control unit.

3.7 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.8 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

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

C. Perform tests and inspections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.10 DEMONSTRATION

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

END OF SECTION 283111

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PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Extent of hot-mix asphalt paving is indicated on drawings.

B. This Section includes the following:

1. Base course for asphalt paving.
2. Hot-mix asphalt paving intermediate and surface courses.
3. Pavement-marking paint.

C. Related Sections include the following:

1. Section 312000 "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Section 079200 "Joint Sealants" for joint sealants and fillers at paving terminations.

1.03 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of state or local DOT.

1.04 SUBMITTALS

A. Material Certificates: Certificates on state-approved forms, signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.

1. Job-Mix Designs: For each job mix proposed for the Work.
2. Material Test Reports: For each paving material.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Regulatory Requirements: Comply with State Highway or Transportation Department standard specifications, latest edition, for asphalt paving work. Comply with local governing regulations if more stringent than herein specified.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Tack Coats: 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 50 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.01 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. 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.

C. Coarse Aggregate for Pavement: ASTM D 692, sound; angular crushed stone, crushed gravel, or properly cured, crushed blast-furnace slag.

D. Fine Aggregate for Pavement: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

E. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.02 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO MP 1, Performance Grade in accordance with DOT recommendations for location indicated.

B. 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.

C. Water: Potable.

2.03 AUXILIARY MATERIALS

A. Geotextile Fabric: Spunbond 100% polyester or polypropylene fabric meeting the following minimum requirements.

1. Permeability: ASTM D4491 0.01 cmps.
2. Grab Strength; ASTM D4632, 130 lbs.
3. Puncture Strength: ASTM D4833 40 lbs.
4. Burst Strength: ASTM D3786, 140 lbs.

B. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

C. Pavement-Marking Paint: White Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952.

1. Manufacturer: Subject to compliance with requirements provide products of the following.

a. Devoe; #416XX Traffic Line
b. Glidden; #6324X Ultra-Hede
c. MAB; "072 Series" Latex Traffic Paint

2.04 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes complying with ASTM D3515 and approved by authorities having jurisdiction to suit project conditions.

B. Properties of bituminous materials shall be as follows:

1. Marshall Stability: 750 lbs., minimum.
2. Marshall Flow, 1/100": 8 – 16.
3. Air Voids: base: 3-8%; surface: 3-5%.

C. Temperature Requirements shall comply with the requirements of IDHSS Section 403.04, (e).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

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

3.02 BASE COURSE

A. Based on unit prices and as recommended by soils engineer, under base course, install drainage fabric on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.

B. Under pavements, place base course on prepared subgrade and as follows:

1. Compact subbase and base courses 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.
2. Shape subbase and base to required crown elevations and cross-slope grades.
3. When thickness of compacted subbase or base course is 6 inches or less, place materials in a single layer.
4. When thickness of compacted subbase or base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

C. Shoulders: Place shoulders along edges of 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.

3.03 PREPARATION OF BASE COURSE FOR PAVING

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from base course surfaces.

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 0.05 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.

3.04 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 intermediate 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.
2. For tennis and recreational surfaces, changing of pavement direction will not be allowed.
3. For outdoor tennis and recreational surfaces, pave parallel to direction of drainage flow.

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.

3.05 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. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

3.06 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 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 AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 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.

3.07 INSTALLATION TOLERANCES

A. 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. 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.

3.08 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. to existing asphalt pavement and al-

low to cure. With a fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.09 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 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.10 FIELD QUALITY CONTROL

A. Thickness: Determine in-place compacted thickness of hot-mix asphalt courses according to ASTM D 3549.

B. Surface Smoothness: Test finished surface of each hot-mix asphalt course for compliance with smoothness tolerances.

C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

a. At the start of the first day of paving for each type of mix, make two Marshall test specimens and test for the following:

1) Density.
2) Stability.
3) Flow.
4) Percent air voids.
5) Percent voids filled with asphalt.

b. 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.

c. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

1) One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
2) 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.
3) Cores shall be tested for Marshall density, stability and flow.

2. 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 excavated materials to accumulate on-site.

END OF SECTION 321216

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Extent of cement concrete pavement is indicated on drawings.

B. Reinforcement Option: Contractor may use either welded wire mesh or fibrous reinforcement at his option.

C. Related Sections include the following:

1. Section 312000 "Earth Moving" for subgrade preparation, grading, and subbase course.
2. Section 033000 "Cast-in-Place Concrete" for general building applications of concrete.
3. Section 079200 "Joint Sealants" for joint sealants within concrete pavement and at isolation joints of concrete pavement with adjacent construction.

1.03 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1.04 QUALITY ASSURANCE

A. Codes and Standards: Comply with local governing regulations if more stringent than herein specified.

B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.

C. Handicap Standards: Provide ramps indicated for handicap access in accordance with ANSI A117 and Federal Americans with Disabilities Act (ADA).

PART 2 - PRODUCTS

2.01 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves of a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Manufacturer: Subject to compliance with requirements, provide products of the following:

   a. "Debond"; L & M Construction Chemicals, Inc.
   b. "Release #1"; The Burke Co.

2.02 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed.

C. 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.

D. Plastic Expansion Caps: Furnish for one end of each dowel bar in expansion joints. Design caps with one end closed and a minimum length of 3" to allow bars movement of not less than 1", unless otherwise indicated.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

2.03 CONCRETE MATERIALS AND ADMIXTURES

A. Concrete Materials and Admixtures: Comply with requirements of applicable Division-3 sections for concrete materials, admixtures, bonding materials, curing materials, and others as required.

2.04 FIBER REINFORCEMENT

A. Fibrous Reinforcement: Fibrous Reinforcement is not permitted.

2.05 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: Subject to compliance with requirements, provide one of the following:

   a. "Safe Cure and Seal"; Dayton Superior Corp.
   b. "Aqua-Cure VOX"; Euclid Chemical Co.
   c. "Dress & Seal WB"; L & M Construction Chemicals, Inc.
   d. "Masterseal W"; Master Builders, Inc.
   e. "Vocomp 20"; W.R. Meadows, Inc.
   f. "Sika Membrane"; Sika Corp.
   g. "Kure-N-Seal WB"; Sonneborn

2.06 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: Comply with requirements of applicable Division 7 section, “Joint Sealants for preformed expansion joint fillers and sealers.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Everbond"; L & M Construction Chemicals
b. "Sonocrete"; Sonneborn
c. "Acrylic Bondcrete"; The Burke Co.
d. "SBR Latex"; Euclid Chemical Co.
e. "Daraweld C"; W.R. Grace
f. "Acryl Set"; Master Builders
g. "Interlok"; W.R. Grace

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Thiopoxy"; W.R. Grace
b. "Sikadur 32 Hi-Mod"; Sika Chemical Corp.
c. "Euco Epoxy 452 or 620"; Euclic Chemical Co.
d. "Epoxy M-V"; The Burke Co.
e. "Epabond"; L & M Construction Chemicals
f. "Concresive 1001"; Master Builders

D. Penetrating Anti-Spalling Sealer: The sealer shall be a silane water based compound which has a 96% chloride-ion screen and a repellency factor of 92% when tested in accordance with NCHRP #244, Test Method. In addition, the sealer-treated concrete must exhibit no scaling when exposed to 120 cycles of freezing-and-thawing in accordance with ASTM C 672.

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Enviroseal 20"; Hydrozo Incorp.
b. "Pentane WB"; L & M Construction Chemicals, Inc.
c. "Weather Worker S-20"; Dayton Superior Corp.

2.07 CONCRETE MIXES

A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

B. Except as indicated in Division 3, Proportion mixes to provide concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 4 inches.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 5 to 8 percent.

2.08 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.

PART 3 - EXECUTION

3.01 PREPARATION

A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Proceed with pavement only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.02 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.

3.03 STEEL REINFORCEMENT

A. Locate, place and support reinforcement as specified in Division 3 section, “Concrete,” unless otherwise indicated.

3.04 JOINTS

A. General: Construct 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.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.

1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
2. Continue reinforcement across construction joints, unless otherwise indicated.
3. Use epoxy bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, 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.

a. Terminate joint filler less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

3. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
4. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

F. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool.

3.05 CONCRETE PLACEMENT

A. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

B. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

C. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

D. Do not add water to concrete during delivery, at Project site, or during placement.

E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

F. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

G. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.

H. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

I. 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.

3.06 CONCRETE FINISHING

A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.07 CONCRETE PROTECTION AND CURING

A. Protect and cure finished concrete paving, complying with applicable requirements of Division 3 section, “Concrete.”

B. Penetrating, Anti-Spalling Sealer Treatment: Apply compounds to clean, dry concrete surfaces free of oil, dirt, and other foreign material according to manufacturer's specifications.

3.08 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, unleveled straightedge not to exceed 1/4 inch.
4. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template, 1/4".

3.09 FIELD QUALITY CONTROL

A. Testing: Test site concrete in accordance with testing requirements contained in Division 3 section, “Concrete.”

3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

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 the following:

B. Exposed aggregate sand matrix concrete pavement.

C. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
2. Division 7 Section “Water Repellents” for penetrating water-repellent treatments.
3. Division 32 Section "Concrete Paving" for cast-in-place concrete paving with other finishes, curbs and gutters.
4. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within decorative concrete paving and in joints between decorative concrete paving and asphalt paving or adjacent construction.
5. Division 32 "Earthwork" for subgrade preparation, grading and subbase course.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated and proposed.

B. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color, pattern, or texture selection.

D. Samples for Verification: For each type of exposed color, pattern, or texture indicated.

E. Placement Procedure: Submit written placement procedure following approval of mock-up and prior to beginning placement of Work.

F. Qualification Data: For Installer, ready-mix concrete producer and testing agency.

1. Installer shall submit documents showing they have a minimum of 5 years experience installing decorative cement concrete pavements.
2. Installer shall submit documentation showing they have completed a minimum of 5 projects of similar size and complexity, including photos of at least two of the projects.

G. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Applied finish materials.
6. Bonding agent or epoxy adhesive.
7. Joint fillers.

H. Material Test Reports: For each of the following:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

I. Field quality-control reports.

J. Minutes of pre-installation conference recorded by Contractor.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that 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" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

D. ACI Publications: Comply with ACI 301 (Exposed Aggregate Finish) unless otherwise indicated.

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.

1.6 Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship for each type of concrete.

A. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.

1. Notify Architect seven days in advance of dates and times when mockups will be constructed.
2. Obtain Architect's approval of mockups before starting construction.
3. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
4. Demolish and remove approved mockups from the site when directed by Architect.

B. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

1. Before submitting design mixes, review concrete pavement mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with concrete pavement to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixes.
c. Ready-mix concrete producer.
d. Concrete subcontractor.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

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. Products: Subject to compliance with requirements, provide one of the products specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel materials to provide full-depth, continuous, straight, and smooth exposed surfaces of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.

1. Use flexible spring steel or laminated curved forms for curves of a radius 100 feet (30.5 m) 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.

2.3 STEEL REINFORCEMENT

A. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.

B. Epoxy-Coated Reinforcement Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars.

C. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A coated, plain steel.

D. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain steel bars.

E. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

F. Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to

CRSI's "Manual of Standard Practice from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer coated wire bar supports.

H. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

2.4 CONCRETE MATERIALS

A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.

B. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, white portland cement Type I/II.

C. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Aggregate Size: 3/4 inch nominal.
2. Exposed/Fine Aggregate: FA-2 natural sand. Free of materials with deleterious reactivity to alkali in cement.

D. Water: Potable and complying with ASTM C 94/C 94M.

2.5 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.

B. Air-Entraining Admixture: ASTM C 260.

C. Water-Reducing Admixture: ASTM C 494, Type A.

D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.

F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.6 COLOR MATERIALS

A. Integral Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.

1. Colors: From Chromix Admixtures full range of colors as manufactured by L.M. Scofield as selected by Architect.

2. Manufacturers:

a. Scofield, L. M. Company.
b. Solomon Colors.
c. Symons Corporation.

2.7 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

2.8 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Polyethylene Film: ASTM D 4397, 1 mil thick, clear.

F. Chemical Surface Retarder: Water-soluble, liquid set retarder without color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch (3 to 6 mm).

G. Products: Subject to compliance with requirements, provide one of the following:

1. Chemical Surface Retarder:

a. True Etch Surface Retarder; Burke Group, LLC (The).
b. Exposee; ChemMasters
c. Delay S; Conspec Marketing & Manufacturing Co., Inc.
d. Concrete Surface Retarders; Euclid Chemical Co.
e. Expose; Kaufman Products, Inc.
f. Surftard; Metaicrete Industries.
g. Crete-Nox TA; Nox-Crete Products Group, Kinsman Corporation.
h. Lithotex; L. M. Scofield Co.
i. Rugasol-S; Sika Corporation.
j. Certi-Vex Envioset; Vexcon Chemicals, Inc.

H. Concrete Silane Sealer: 100% reactive, 40% solids by weight, deep penetrating alkyl polymer silane, non-volatile, non-staining, invisible, 10 year performance guarantee for protection of concrete subject to severe environmental conditions with frequent exposure to de-icing salts (chlorides) complying with National Cooperative Highway Research Program (NCHRP) No.244 and ASTM C 672 with a rating of 0, no scaling, the highest rating with the following physical properties:

1. Yellowing: No.
2. Surface Darkening: No.
3. Film Forming: No.
4. NCHRP 244 Series II:

    a. Absorption: 93% reduction, minimum.
    b. Total Chloride-Ion:

5. NCHRP 244 Series IV:

    a. Total Chloride-Ion: 98% reduction, minimum.

6. Resistance to Chloride-Ion Penetration:

    a. AASHTO-T 259:

        1) 1/2 inch depth: 98% minimum.
        2) 1 inch depth: 98% minimum.

    b. 20 percent solutions are not acceptable.

    c. Acceptable Product:

        1) Penetrating Sealer 40 by Sonneborn.
        2) Baracade Silane 40 by Tamms.
        3) Pentane 40 or Pentane 40 WB by L&M Construction Chemicals, Inc.
        4) Weather Worker 8-40 by Dayton Superior.

2.9 CONCRETE MIXES

A. Prepare design mixes as follows: Proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.

1. Do not use Owner's field quality-control testing agency as the independent testing agency.

C. Mix Design: Provide plant mixed concrete for exposed aggregate finish to match Architects Sample (Simon Plaza, Indianapolis, Indiana). The following design mix is given as a general guide. The Contractor is responsible for providing a mix which matches the referenced standard.

1. 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.

    a. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

2. Proportion mixtures to provide normal-weight concrete with the following properties:

    a. Select strength from options in subparagraph below or revise to suit Project. Add
    b. Compressive Strength (28 Days): 4000 psi.
    c. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
    d. Slump Limit: 3 inches.

3. 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:

   a. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

5. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

   a. Use water reducing admixture in concrete, as required, for placement and workability.
   b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

6. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.

7. Coloring Agent: Add coloring agent to mix according to manufacturer's written instructions.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.

B. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with tolerances for dimensional, grading, and elevation tolerances.

B. Proceed with decorative cement concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Proof-roll prepared subbase surface with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

   1. Completely proof-roll subbase in one 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. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 32 Section "Earthwork."

B. Remove loose material from compacted subbase surface immediately before placing concrete.

C. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

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 reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for p]acing and supporting reinforcement.

1. Apply epoxy repair coating to uncoated or damaged surfaces of epoxy–coated reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap to adjacent mats.

3.5 JOINTS

A. General: Construct 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.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.

C. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.

1. Provide tie bars at sides of pavement strips where indicated.

2. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

D. 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 (15.25 m), unless otherwise indicated.

2. Extend joint fillers full width and depth of joint.

3. Terminate joint filler less than 1/2 inch (12 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.

4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

E. 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.

F. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

a. Hand saw cut joints with mini grinder to finish joints where power grinder cannot proceed without damage to adjacent work including, but not limited to, the base of the building and as required at other locations.
b. Bevel Joints where indicated on the drawings.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery, at Project site, or during placement.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. When reinforcing is not set prior to placement of concrete, place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.

I. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

J. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

K. 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.

L. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 CONCRETE FINISHING

A. General: Do not wet concrete surfaces during screeding, initial floating, and finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.

C. Monolithic Sand Matrix Finish: Expose sand aggregate to pavement surfaces as follows and in accordance with procedures developed during the mock-up:

1. Immediately after floating, spray-apply chemical surface retarder to pavement according to manufacturer's written instructions.

2. Cover with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
3. When concrete has taken its initial set, and after the finishing operations are completed, direct a fine spray of water at an approximate angle of fifteen degrees to the surface of the concrete.
4. Wash the laitance and retarder from the surface without both disturbing the small aggregate and causing sand runs to appear.
5. Remove laitance, retarder residue, and dirty wash water from finished surfaces as soon as washing operations are complete.
6. Apply a dilute solution acid wash as required to kill the efflorescence.

    a. Later applications may be stronger.

7. Design consolidation and finishing methods to avoid uneven settlement of aggregate above reinforcing bar locations. Uneven settlement results in uneven surface when combined with retarder application.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing or comply with similar recommendations of the Standard Specification, Section 625, Article 625.01 and silane sealer application requirements.

B. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

C. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.9 CONCRETE SILANE SEALER

A. Sealing: Apply in accordance with the silane sealer manufacturer's written published application instructions and as follows:

1. Do not apply until construction, contraction and other joints have been sealed with elastomeric sealant.
2. Surfaces have been dry for a minimum of 24 hours.
3. Adjacent surfaces including, but not limited to plants, grass, shrubs, and asphalt are masked to protect from drips and overspray.

3.10 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, unleveled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Dowels: 1 inch.
5. Vertical Alignment of Dowels: 1/4 inch.
6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
7. Joint Spacing: 3 inches.
8. Contraction Joint Depth: Plus 1/4 inch, no minus.
9. Joint Width: Plus 1/8 inch, no minus.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.

B. Testing Services: Testing shall be performed according to the requirements of the Standard Specification or the following as directed by Owner:

1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C 172, except modified for slump to comp]y with ASTM C 94.
2. Slump: ASTM C 143; one test at point of placement for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
3. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m). One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.
7. When frequency of testing will provide fewer than five compressive-strength tests for a given c]ass of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.
9. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal. or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi.

C. Test results shall be reported in writing to Owner, Architect, concrete manufacturer, and Contractor within 24 hours of testing Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and c]ass, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as the sole basis for approval or rejection.

E. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321316

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Isolation and contraction joints within cement concrete pavement.
2. Joints between cement concrete pavement and concrete and masonry walls.

B. Related Sections include the following:

1. Division 7 Section "Joint Sealants" for sealing non-traffic 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.
4. Division 32 Section "Decorative Concrete Paving" for constructing joints in concrete pavement.

1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

D. Qualification Data: For installer and testing agency.

E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. 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 methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the commencement of the Work.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
3. When joint substrates are wet or covered with frost.
4. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
5. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below begin lists, the following requirements apply for product selections:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2. Products: Subject to compliance with requirements, provide the product indicated or an equivalent product by one of the manufacturers specified for that type of sealant.

B. Cold-Applied Joint Sealant Manufacturers:

1. Silicone Sealant:

    a. Crafco, Inc.
    b. Dow Corning Corp.
    c. GE Silicones.
    d. Pecora Corp.
    e. Sonneborn Building Products Div., ChemRex, Inc.
    f. Tremco.

C. Hot-Applied Joint Sealant Manufacturers:

1. Elastomeric Sealant:

    a. Crafco, Inc.
    b. Koch Materials Company.
    c. W.R. Meadows, Inc.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 COLD-APPLIED JOINT SEALANTS

A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.

1. Product: Dow Corning Corporation; 888 Silicone Joint Sealant.

B. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.

1. Product: Dow Corning Corporation; 890-SL Self-Leveling Silicone Joint Sealant.

C. Multicomponent Low-Modulus Sealant for Concrete and Asphalt: Proprietary formulation consisting of reactive petropolymer and activator components producing a pourable, self-leveling sealant.

1. Product: Meadows, W. R., Inc.; Sof-Seal.

2.4 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction compatibility and adhesion tests, field tests, and prior experience.

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.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. 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 backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of backer materials.
2. Do not stretch, twist, puncture, or tear backer materials.
3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses provided for each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

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 with repaired areas are indistinguishable from the original work.

END OF SECTION 321373

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Concrete pavers set in aggregate and bituminous setting beds.
2. Aluminum edge restraints.
3. Precast concrete curbs.

B. Related Sections include the following:
1. Division 7 Section "Joint Sealants" for sealing control and expansion joints in unit pavers with elastomeric sealants.
2. Division 31 Section "Earth Moving" for excavation and compacted subgrade.
3. Division 32 Section "Asphalt Paving" for asphalt base under unit pavers.
4. Division 32 Section "Concrete Paving" for concrete base under unit pavers and for cast-in-place concrete curbs and gutters serving as edge restraint for unit pavers.

1.3 SUBMITTALS

A. Product Data: For materials other than water and aggregates.

B. Product Data: For the following:

1. Pavers.
2. Bituminous setting materials.
3. Edge restraints.
4. Precast concrete curbs.

C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.

D. Samples for Initial Selection: For the following:

1. Each type of unit paver indicated.
2. Joint materials involving color selection.
3. Exposed edge restraints involving color selection.
4. Precast concrete curbs.

E. Samples for Verification:

1. Full-size units of each type of unit paver indicated.
2. Joint materials.
3. Exposed edge restraints.
4. Precast concrete curbs.

F. Compatibility and Adhesion Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

B. Preconstruction Compatibility and Adhesion Testing: Submit to latex-additive manufacturer, for testing indicated below, samples of paving materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be nonstaining to, installed pavers and other materials constituting paver installation.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.6 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above 40 deg F and when base is dry.
2. Apply asphalt adhesive only when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Protect unit paver work against freezing when ambient temperature is 40 deg F and falling. Heat materials to provide mortar and grout temperatures between 40 and 120 deg F. Provide the following protection for completed portions of work for 24 hours after installation when the mean daily air temperature is as indicated: below 40 deg F, cover with weather-resistant membrane; below 25 deg F, cover with insulating blankets; below 20 deg F, provide enclosure and temporary heat to maintain temperature above 32 deg F.
2. Hot-Weather Requirements: Protect unit paver work when temperature and humidity conditions produce excessive evaporation of setting beds and grout. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

    a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 CONCRETE PAVERS

A. Concrete Pavers: Solid paving units, made from normal-weight concrete with a compressive strength not less than 6000 psi, water absorption not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.

1. Basis-of-Design Product: The design for concrete pavers is based on **Hanover Architectural Products Inc**., 500 Hanover Road, Hanover, PA 17331, (800) 426-4242. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:

    a. Wausau Tile Inc., Wausau, WI.

2. Style: ‘Prest’ and Permeable Pavers.
3. Thickness: 2 ½” standard, 4” permeable.
4. Face Size and Shape: 24” x 48” rectangle, 6” x 24” plank, 3 ¼” x 18” permeable.
5. Texture: As selected by Architect from manufacturer's full range.
6. Color: As selected by Architect from manufacturer's full range.

B. Job-Built Concrete Edge Restraints: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi.

C. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.

D. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

2.2 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 57.

B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 8.

C. Sand for Leveling Course: Sound, sharp, washed natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.

D. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D 448 for Size No. 10.

E. Sand for Joints: Fine, sharp, washed natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.

1. Provide sand of color needed to produce required joint color.

F. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefin 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. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
3. Permittivity: 0.02 per second, minimum; ASTM D 4491.
4. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

G. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefin 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. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
4. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

H. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.3 BITUMINOUS SETTING-BED MATERIALS

A. Primer for Base: ASTM D 2028, cutback asphalt, grade as recommended by unit paver manufacturer.

B. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.

C. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or Grade AC-20.

D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

E. Sand for Joints: Fine, sharp, washed natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.

1. Provide sand of color needed to produce required joint color.

F. Water: Potable.

2.4 BITUMINOUS SETTING-BED MIX

A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate, unless otherwise indicated. Heat mixture to 300 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Clean concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive sub-base and base course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, un-chipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. Exercise care in handling coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. Remove coating from bonding surfaces before setting brick.

E. Joint Pattern: As indicated in the Drawings.

F. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.

G. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

H. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide foam filler as backing for sealant-filled joints. Install joint filler before setting pavers. Sealant materials and installation are specified in Division 7 Section "Joint Sealants."

I. Expansion and Control Joints: Provide joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

J. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch below top edge.
3. Install job-built concrete edge restraints to comply with requirements in Division 3 Section "Cast-in-Place Concrete."
4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
5. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

3.4 AGGREGATE SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. 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. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches.

D. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.

E. Place aggregate base, compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.

F. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.

G. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

H. Treat leveling course with herbicide to inhibit growth of grass and weeds.

I. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

J. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:

1. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
2. Before ending each day's work, fully compact installed concrete pavers to within 36 inches of the laying face. Cover pavers that have not been compacted and leveling course on which pavers have not been placed, with non-staining plastic sheets to protect them from rain.

K. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

L. Do not allow traffic on installed pavers until sand has been vibrated into joints.

M. Repeat joint-filling process 30 days later.

3.5 BITUMINOUS SETTING-BED APPLICATIONS

A. Apply primer to concrete slab or binder course immediately before placing setting bed.

B. Prepare for setting-bed placement by locating 3/4-inch- deep control bars approximately 11 feet apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of 250 deg F. Strike setting bed smooth, firm, even, and not less than 3/4 inch thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.

1. Roll setting bed with power roller to a nominal depth of 3/4 inch. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F.

D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.

F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

3.6 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION 321400

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Proof rolling sub-grade.
2. Distributing stockpiled topsoil.
3. Furnishing and placing manufactured soil.
4. Furnishing and placing storm water quality facility manufactured soil and associated underdrains.

1.3 RELATED SECTIONS

A. Refer to the following Specification Section for Related Work:

1. Division 31 Section “Site Clearing” for topsoil stripping.
2. Division 31 Section “Earth Moving” for filling and rough-grading work.
3. Division 32 Section “Plants” for fertilization and plant material installation work.
4. Division 33 Section “Sub-Drainage” for subsurface drainage.

1.4 REFERENCES

A. ASTM D2607 – Classification of peats, mosses, humus and related products.

B. ASTM D2976 – Standard pH test method of peat materials.

1.5 SUBMITTALS

A. Imported Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating topsoil’s suitability for plant growth, percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; soluble salt content and mineral and plant-nutrient content of topsoil. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.

B. Manufactured Soil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating soil mix’s suitability for plant growth, percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; soluble salt content and mineral and plant-nutrient content. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory soil mix.

C. Spent Mushroom Compost Fertilizer Label: Furnish label indicating NPK content, compost manufacturers name and address.

D. Qualification Data: For qualified Installer, including:

1. Required qualifications of Installer.
2. Required qualifications of Installer's project manager and superintendent.

E. Certification from provider of manufactured and water quality facility manufactured soil mix**es** certifying the contents of the mix meets the specification.

F. Product data for each type of soil amendment to be used.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm qualified as a landscape installer with a minimum of five (5) years experience of work of this type whose work has resulted in successful establishment of exterior plants.

B. The Installer shall have a member of the firm that holds the following credentials:

1. Hold a minimum of a four (4) year bachelor degree in the field of landscape contracting, landscape management, agronomy, landscape architecture or horticulture or be a Certified Landscape Professional by the Professional Landcare Network (PLANET).
2. Be available to respond to inquiries from Architect.

C. The Installer's project superintendent shall have the following credentials and be available to the project as follows:

1. Hold a minimum of two (2) year degree in the field of landscape contracting, landscape management, agronomy, or horticulture or be a Certified Landscape Technician – Exterior by the Professional Landcare Network (PLANET).
2. Be present on the project site a minimum of 85% of the time the Installer's crew is present on site.

1.7 DFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Finish Grade: Elevation of finished surface of topsoil following natural settling, light rolling or light compaction activities.

C. Installer: The firm performing the installation of the topsoil.

D. Manufactured Soil: Soil produced off-site by homogeneously blending topsoil with sand and stabilized organic soil amendments to produce superior planting soil.

E. Plant Pit Backfill: Soil mix specified for placement within the excavated holes for individual plant pits.

F. Planting Soil: Soil specified for planting beds and containers.

G. Structural Soil: Manufactured topsoil comprised of a structural crushed stone matrix and a plant sustaining soil capable of providing for the horticultural needs of plant material while ensuring suitable bearing capacity of pavements.

H. Sub-grade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing topsoil.

I. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

J. Stormwater Management Facility Soil Mix: Soil produced off-site by homogeneously blending topsoil with sand and stabilized organic soil amendments to produce superior planting soil while allowing for high percolation rates through the soil profile.

K. Topsoil: Natural or cultivated, imported or native, surface-soil layer containing organic matter, sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, weeds, roots, materials toxic to plants or other nonsoil materials.

PART 2 - PRODUCTS

2.1 MATERIALS

A. On-site Topsoil: Soil stripped from disturbed portions of Site and stockpiled separately from subsoil and cleaned of roots, plants, sod, stones larger than 1" in any dimension, clay lumps, and other extraneous materials harmful to plant growth. Limit height of stockpile to 8' and do not allow earthmoving equipment to run over the top of the topsoil during stripping, stockpiling, or distribution activities.

B. Imported Topsoil: Dark loam, free of hard clods, stiff clay, sod, stones, roots, sticks or other debris over one inch in size. Topsoil shall be free of toxic materials, tested for pH and adjusted to range between 6.0 and 7.5. Topsoil shall be tested for percentage of sand, silt, clay and organic matter and fall within the following ranges: sand, 25%-30%, silt, 28%-60%, clay, 8%-27%. Organic matter shall not be less than 3% as determined by loss on ignition of moisture-free samples dried at 65 degrees centigrade. Obtain imported topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

C. Manufactured Topsoil: Provide mix in the following proportions:

1. 2/5 spent mushroom compost
2. 3/5 imported topsoil
3. Between 25% and 35% sand.

D. Structural Soil: Provide uniform blend of the following components in the following proportions by weight:

1. 80% crushed angular granite or limestone graded from ¾ to 1 ½ inch washed free of fines
2. 20% imported topsoil
3. .03% of a potassium propenoate-propenamide copolymer hydrogel.
4. Total moisture at time of mixing to be 10%.
5. Soil to be manufactured by a CU Soil licensed supplier.

E. Spent Mushroom Compost: Well-composted, actively aged, stable, and weed and pesticide-free organic matter, made from wheat straw, haw, corn cobs, cotton seed hulls, gypsum, sphagnum peat, ground limestone, and chicken manure and specifically formulated for the production of mushrooms. The pH is to be between 6.0 and 8.0 and free of substances toxic to plants. The composting process is to be actively managed with regular and repeated aerations over a period of three months. The NPK ratio is to be a minimum of 1:0.7:1.1.

F. Peat: ASTM D 2607, finely divided or granular texture, with a pH range of 4.0 to 5.0, containing partially decomposed moss peat, native peat, or reed-sedge peat with 85 percent minimum organic material and moisture content of thirty percent.

G. Sand: Hard, granular natural sand, washed free of materials and chemicals deleterious to plant growth.

H. Sphagnum Peat: Imported Canadian sphagnum peat moss, brown, partially decomposed, finely divided or granular texture, low in woody material content, free of mineral material harmful to plant growth, with a pH range of 3.4 to 4.8 and having a water-absorbing capacity of 1100 to 2000 percent. Native or sedge peats are not acceptable.

I. Stormwater Management Facility Soil Mix: Provide mix in the following proportions:

1. 50% hard granular low phosphorous natural sand
2. 25% spent mushroom compost
3. 25% imported topsoil

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify site conditions are suitable for Work of this Section to begin.

B. Proof roll sub-grade.

C. Beginning Work of this Section means acceptance of existing conditions.

3.2 PROTECTION

A. Do not damage plant material and other features remaining as final work.

B. Repair damage to existing improvements at no cost to the owner.

3.3 PLACING TOPSOIL AT LAWN AREAS

A. Place topsoil in disturbed areas where sodding is scheduled.

B. Use topsoil in relatively dry state and place during dry weather.

C. Cover topsoil with one (1) inch of spent mushroom compost and till into top 4-6 inches of topsoil as required to achieve a uniform mix.

D. Fine grade topsoil eliminating rough or low areas. Maintain levels, profiles, and contours of subgrade.

E. Remove stones, roots, grass, weeds, debris, and foreign material over one (1) inch in any dimension.

F. Manually spread topsoil around improvements to prevent damage.

G. Lightly compact placed topsoil to 90% modified proctor.

3.4 PLANTING BED ESTABLISHMENT

A. Provide beds with straight lines and true arcs according the configuration delineated on the drawings.

B. Excavate beds for shrub masses and perennials entirely from bed edge to edge. Do not treat as individual planting pits.

C. Loosen sub-grade of planting beds to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

D. Remove contaminated subsoil.

E. Spread topsoil to depth indicated but not less than required to meet finish grades after natural settlement.

F. Do not spread if planting soil or sub-grade is frozen, muddy, or excessively wet.

G. Spread approximately one-half the thickness of planting soil mix over loosened sub-grade. Mix thoroughly into top 2 inches of sub-grade. Spread remainder of planting soil mix.

H. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. Ensure positive drainage is achieved.

3.5 PLACING STRUCTURAL SOILS

A. Place structural soils in 6-inch lifts.

B. Compact to 95% modified proctor.

C. Conform to CU Soil installation specifications.

3.6 PLACING STORMWATER MANAGEMENT FACILITY SOIL MIX

A. Ensure stormwater management facility is rough graded to contours and slopes indicated on Drawings. All construction phase sediment is to be removed from the Facility.

B. Do not install soil mix or underdrains until erosion within the Facility’s watershed is stabilized as required to protect the Facility from sedimentation.

C. Install underdrains as required to ensure positive drainage.

D. Backfill Facility utilizing stormwater management facility soil mix. Ensure soils are lightly compacted and maintain the free draining characteristics.

3.7 SOIL PREPARATION AT UNDISTURBED AREAS

A. Where lawns, bedding plants, shrub beds, perennials or ground cover are to be planted in areas that have not been stripped of topsoil or altered by grading operations, prepare soil as follows:

1. Remove existing grass, vegetation and turf. Do not impact existing vegetation to remain.
2. Dispose of removed material off of Owner's property. Do not turn debris over into soil.
3. Shrub, perennial, bedding plant and ground cover beds: Amend existing topsoil with one (1) part spent mushroom compost and one (1) part sand per three (3) parts existing topsoil. Till to a depth of not less than twelve (12) inches. Prepare entire breadth of portion of shrub bed that is to be planted; do not limit bed preparation to just the individual shrub planting pit. Amending is to occur in two lifts of 6" deep. Top lift to be removed to facilitate amending bottom lift.
4. Lawn Areas: Till to a depth of not less than four (4) inches except where existing vegetation prohibits extensive disturbance of soil.
5. Remove high areas and fill in depressions.
6. Till soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter.

3.8 TOLERANCES

A. Top of Topsoil: Plus or minus ½ inch.

3.9 FIELD QUALITY CONTROL

A. Testing and analysis will be performed under provisions of Division One.

B. Provide one topsoil analysis for the imported topsoil and manufactured soils prior to delivery to site.

C. Provide one topsoil test for every 100 cubic yards of imported topsoil and manufactured soil after delivery to Site.

D. Replace or amend any imported topsoil or manufactured soil in non-conformance.

3.10 CLEANUP

A. Remove excess topsoil manufactured soil, structural soil, and subsoil, trash, and debris from the Site and legally dispose of them off Owner's property.

3.11 SCHEDULE OF SOIL THICKNESS

A. Provide the following compacted topsoil and manufactured soil thicknesses:
   1. Sodded Grass: Four (4) inches.
   2. Ground Cover Beds: Eight (8) inches.
   3. Shrub and Perennial Beds: Fourteen (14) inches.

END OF SECTION 329119

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sodding
2. Fertilizing
3. Maintenance

B. Related Sections:

1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
3. Division 32 Section “Landscape Grading” for topsoil placement and finish grading.
4. Division 32 Section "Plants" for coordination with plant material installation.
5. Division 33 Section "Sub-drainage" for subsurface drainage.

C. Allowances: Quantity allowances for establishing lawns are specified in Division 1 Section “Allowances.”

1. Establish sodded lawns included in quantity allowances only as authorized. Authorized work includes work required by specifications and only work authorized in writing by Architect.
2. Notify Architect weekly of extent of work performed that is attributable to quantity allowances.
3. Perform work that exceeds quantity allowances only as authorized by Change Orders.

D. Unit Prices: Unit prices for establishing lawns are specified in Division 1 Section “Unit Prices.”

1. Unit prices apply to authorized work covered by quantity allowances.
2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Topsoil: Imported or native organic soil as specified in Landscape Grading section.

D. Sub-grade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath topsoil.

E. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

F. Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

G. Installer: The firm performing the sodding work.

1.4 SUBMITTALS

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

1. Fertilizer: Nitrogen, phosphorus and potassium ratio.

2. Certification of each seed mixture for turfgrass sod, identifying source, including name and telephone number of supplier.

B. Qualification Data: For seeding contractor, including:

1. List of at least five (5) similar completed projects with names, addresses and contact information for each associated Landscape Architect and Owner.
2. Required qualifications of Installer
3. Required qualifications of Installer's project manager and superintendent.

C. Planting Schedule: Indicating anticipated sodding dates.

1.5 QUALITY ASSURANCE

A. Sod Producer: Company specializing in sod production and harvesting with a minimum of five (5) years' experience and certified by the State of Indiana.

B. Installer Qualifications: A qualified landscape installer with a minimum of five (5) years' experience of work of this type whose work has resulted in successful lawn establishment. The Installer must be a member of the Professional Landcare Network (PLANET).

C. The Installer shall have a firm member that holds the following credentials and be available to the project as follows:

1. Hold a minimum of a four (4) year bachelor degree in the field of landscape contracting, landscape management, agronomy, landscape architecture or horticulture or be a Certified Landscape Professional by the Professional Landcare Network (PLANET).
2. Be available to respond to inquiries from Architect and Owner.

D. The Installer's project superintendent shall meet the following criteria:

1. Hold a minimum of two (2) year degree in the field of landscape contracting, landscape management, agronomy, landscape architecture or horticulture or be a Certified Landscape Technician – Exterior by the Professional Landcare Network (PLANET).
2. Be present on the project site a minimum of 85% of the time the Installer's crew is present on site.

E. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

F. Pre-installation Conference: Conduct conference at Project site.

1.6 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies and authorities having jurisdiction for fertilizer and herbicide composition and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and exposed roots from dehydration.

B. Fertilizer: Deliver fertilizer in original sealed, waterproof containers labeled with weight, chemical analysis and manufacturer. Retain all labels and/or containers in an on-site location, through substantial completion date.

1.8 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: April 15 to May 15, inclusive.
2. Fall Planting: September 15 to October 15, inclusive.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.9 COORDINATION

A. Coordinate Work of this Section with installation of underground utilities. Coordinate as required to determine who is controlling the watering rates and times and ensure rates are appropriate for work of this section and does not harm any other plant material.

1.10 MAINTENANCE SERVICE

A. Initial Lawn 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 lawn is established, but for not less than the following periods:

1. Sodded Lawns: 60 days from date of Substantial Completion.
2. Where installation is phased, continue maintenance until last phase meets requirements.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

A. Turfgrass Sod: Turfgrass Producers International (TPI) certified nursery-grown grade, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture; strongly rooted; free of stones, burned or bare spots; containing no more than ten (10) weeds per 50 sq. yards and capable of vigorous growth and development when planted.

1. Minimum Age: **24** months.
2. Select sod grown in soils similar to those present on the project site.
3. Turfgrass Species: A minimum of three cultivars of turf type tall fescue with up to one cultivar of Kentucky Bluegrass comprising a maximum of 10% of the mix. A minimum of two (2) of the fescue cultivars are to be rhizomous.

B. Harvesting Sod: Machine-cut sod not exceeding one (1) sq. yd. in area with a minimum of 3/4 inch and a maximum of 1-1/4 inch topsoil base. Minimum width shall be eighteen (18) inches. Broken pads or pads with uneven ends shall not be acceptable.

2.2 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

B. Mychorrhizae Innoculant: Provide one of the following:

1. Landscape Innoculant as manufactured by Bio-Organics (888) 332-7676
2. MycoGrow for Lawns as manufactured by Fungi Perfecti (800) 780-9126
3. Mycor Root Building by GreenSense (800) 864-4445
4. Turf Saver as manufactured by Plant Health Care (800) 421-9051

C. Water: Clean, fresh and free of material harmful to plant growth.

2.3 FERTILIZER

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea-formaldehyde, phosphorous, and potassium in the following proportions:

1. Pre-Sodding Fertilizer: 0:20:0 proportion by weight.
2. Post-Sodding Fertilizer: 4:1:2 proportion by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance.

1. Do not sod when soil is wet and unable to support load of equipment.
2. Verify that prepared topsoil is ready to receive work of this Section.
3. Verify that required utilities are available and ready for use.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect grade stakes set by others until directed to remove them.

3.3 LAWN PREPARATION

A. Apply pre-sodding fertilizer as required to apply one pound of actual phosphorous per 1000 square feet.

B. Apply mycorrhizal inoculant at the rate of ½ pound per 1000 square feet of sod. Apply per manufacturers recommendations.

C. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before sodding, restore areas if eroded or otherwise disturbed after finish grading.

E. Do not lay sod unless soil is friable to a depth of three inches.

3.4 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Laying sod:

1. The first row of sod shall be laid in a straight line with subsequent rows laid parallel.
2. Lay sod to form a solid mass with tightly fitted joints.
3. Butt ends and sides of sod; do not stretch or overlap.
4. Stagger sod strips or pads to offset joints in adjacent courses a minimum of 12 inches.
5. Avoid damage to sub-grade or sod during installation.
6. Tamp and roll lightly to ensure contact with sub-grade, eliminate air pockets, and form a smooth surface.
7. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
8. Lay sod across angle of slopes exceeding 1:3.
9. Anchor sod on slopes exceeding 1:3 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage. Drive stakes flush with soil portion of sod.
10. Place top elevation of sod 1/2 inch below adjacent pavement.
11. Place sod in a single strip 18 inches wide adjacent to all pavement.
12. The installation of sod in drain ways or intermittent waterways:
    a. Stagger to prevent a continuous seam along line of flow.
    b. Pegged to prevent washout during establishment period.

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 below sod.

1. After initial watering and sod and soil have dried, roll sod with roller not exceeding 90 lbs to ensure good bond.

3.5 LAWN RENOVATION

A. Renovate existing lawn where indicated on drawings or where existing lawns have been damaged by construction activities.

B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
2. Provide new topsoil as required.

C. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.

D. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.

E. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

F. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

G. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.

H. Apply sod as required for new lawns.

I. Water newly planted areas and keep moist until a satisfactory stand of grass is established.

3.6 LAWN MAINTENANCE

A. Maintain and establish a satisfactory lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, re-grade, and immediately replant bare or eroded areas and re-mulch to produce a uniformly smooth lawn. Provide materials and installation the same as those used in the original installation.

B. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches until Project acceptance.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of sod. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. First Week: Water lawn with fine spray as required to keep sod and soil, to a depth of 4", moist.
3. Second and Subsequent Weeks: Water lawn with a fine spray as required to maintain soil moisture to a depth of 4 inches as required to encourage deep root growth.
4. Do not use open-ended or nozzled hoses.

C. Mow lawn 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 a maximum height of 3 inches.

1. Trim edges and hand clip where required.
2. Remove clippings immediately after mowing and clipping.

D. Lawn Post-Sodding Fertilization:

1. Apply fertilizer six (6) weeks after initial post-sodding fertilization when grass is dry. Apply at rate required to apply one (1) pound of actual nitrogen per 1000 square feet.

E. Herbicide Treatment: Apply herbicides in accordance with manufacturers written instructions. Correct damage resulting from improper use of herbicides.

3.7 SATISFACTORY LAWNS

A. Lawn installations shall meet the following criteria as determined by Architect during final inspection and at acceptance:

1. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established and with grass height between 2-1/4 and 2-1/2 inches, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

C. If satisfactory lawn has not been established at final inspection, another inspection shall be made upon written Contractor request that the lawn is ready for re-inspection, but no earlier than sixty (60) calendar days thereafter.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris, created by lawn 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 36-inch high 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 lawn is established.

C. Allow only vehicles and equipment required to perform and maintain work of this Section onto completed lawn areas.

END OF SECTION 329223

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Trees
2. Shrubs
3. Ground cover
4. Perennials
5. Bulbs
6. Tree stabilization
7. Edgings
8. Fertilizing
9. Mulching
10. Maintenance

B. Related Sections:

1. Division 12 Section "Site Furnishings" for exterior unit planters.
2. Division 31 Section "Site Clearing" for protection of existing trees, topsoil stripping and stockpiling, and site clearing.
3. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
4. Division 32 Section “Landscape Grading” for topsoil placement and finish grading.
5. Division 32 Section “Sodding” for lawn planting.
6. Division 33 Section "Sub-drainage" for below-grade drainage of landscaped areas, paved areas, and wall perimeters.

C. Allowances: Quantity allowances for exterior plants are specified in Division 1 Section “Allowances.”

1. Provide exterior plants included in quantity allowances only as authorized. Authorized work includes work required by specifications and work authorized in writing by Architect.
2. Notify Architect weekly of extent of work performed that is attributable to quantity allowances.
3. Perform work that exceeds quantity allowances only as authorized by Change Orders.

D. Unit Prices: Unit prices for exterior plants are specified in Division 1 Section “Unit Prices.”

1. Unit prices apply to authorized work covered by quantity allowances.
2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with caliper size not less than sizes indicated; wrapped, tied, rigidly supported, and drum laced as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Caliper size not less than sizes indicated.

D. Bare-Root Stock: Exterior 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 caliper size indicated.

E. Clump: Where three or more young trees were planted in a group and have grown together as a single tree having three or more main stems or trunks.

F. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with 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 exterior plant required.

G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted exterior 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 exterior plant.

H. Finish Grade: Elevation of finished surface of topsoil.

I. Installer: The firm performing the installation of the plant material.

J. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

K. Multi-Stem: Where three or more main stems arise from the ground from a single root crown or at a point right above the root crown.

L. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

M. Structural Soil: Manufactured topsoil comprised of a structural crushed stone matrix and a plant sustaining soil capable of providing for the horticultural needs of plant material while ensuring suitable bearing capacity of pavements.

N. Sub-grade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing topsoil.

O. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

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

B. Samples for Verification: For each of the following:

1. 5 lb of each type of mulch material, in labeled plastic bags.
2. Waterproof tags.

C. Qualification Data: For qualified landscape Installer, including:

1. List of at least five (5) similar completed projects with names, addresses and contact information for each associated Landscape Architect and Owner.
2. Required qualifications of Installer
3. Required qualifications of Installer's project manager and superintendent.

D. List of plant material growers, including names, addresses, contact information and latest date for tagging completion.

E. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis for standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

F. Planting Schedule: Indicating anticipated planting dates for exterior plants, including schedule of arrival for plant material.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer with a minimum of five (5) years experience of work of this type whose work has resulted in successful establishment of exterior plants. The Installer must be a member of the Professional Landcare Network (PLANET).

B. The Installer's project manager shall meet the following criteria:

1. Hold a minimum of a four (4) year bachelor degree in the field of landscape contracting, landscape management, agronomy, landscape architecture or horticulture or be a Certified Landscape Professional by the Professional Landcare Network (PLANET).
2. Be present on the project site a minimum of 5% of the time the Installer's crew is present on site.

C. The Installer's project superintendent shall meet the following criteria:

1. Hold a minimum of two (2) year degree in the field of landscape contracting, landscape management, agronomy, landscape architecture or horticulture or be a Certified Landscape Technician – Exterior by the Professional Landcare Network (PLANET).
2. Be present on the project site a minimum of 85% of the time the Installer's crew is present on site.

D. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

E. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above the ground for trees up to 4-inch caliper size, and 12 inches above the ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

F. Tagging: Allow Architect option of traveling to Grower's facility to select trees from available stock. Allow six (6) weeks, after receipt of list of plant material growers, to complete tagging. Trees dug prior to tagging by Architect are subject to rejection. Unacceptable trees will not be tagged and Contractor will select a different grower at no expense to Owner. A second tagging trip will be scheduled thereafter. Decision by Architect to forego tagging trip does not release Contractor from the responsibility of obtaining plant material, which meets standards and conditions.

G. Observation: Architect may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

H. Pre-installation Conference: Conduct conference at Project site.

1.6 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies and authorities having jurisdiction for fertilizer and herbicide composition and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver exterior plants freshly dug.

1. 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.

B. Do not prune trees and shrubs before delivery except as approved by Architect. Protect bark, branches, and root systems from sunscald, drying, 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 exterior plants during transport and delivery. Do not drop exterior plants during delivery and handling.

C. Handle planting stock by root ball or container.

D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants and trees in shade, protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in dry condition in water for two hours. Reject dried-out plants.
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 exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

E. Relocating Existing Plant Material: Move existing plants in Spring before leaves appear. Comply with ANSI Z60.1 for root ball size. Cleanly cut roots at ball's surface and do not pull roots from ground. If not replanted within one hour of digging, wrap root ball with burlap and keep moist.

F. Deliver fertilizer in original sealed, waterproof containers labeled with weight, chemical analysis and manufacturer.

1.8 PROJECT CONDITIONS

A. 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 15 to June 1, inclusive.
2. Fall Planting: October 15 to December 1, inclusive.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed according to manufacturer's written instructions and warranty requirements.

1. Do not install exterior plants when ambient temperatures are forecast to drop below 30 degrees F or rise above 90 degrees F.
2. Do not install exterior plants when wind velocity exceeds, or is forecast to exceed, 30 mph.
3. Do not install exterior plants when ground is frozen, snow-covered, or in an otherwise unsuitable condition.

C. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns unless otherwise acceptable to Architect.

1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

D. Coordinate Work of this Section with installation of underground utilities and sodding.

1.9 WARRANTY

A. Special Warranty: Installer's standard form in which 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 lack of adequate maintenance, neglect, abuse by Owner, or incidents that are beyond Contractor's control.
b. Structural failures including plantings falling or blowing over.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods from Date of Substantial Completion:

a. Trees and Shrubs: Twelve (12) months, including one continuous growing season.
b. Ground Cover, Bulbs, and Perennials: Twelve (12) months, including one continuous growing season.

3. Include the following remedial actions as a minimum:

a. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
b. Replace exterior plants that are more than 10 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each exterior plant will be required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for replaced plant materials; warranty period equal to original warranty period.

1.10 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees and Shrubs: 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 plantings are acceptably healthy and well established, but for not less than one growing season or maintenance period below.

1. Maintenance Period: 12 months from date of Substantial Completion.

B. Initial Maintenance Service for Ground Cover, Perennials, and Bulbs: 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 plantings are acceptably healthy and well established, but for not less than one growing season or maintenance period below.

1. Maintenance Period: Twelve months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sunscald, windburn, injuries, abrasions, and disfigurement. Provide symmetrically developed plant material of uniform habit with straight boles and free from objectionable disfigurements. Tree leader shoots shall not be broken or cut. Plants shall have been grown in the same or colder climate zone as this Project location.

B. Quantities: "Planting Plans" supersede "Planting Material Schedules" on the Drawings.

C. Provide trees and shrubs of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

D. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

E. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

F. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 SHADE AND FLOWERING TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.

1. Provide balled and burlapped trees.
2. Branching Height: One-third to one-half of tree height.

B. Small Upright Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:

1. Stem Form: Single trunk or multi-trunk clump as indicated.
2. Provide balled and burlapped trees.

C. Small Spreading Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:

1. Stem Form: As indicated.
2. Provide balled and burlapped trees.

2.3 DECIDUOUS SHRUBS

A. Form and Size: Shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

1. Shrub sizes indicated are sizes after pruning.
2. Provide balled and burlapped shrubs.

2.4 GROUND COVER PLANTS

A. Ground Cover: Provide vigorous ground cover of species indicated, with number of vines and length of runners and clump size specified, established and well rooted in removable or integral containers or formed homogenous soil sections or similar containers, and complying with ANSI Z60.1.

2.5 PLANTS

A. Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

B. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed, complying with requirements in ANSI Z60.1.

C. Vines: Provide vines of species indicated complying with requirements in ANSI Z60.1 as follows:

1. Two-year plants with heavy, well-branched tops, with not less than 3 runners 18 inches or more in length, and with a vigorous well-developed root system.
2. Provide field-grown vines. Vines grown in pots or other containers of adequate size and acclimated to outside conditions will also be acceptable.

2.6 FERTILIZER

A. Slow-Release Fertilizer for Trees and Shrubs: Tightly compressed tablet fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight.
2. Product: Agriform 20-10-5 Planting Tablets Plus Minus, The Scotts Company, (800) 492-8255.

B. 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. Ratio for Ground Cover and Perennial Beds: 1:2:1.
2. Ratio for Bedding Plant Beds: 2:1:1.

2.7 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following:

1. Type: finely ground native hardwood bark, 5/8” maximum size.
2. Product:

a. AAA Hardwood Fines, Tiffany Lawn and Garden Supply, Inc., (317) 228-4900.
b. Forrest Fines, Greendell Mulch & Mix, Mooresville, IN (317) 996-2826
c. Hardwood Fines, Indiana Mulch, Indianapolis, IN (317) 638-8334

B. Mushroom Compost: Spent Mushroom Substrate as defined by the American Mushroom Institute and consisting of well-composted, stable, and weed-free mixture of wheat straw, peat moss, cottonseed meal, cottonseed hulls, corncobs, cocoa bean shells, gypsum, lime, chicken litter, and /or horse stable bedding and free of substances toxic to plantings.

C. Granite Cobbles: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of following type, size range, and color:

1. Type: Rounded, smooth-faced granite cobbles.
2. Size Range: 2 inches minimum, 6 inches maximum
3. Color: Uniform dark gray/charcoal color range, approved by Landscape Architect.

2.8 WEED-CONTROL BARRIERS

A. Filter Fabric: Thermally spunbound landscape fabric suitable for weed control while allowing moisture to pass through.

2.9 TREE STABILIZATION MATERIALS

A. Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood or redwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes.
3. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Border Concepts, Inc.; Tomahawk Tree Stabilizers.
2) Foresight Products, LLC; Duckbill Rootball Fixing System.
3) Tree Staple, Inc.; Tree Staples.

2.10 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. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4-inch-wide minimum, with stretch factor of 33 percent.

C. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.

D. Planter Filter Fabric: Woven or non-woven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

E. Mychorrhizae Innoculant: Provide one of the following:

1. Landscape Innoculant as manufactured by Bio-Organics (888) 332-7676.
2. MycoGrow Soluble for Potting Soils as manufactured by Fungi Perfecti (800) 780-9126
3. Mycor Root Builder by GreenSense (800) 864-4445.

F. Water: Clean, fresh and free of material harmful to plant growth.

2.11 PLANTING SOIL MIX

A. Planter Soil Mix: 1 part imported topsoil, 1 part coarse sand, 1 part mushroom compost.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas with Installer present to receive exterior plants for compliance with requirements and conditions affecting installation and performance.

1. Locate above and below-grade utilities and perform Work in a manner to prevent damage, hand excavate as required.
2. Verify that required utilities are available and ready for use.
3. Test drainage of beds and pits by filling with water twice in succession. Notify Architect of water retention for longer than 24 hours.
4. If conditions detrimental to plan growth are encountered, such as rubble fill or adverse drainage conditions, notify Architect before proceeding.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

1. Protect grade stakes set by others until directed to remove them.

B. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations with surveyor’s flags, outline planting bed areas, adjust locations when requested, and obtain Architect's acceptance of layout before planting. Make minor adjustments as required.

1. Notify Architect when staking and bed layout is complete and allow one week for adjustments.
2. Plant material installed prior to Architect’s approval of staking and bed outlines is subject to relocation at Contractor’s expense.

C. 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.

D. 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 EXCAVATION FOR TREES AND SHRUBS

A. Before planting, restore planting beds if eroded or otherwise disturbed after finish grading.

B. Pits and Trenches: Excavate circular pits with sides sloped inward per planting detail on the drawings.
   1. If drain tile is shown or required under planted areas, excavate to top of porous backfill over tile.

C. Subsoil removed from excavations is to be used as backfill. Amend plant pit backfill with 1 part mushroom compost to 2 parts excavated native soil.

D. 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 10 feet, whichever is less, and backfill with free-draining material.

E. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

F. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.4 TREE AND SHRUB PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.

B. Set balled and burlapped and container grown stock plumb and in center of pit or trench with top of root ball 1 inch above with adjacent finish grades.

   1. Remove burlap and wire baskets from tops of root balls and partially 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.
   2. Place fertilizer and mycorrhizal inoculants prior to backfilling. Provide one ounce of inoculants per inch of stem caliper.
   3. Plumb before backfilling and maintain plumb while backfilling.
   4. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

C. Set and support bare-root stock in center of pit or trench with trunk flare flush with adjacent finish grade. Place fertilizer prior to backfilling. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots. Tamp final layer of backfill. Remove injured roots by cutting cleanly; do not break.

D. Form earth saucers around isolated plants of ample size to hold at least 5 gallons for trees and 2-1/2 gallons for shrubs.

E. Mulching: Apply 3-inch average thickness of organic mushroom compost mulch extending 12 inches beyond edge of planting pit or trench. Do not place mulch within 3 inches of trunks or stems.

F. Trunk Wrapping: Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping. Wrap thin barked trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Do not wrap prior to October 1 and remove wrap by the following April 1.

3.5 TREE AND SHRUB PRUNING

A. Prune with clean cuts using sharp tools.

B. Remove only dead, dying, or broken branches. Do not prune for shape.

C. Prune, thin, and shape trees and shrubs according to standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured or dead branches from flowering trees. Prune shrubs to retain natural character.

D. Promptly treat accidental damage according to standard horticultural practice.

3.6 TREE STABILIZATION

A. Trunk Stabilization: Unless otherwise indicated, provide trunk stabilization as indicated on the Drawings and as follows:

1. Upright Staking and Tying: Stake trees as indicated on Drawings. Use length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend one half of trunk height above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Support trees with flexible ties.

3.7 GROUND COVER AND PERENNIAL PLANTING

A. Set out and space ground cover and plants as indicated. Do not damage roots by separating individual plants.

B. Dig holes large enough to allow spreading of roots and backfill with planting soil.

C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Bulbs: Plant in location and at spacings indicated. Plant at depths and orientation recommended by grower. Do not remove leaves until they have lost green color and remove only by cutting.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

G. At Contractor’s option, ground cover may be planted following mulching.

3.8 PLANTING BED MULCHING

A. Mulch backfilled surfaces of planting beds and other areas indicated within 24 hours of planting. Provide mulch ring around trees in lawn areas.

1. Organic Mulch: Apply 3-inch average thickness of organic mulch, and finish level with adjacent finish grades. Do not place mulch against plant stems.

B. Do not contaminate mulch with planting soil mix.

3.9 PLANT MAINTENANCE

A. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing stakes and guy supports and root-ball stabilization, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings.

B. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

C. Fertilize in accordance with manufacturer's written instructions and grower's recommendations.

3.10 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Promptly treat, repair, or replace damaged plantings.

3.11 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 329300