

SECTION 00 91 13.01 - ADDENDUM 1

PART 1 GENERAL

1.1 PROJECT INFORMATION:

- A. Project Name: ISU Science Building Rooms 018, 022, and 138 Renovation.
- B. Owner: Indiana State University Board of Trustees.
- C. Owner Project Number: ISU Bid No. B0028832.
- D. Architect: arcDESIGN.
- E. Architect Project Number: 26139.
- F. Date of Addendum: Friday, July 31, 2026.

1.2 NOTICE TO BIDDERS

- A. This Addendum is issued to all registered plan holders pursuant to the Instructions to Bidders and Conditions of the Contract. This Addendum serves to clarify, revise, and supersede information in the Project Manual, Drawings, and previously issued Addenda. Portions of the Addendum affecting the Contract Documents will be incorporated into the Contract by enumeration of the Addendum in the Owner/Contractor Agreement.
- B. The Bidder shall acknowledge receipt of this Addendum in the appropriate space on the Bid Form.
- C. The date for receipt of bids is unchanged by this Addendum, at same time and location.
 - 1. Bid Date: Thursday August 20, 2026, 2:00 PM local time.

1.3 ATTACHMENTS

- A. This Addendum includes the following attached Documents and Specification Sections:
 - 1. Specification Divisions 20, 21, 23, 26, 27, and 28.
 - a. Refer to the original Project Manual's Table of Contents for Divisions 20, 21, 23, 27, and 28 for each specification section.
 - b. Table of Contents has not changed from initial Bid Documents.

1.4 REVISIONS TO DIVISIONS 02 - 49 SPECIFICATION SECTIONS

- 1. Revisions are:
 - a. 20 00 10 – COMMON WORK RESULTS FOR FIRE SUPPRESSION AND HVAC
 - b. 20 00 60 – COMMON PIPE, VALVES, FITTINGS AND HANGERS FOR FIRE SUPPRESSION AND HVAC
 - c. 20 01 80 – COMMON INSULATION HVAC
 - d. 21 10 00 – WATER-BASED FIRE SUPPRESSION SYSTEMS
 - e. 23 05 93 – TESTING AND BALANCING
 - f. 23 31 13 – METAL DUCTS
 - g. 23 33 00 – AIR DUCT ACCESSORIES
 - h. 23 37 13 – DIFFUSERS, REGISTERS, GRILLES AND LOUVERS
 - i. 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL
 - j. 26 05 02 – SELECTIVE DEMOLITION
 - k. 26 05 19 – ELECTRICAL POWER CONDUCTORS AND CABLES

- l. 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
- m. 26 05 33 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
- n. 26 09 23 – LIGHTING CONTROL DEVICES
- o. 26 24 16 – PANELBOARDS
- p. 26 27 26 – WIRING DEVICES
- q. 26 51 00 – INTERIOR LIGHTING
- r. 27 00 00 – ISU GENERAL REQUIREMENTS BY OWNER
- s. 27 00 10 – GENERAL REQUIREMENTS FOR COMMUNICATIONS
- t. 27 01 00 – OPERATIONS AND MAINTENANCE OF COMMUNICATIONS SYSTEMS
- u. 27 05 01 – BASIC MATERIALS AND METHODS FOR COMMUNICATIONS
- v. 27 05 28 – PATHWAYS FOR COMMUNICATIONS SYSTEMS
- w. 27 05 50 – FIRESTOPPING FOR COMMUNICATIONS SYSTEMS
- x. 27 05 53 – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS
- y. 27 08 10 – VERIFICATION TESTING OF STRUCTURED CABLING
- z. 27 15 13 – COMMUNICATIONS COPPER HORIZONTAL CABLING
- aa. 27 16 00 – COMMUNICATIONS CONNECTING CORDS, DEVICES AND ADAPTERS
- bb. 27 41 10 – AUDIO AND VIDEO SYSTEMS CABLING
- cc. 27 41 11 – INSTRUCTIONAL CLASSROOM AUDIO VIDEO SYSTEMS
- dd. 28 05 00 – COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY
- ee. 28 31 12 – FIRE-ALARM ADDRESSABLE FOR RENOVATION PROJECTS

1.5 BIDDERS QUESTIONS

- A. Question: Divisions 20, 21, 23, 26, 27, and 28 are missing from the Project Manual.
 - 1. Answer: Divisions will be issued immediately, 7/31/2026.
- B. Question: Has anything else changed in the Project Manual?
 - 1. Answer: No, the rest of the Project Manual is unchanged.
- C. Question: Has a hazardous materials survey been performed and is there any hazardous materials removal as part of the project?
 - 1. Answer: Any abatement of hazardous materials is being performed outside of this contract by Owner's consultants.

END OF SECTION 00 91 13.01

SECTION 20 00 10 – COMMON WORK RESULTS FOR FIRE SUPPRESSION AND HVAC

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, 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 Fuel-Gas Code.
 - 5. The Indiana Fire Code.
 - 6. The Indiana Plumbing Code. (IPC)
 - 7. The Indiana Elevator Code.
 - 8. The Indiana Handicapped Accessibility Code.
 - 9. National Fire Protection Associates (NFPA) codes and regulations.
 - 10. Regulations of the Indiana State Board of Health.
 - 11. Regulations of the Insurance Bureau of Indiana.
 - 12. Requirements of Factory Mutual (FM).
 - 13. Regulations of the Indiana Department of Fire Prevention and Building Services.
 - 14. The Americans with Disabilities Act (ADA).
 - 15. 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 a prominent place at building site properly protected from weather and physical damage. Where applicable (i.e. ESSER-funded), acquire and display required workplace posters. Maintain and adhere to all project, wage-rate and payroll documentation processes and requirements.

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 ensure 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 and wiring diagrams: Power, signal, and control wiring. Wiring diagrams must match the equipment provided. Custom factory wiring such as terminal strip designations must be provided. Costs associated with field changes required if accurate wiring diagrams are not provided shall be borne by the equipment manufacturer.
 - 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 lists 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 blue-line drawings in accordance with Division 1. This set shall contain all deviations between actual construction and Contract Drawings.
- 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 "PROJECT 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. Complete set of reviewed shop drawings.
 4. 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.
 5. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 6. Servicing instructions and lubrication charts and schedules.
 7. Warranty letter from contractor stating general warranty and any extended warranty items included in this contract.
 8. Refer to Division 1 "Contract Closeout" for additional instructions.
 9. O&M Manuals shall also be submitted in electronic format and neatly organized to the satisfaction of the engineer.

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 and or the specifications, 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. Note: Respective contractor infers the contractor installing the work.
- B. Each Contractor and Subcontractor shall study all Drawings applicable to this work so complete coordination between trades will be affected. 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. Temperature controls interface, where applicable, shall be given attention.
- C. 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 in new or existing walls shall be furnished by **Respective Contractor**. Contractor shall be responsible for notifying other Contractor of correct size and locations for all lintels prior to wall construction.
- B. Painting: **Respective 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 Contractor**.
- C. Color Code Painting: piping shall be color coded by the **Respective Contractor** as specified in Section 20 00 50.
- D. Penetrations: holes required for piping or ductwork shall be cut in field at expense of **Respective Contractor**. Engineer shall give approval prior to any cutting.
- E. Holes required for piping or ductwork shall be *****cut or installed as walls are erected***** at the expense of the **Respective Contractor**. Mechanical Contractor to coordinate location and size of all openings prior to building erection or he will assume all costs for providing openings.
- F. Penetrations through Structure: **Respective Contractor** shall cut openings through structure unless otherwise indicated by others on structural drawings. Engineer shall give approval prior to cutting.
- G. Chemical Treatment, system fill, and glycol (where applicable) of closed loop systems by **Respective Contractor/Owner**.
- H. Chemical Treatment and system fill of open loop systems by **Respective Contractor/Owner**.
- I. Caulking of all plumbing fixtures shall be by Mechanical Contractor.

- J. All fire stopping of mechanical penetrations by **Respective** Contractor.
- K. All caulking of mechanical penetrations through interior partitions by **Respective** Contractor. All sleeve seals for mechanical penetrations through exterior below grade penetrations by Mechanical Contractor.
- L. Mechanical Contractor will install all taps, control valves and thermowells 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.
- M. 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** Contractor. **Respective** Contractor shall coordinate necessity and location of such protection with Owner.
 - 2. Temporary filters and covers for protection of new and existing ductwork, piping, and equipment is required during construction and shall be by **Respective** Contractor.
- N. Pipe identification shall be by Mechanical Contractor as specified in Section 20 00 50.
- O. 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** 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.
- P. All electrical control wiring between mechanical equipment (i.e., air-cooled chiller and condensing unit, respective indoor and outdoor equipment, etc.) shall be by **Respective** Contractor. Conduit and wiring requirements shall adhere to those specified in Division 26.
- Q. Cutting and Patching: **Respective** Contractor shall cut and patch finished areas as required by Mechanical Contractor.
- R. Wall Sleeves in new construction for Mechanical systems shall be provided by the **Respective** Contractor and coordinated by Mechanical Contractor.
- S. Wall Sleeves in existing construction shall be provided and installed by the **Respective** Contractor.
- T. Ceiling and Wall Access Panels: shall be located by mechanical contractor and installed by **Respective** 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 starts 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 and change temporary filters over ductwork openings or grilles connected to air handling equipment operated prior to Owner occupancy and Substantial Completion for temporary heating and cooling. Respective Contractor shall submit equipment and ductwork dust protection measures prior to installation of equipment and ductwork.
- F. 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 desiccant 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, 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. Manufacturers listed on schedules shall be considered "Basis of Design" (BOD). Note that manufacturers listed as equals may have physical characteristics such as weight, footprint, sound levels, electrical, etc., 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. Contractors should seek clarification prior to bid for any equipment that does not meet or exceed the scheduled or specified characteristics.
- D. Manufacturers listed for products and equipment does not imply that their standard construction or configuration is acceptable or meets the specifications. Equipment proposed "as equal", must meet the specifications including all architectural, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications.

PART 3 - EXECUTION

3.1 PROTECTION AND TREATMENT OF PROPERTY

- A. Protect existing utilities. Cap existing utilities that are abandoned.
- B. 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 3/4 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'-0" o.c.
- D. All flexible conduits shall not exceed 2'-0".
- 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 manufacturer's 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 **Engineer**.
- 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 **Engineer** 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.

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 ensure proper functioning of all mechanical systems after building occupancy and during guarantee period.
 - 8. Provide duct stiffeners, air straighteners, or turning vanes as required to stop any oil canning, drumming or fan surge to the satisfaction of the engineer.

END OF SECTION 20 00 10

SECTION 20 00 60 – COMMON PIPE, VALVES, FITTINGS AND HANGERS FOR FIRE SUPPRESSION AND HVAC

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 #14
 - Sanitary Inside Building
 - Vent Inside Building
 - Storm Gravity Inside Building
 - 2. System Piping Schedule #17
 - Domestic Hot Water Aboveground
 - Domestic Cold Water Aboveground
 - 3. System Piping Schedule #19
 - Fire Protection
- 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. Fire Protection Specialty Valves – 21 00 00 “Fire Protection”
 - 2. Refrigeration Specialty Valves – 23 00 00
 - 3. Hydronic Specialty Valves – 23 00 00 “Heat Transfer”
 - 4. 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 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. All grooved joint couplings, fittings, valves and specialties shall be products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- D. 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-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.
 3. 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.
 4. CP-33 PVC DWV Drainage Pipe: ASTM D2665, Polyvinylchloride pipe solid-wall, waste, and vent. Schedule as noted.
 5. 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.
 6. 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-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 fittings shall be long radius unless otherwise specified. UL listed, FM approved for fire service. Victaulic; Anvil; Gruvlok.
 4. CF-8 Wrought Copper: ASME B16.22. Wrought copper solder joint fitting as manufactured by Flagg; Mueller; Chase, NIBCO; Anaconda; American Brass.
 5. CF-20 Mechanical Joint: AWWA C111 ductile or grey-iron, standard pattern, same class as noted for pipe. Alabama Pipe, U.S. Pipe & Foundry.
 6. CF-33 PVC Drainage Fittings: ASTM D2665, socket type, made to ASTM D 3311 drain waste and vent patterns.
 7. CF-40 (HUB) Bell and Spigot: Cast iron bell and spigot Type fitting DWV configuration, extra heavy duty. American Brass & Iron; Tyler; Charlotte.
 8. 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.
 1. CJ-6: grooved mechanical-joint couplings: Two ductile or iron housing segments and synthetic rubber EPDM (+250°F) gasket of central cavity pressure-response design; with ASTM A449/ASTM A183 nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings; Installation-Ready rigid coupling, or equal by Victaulic, Gruvlok, or

engineer approved equal. UL classified in accordance with ANSI / NSF-61 for potable water service and shall meet the low-lead requirements of NSF-372. Torque of fittings, if required, shall be in accordance with the manufacturer's latest recommendations and each coupling shall be tagged or marked with the specific value of torque attained to confirm joint rigidity and proper installation, when applicable.

2. CJ-8: 95% tin, 4.85% copper, 0.15% selenium. Premium Contractor Grade solder. 410°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).
3. CJ-20 Mechanical Joint: AWWA C 111 ductile - or grey - iron glands, 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.
4. CJ-33 PVC/CPVC
 - 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.
5. CJ-40 (HUB) Bell & Spigot: Gasket-ASTM C 564, Rubber. American Brass & Iron; Tyler; Charlotte.
6. 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 and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. 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 - °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 - °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 - °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-B F-918-B
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 | CLASS NO. | CV-20 |
| 3 | TYPE | Ball - Full Port |
| 4 | MAXIMUM WORKING | |
| 4.1 | Pressure - PSIG | 600 |
| 4.2 | Temperature - °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 | |
| 7.1 | Nibco | T-585-70 |
| 7.2 | Crane/Capri | 9202 |
| 7.3 | Conbraco Industries, Inc. | 70-100 |
| 7.4 | Apollo Series | |
| 7.5 | Milwaukee Valve | |
| 8 | NOTES | |
| 8.1 | Soldered valves are not allowed. | |
| 8.2 | Provide metal valve stem extension or valve manufacturer's insulated metal extension handle system on all valves installed in insulated systems and specified to be insulated. Plastic valve stem extensions are not acceptable. | |
| 8.3 | Provide lead-free valves for all domestic water applications. | |

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 300
 - 4.2 Temperature - °F 200
- 5 SIZE LIMITS - Inches 3 – 6 (see note below)
- 6 DESCRIPTION
 - 6.1 Body/End Piece Duct. Iron ASTM A-126 Threaded Lug for dead end service
 - 6.2 Disc AL. Bronze ASTM B-148 Alloy 954/955; Coated Ductile Iron
 - 6.3 Stem 416 Stainless steel ASTM A-582
Collar bushings upper and lower bushing
Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.
 - 6.4 Seats Pressure Responsive EPDM
 - 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 2000-3
 - 8.2 Crane 14-TL
 - 8.3 Apollo 6L-31
 - 8.4 Lunkenheimer FIG. 4735
 - 8.5 Stockham LD-711-BS3-E
 - 8.6 Victaulic VIC300 Series
 - 8.7 Bray Series 31
- 9 NOTES
 - 9.1 Do not use butterfly valves on pipes size 2 1/2" and smaller.

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 - °F 200
- 5 SIZE LIMITS - Inches 8 - 12
- 6 DESCRIPTION
 - 6.1 Body/End Piece Duct. Iron ASTM A-536 Threaded Lug for dead end service
 - 6.2 Disc AL. Bronze ASTM B-148 Alloy 954/955; Coated Ductile Iron
 - 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
 - 8.7 Bray Series 31

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 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	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
2.2.1.3	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 piping installed above ceilings and within all plenum types shall be insulated. Reference Insulation Section 20 01 80.
 - 4.2 All waste pipe for kitchens shall be cast iron under entire footprint of the kitchen.

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 Not Allowed Not Allowed
 - 5.2 Wrought CF-8 -
 - 5.3 Grooved Mech. - CF-6
- 6 JOINT DESIGNATIONS
 - 6.1 Cold Press Not Allowed Not Allowed
 - 6.2 Solder CJ-8 -
 - 6.3 Grooved - CJ-6
- 7 VALVES
 - 7.1 Ball CV-20
 - 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.
 - 8.3 Saddle type fittings are prohibited.
 - 8.4 Mechanical T-bolted branch outlets not approved.

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	Class 125 Cast Iron	-	CF-2	-
6.3	Class 150 Malleable Iron	-	CF-1	-
6.4	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 21 10 00.			
8.2	Provide manufacturer's standard gasket for service intended on mechanical joint pipe.			
8.3	Provide thrust blocks, tie-rods on fittings below grade as required by NFPA #24, Chapter 8.			
8.4	The minimum burial depth of exterior fire protection systems shall be 5'-0".			
8.5	Saddle type fittings are prohibited.			
8.6	Mechanical T-bolted branch outlets not approved.			

3.2 PIPE SUPPORT

A. Pipe Support

1. Furnish and install supports, guides, anchors and swaybraces required for proper installation and support of pipelines 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 pipelines 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

<u>PIPE SIZE (NPS)</u>	<u>ROD SIZE (DIAMETER)</u>	<u>MAXIMUM HANGER SPACING</u>
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

<u>PIPE SIZE (NPS)</u>	<u>ROD SIZE (DIAMETER)</u>	<u>MAXIMUM HANGER SPACING</u>
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.
- B. Pre-Insulated Piping Installation Requirements: Piping shall be installed at burial depth noted on the plans, and in accordance with the piping manufacturer's requirements. Provide manufacturer's field technician for installation, unloading, field joint instruction, and testing. Service pipe shall be hydrostatically tested as noted in Section 3, Testing Piping. Joints shall be insulated/jacketed per manufacturer's requirements, using manufacturer's materials.

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°F. Use gate (Crane 431) or globe valves for systems which operate above 121°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 manufacturer's 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. 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 20 01 80 for insulation data. PVC piping installed above ceilings and within all plenum types shall be insulated.
- O. Conceal all pipes 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 pipes 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 pipes 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.
- X. No pulled "T" drilling of copper piping for branch takeoff's allowed.
- Y. Condensate piping shall be installed with slope of not less than 1/8" per foot.
- Z. If grooved piping system is used, it is not acceptable to use mechanical-T bolted branch outlet fittings.**

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.
- N. Cold Press – Not Allowed

3.11 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2-1/2 and smaller, adjacent to each threaded 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.
 - 5. "Pulled Tee's" in copper piping are not allowed.

3.12 GROOVED PIPING

- A. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks. Gaskets shall be molded and produced by the coupling manufacturer, and shall be verified as suitable for the intended service. A factory-trained field representative (direct employee) of the mechanical joint manufacture shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory-trained representative shall periodically review the product installation and ensure best practices are being followed. Contractor shall remove and replace any improperly installed products. A distributor's representative is not considered qualified to conduct the training.
- B. For applicable projects, the grooved coupling manufacturer shall provide inspection services and/or certify the installing contractor for the installation of their product. The manufacturer's factory trained representative shall provide certification training for the installing contractor's field personnel in the use of grooving tools, application of groove, and product installation. The training program shall be designed, developed, administered and evaluated in accordance to the ANSI/IACET Standard for Continuing Education and Training. (IACET-International Association for Continuing Education and Training)

END OF SECTION 20 00 60

SECTION 20 01 80 – COMMON INSULATION FOR PLUMBING AND HVAC

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:
 - Domestic Cold Water Pipe
 - Domestic Hot Water Pipe
 - Sanitary Waste & Vent
- B. Any equipment that is to be factory insulated is specified with respective equipment.
- C. All PVC piping installed 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 .27 or less @ 75°F. Designed for use to 650°F.
 - a. Preformed Pipe Insulation with Jacket: 3 lb/ft³, ASTM C547, Type 1, Class 1 with factory applied all-purpose, vapor-retarder ASJ jacket, 0.02 perm max water vapor permeance. Designed for use to 850°F max.

- b. Board Insulation: 3 lb/ft³, ASTM C 612, Type IB, without facing and with FSK jacket manufactured from kraft paper, reinforcing scrim, aluminum foil and vinyl film. Verify jacketing with Engineer prior to insulating exposed ductwork with board insulation within finished spaces. Design for use to 450°F max.
 - c. Blanket Insulation: 3/4 lb/ft³, ASTM C 553, Type II, without facing and with FSK manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film. Designed for use to 250°F max.
- 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

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°F. Jacket to be completely sealed with solvent weld for vapor proof barrier where noted in schedule.

B. Foil, Scrim and Kraft-Paper (FSK) 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. All-Service Jacket (ASJ)

1. White, kraft-paper fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type 1.

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.

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 & VENT

- | | | | |
|-------|--|----------------------------------|---------|
| 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 | ASJ Integral to Insulation | |
| 5.2 | Fittings | Preformed PVC | |
| 5.3 | Vapor-Retardant | Yes | |
| 6 | NOTES | | |
| 6.1 | Application of insulation on sanitary waste pipe shall be as follows: | | |
| 6.1.1 | Piping installed above ground floor. | | |
| 6.1.2 | Serving discharge from cooling coils or electric water coolers. | | |
| 6.1.3 | Piping installed in return air plenum. | | |
| 6.1.4 | Where insulation is required, install along pipe lengths connecting fixture to waste stack/main building drain only. | | |
| 6.2 | All PVC piping in return air plenums shall be insulated per this schedule. | | |

3.2 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

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

3.4 GENERAL APPLICATION REQUIREMENTS

- A. All insulation that is to be painted shall have all-service jacket (ASJ) 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, storeroom 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 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.

3.5 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.

3.6 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.

3.7 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 strainers, 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 inches (50 mm), and seal joints with vapor-retardant mastic.

END OF SECTION 20 01 80

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SECTION 21 10 00 – WATER-BASED FIRE-SUPPRESSION SYSTEMS

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 21 Section "Electric-Drive, Centrifugal Fire Pumps" for fire pumps, pressure-maintenance pumps, and pump controllers.
- D. See Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

1.2 SYSTEM DESCRIPTIONS

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

1.3 GENERAL

- A. Provide all material, labor, engineering and operations for the installation of complete and operable fire suppression system as shown on the Drawings and as specified herein.
- B. Provide all equipment and materials including pipes, valves, fittings, sprinkler heads, fire department connections, backflow preventer, pipe supports, specialties and accessories necessary for a complete and approved fire suppression system.
- C. This Contractor shall be completely responsible for the design, layout, submittals, installation, testing, certification and acceptance of the fire suppression system by the Indiana Department of Homeland Security Division for Fire and Building Safety.

1.4 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. Auditoriums: Ordinary Hazard, Group 1.
 - b. Building Service Areas: Ordinary Hazard, Group 1.

- c. Classrooms: Light Hazard.
 - d. Corridors: Light Hazard.
 - e. Display Cases: Light Hazard.
 - f. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - g. General Storage Areas: Ordinary Hazard, Group 1.
 - h. Janitors: Ordinary Hazard, Group 1.
 - i. Laundries: Ordinary Hazard, Group 1.
 - j. Libraries, Except Stack Areas: Light Hazard.
 - k. Library Stack Areas: Ordinary Hazard, Group 2.
 - l. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - m. Office and Public Areas: Light Hazard.
 - n. Residential Living Areas: Light Hazard.
 - o. Restaurant Service Areas: Ordinary Hazard, Group 1.
 - p. Restrooms: Light Hazard.
 - q. Stages/Stagecraft: Ordinary Hazard, Group 2.
 - r. Stairs: 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: 0.20 gpm/sq. ft. over 2500 sq. ft.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm/sq. ft. over 2500 sq. ft. (stage calculation should be over entire area of stage, up to max 2500 sq. ft.).
 - d. Remote area may NOT be reduced where listed quick response sprinklers are used.
4. Maximum Protection Area per Sprinkler:
- a. Light Hazard: 225 sq. ft.
 - b. Ordinary Hazard: 130 sq. ft.
 - c. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.
 - d. 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.
- C. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.5 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.
 9. Seismic restraints.
- C. Field test reports and certificates.
- D. Field quality-control test reports.
- E. Operation and maintenance data.
- F. **Submit shop drawings to Insurance Carrier first. Then, submit approved shop drawings to the Indiana Department of Homeland Security for approval. Submit shop drawings bearing stamp of Insurance Carrier and Department of Homeland Security to the Engineer for approval.**
- G. Shop Drawings must be created in a format compatible with AutoCad .dwg extension.

1.6 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.
 3. All equipment and components shall bear UL and FM label or marking and shall be FM approved for fire service.
- C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. FM, "Factory Mutual Approval Guide".
 2. UL, "Underwriters Laboratory Fire Protection Equipment Directory.
 3. Local Fire Department requirements.
 4. Local, city, state, or any other requirements of the Authority Having Jurisdiction.
 5. NFPA 13, "Installation of Sprinkler Systems"; 2010 version.
 6. NFPA 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height"; 2010 version.
 7. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems"; 2000 version.

8. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances"; 1995 version.

1.7 EXTRA MATERIALS

- A. For Projects requiring more than thirty (30) sprinkler heads, provide 10% extra sprinkler heads and head wrench.
- B. For Projects requiring three (3) or more flow and/or tamper switches, provide 10% (or a minimum of 1) extra for each device.
- C. Provide fifty (50) spare concealed sprinkler head cover plates for the Owner's future use.

1.8 IMPAIRING THE FIRE PROTECTION SYSTEM

- A. Coordinate with Owner all existing fire protection systems.
- B. Use the FM Global Red Tag Regulations.
- C. Plan and coordinate work to minimize the period of time which the system is impaired.
- D. In general, reactivate system at the end of each workday, under the supervision of Facilities Management. System may be left impaired overnight only if explicitly authorized by Owner.

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. Outlet Specialty Fittings:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Central Sprinkler Corp.
 - c. National Fittings, Inc.
 - d. Star Pipe Products; Star Fittings Div.
 - e. Victaulic Co. of America.
 - f. Ward Manufacturing.
 2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
 - a. Saddle Type fittings are prohibited.
- 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 and Smaller: Bronze body with threaded ends.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Crane Co.; Crane Valve Group; Crane Valves.
 - 2) Hammond Valve.
 - 3) NIBCO.
2. 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, pre-wired, 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 AIR VENT

- A. Automatic Air Vent:
 - 1. Description: Automatic air vent that automatically vents trapped air without human intervention.
 - 2. Standard: UL listed or FM Global approved for wet-pipe fire sprinkler systems.
 - 3. Vents oxygen continuously from system.
 - 4. Float valve to prevent water discharge.
 - 5. Minimum Water Working Pressure Rating: 175 psig.

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.
 - 2. UL 1626, for residential applications.
 - 3. UL 1767, for early-suppression, fast-response 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. Pendent sprinklers.
 - 3. Quick-response sprinklers.
 - 4. Recessed sprinklers, including escutcheon.
 - 5. Sidewall sprinklers.
 - 6. Upright sprinklers.
 - 7. Dry sidewall sprinklers.
 - 8. Dry pendent sprinklers.

- F. Sprinkler Finishes: Chrome plated, bronze, painted, custom-color painted where indicated on Drawings.
- G. Special Coatings: Wax, lead, and corrosion-resistant paint.
- H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, sidewall, and recessed-type sprinklers are specified with sprinklers.
 - 1. Ceiling Mounting: Chrome-plated steel, 2-piece, with 1-inch vertical adjustment.
 - 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- I. 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.
- J. Flexible Sprinkler Hose Fittings:
 - 1. Standard: UL 1474.
 - 2. Type: Flexible hose for connection to sprinkler, and with manufacturer furnished bracket for connection to ceiling grid.
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Size: Same as connected piping, for sprinkler.

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 zoned on a floor-by-floor basis. In addition, systems protecting special hazards shall be zoned separately.
2. Refer to Drawings for sprinkler zone locations.

E. Pipe Supports

1. All piping shall be supported from the structure above with UL approved hangers. Sizing, spacing, and installation shall be in accordance with NFPA 13 except as otherwise shown on the Drawings or specified herein. Comply with other sections of this specification relating to Basic Mechanical Materials and Methods for basic pipe installation.
2. 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 250 lb.

F. 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.

G. Wet Sprinkler System

1. Fire sprinklers shall be provided for the entire building except as follows:
 - a. Do not install sprinkler piping or heads in elevator shafts or elevator equipment rooms.
 - b. Do not install sprinkler heads in transformer vaults.
2. Air Vent:
 - a. Provide at least one air vent in each wet pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping. Where trapped portion of pipe exists, provide air vent for each location.
 - b. Provide dielectric union for dissimilar metals, ball or globe valve, and strainer upstream of automatic air vent.

H. 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 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. Do not install sprinkler piping directly below roof relief vents, wall intake louvers or anywhere where piping will be subjected to ambient conditions which will result in freezing of sprinkler piping.
- H. Hangers and Supports: Comply with NFPA 13 for hanger materials.
 - 1. Install sprinkler system piping according to NFPA 13.
- I. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- J. Fill wet-pipe sprinkler system piping with water.

3.3 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 and NFPA 14.
 - 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 and NFPA 14.
 - a. Shutoff Duty: Use butterfly or gate valves.
 - b. Throttling Duty: Use globe valves.

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 NFPA 14 and authorities having jurisdiction.

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; wax coated where exposed to acids, chemicals, or other corrosive fumes.
 - b. Recessed Pendent, and Sidewall Sprinklers: Factory painted white, with white escutcheon.
 - c. Concealed Sprinklers: Rough brass, with factory-painted cover plate. Finish shall be specified by architect.

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 pendent or sidewall, 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. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
 - 4. Coordinate with fire alarm tests. Operate as required.
 - 5. 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 all piping hydrostatically at not less than 200 psi for 2 hours without loss of pressure.
 - 3. Retest piping that initially fails after corrective actions have been made.
 - 4. All tests shall be made in the presence of the Owner's Representative or as directed by the Engineer. Allow for at least 24-hour notice of all tests.
 - 5. 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

SECTION 23 05 93 – TESTING AND BALANCING

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

1.2 SUMMARY

- A. This Section includes testing, adjusting and balancing of HVAC Systems to produce design objectives, including the following:
 - 1. Adjusting ducts to deliver design air flow.
 - 2. Adjusting diffusers, registers and grilles to supply, or return design air flow.
 - 3. Adjusting diffusers, registers and grilles to minimize drafts.
 - 4. Adjusting all zones for design supply and return air flow.
 - 5. Balancing of domestic hot water return loop.
 - 6.
 - 7. 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. If so requested on the bid form Submit name of the Test and Balance Agency to Architect/Engineer as a subcontractor on the Materials and Subcontractors Listing.
 - 2. 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 typewritten 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 30, 60, 90 percent site visit reports on installation of HVAC systems.
2. Forms shall be 8-1/2" x 11", with blanks for listing of the required test ratings and for certification of report.
3. Submit preliminary pencil copies of reports as A/E determines.

E. Final Report

1. Upon completion, all information shall be neatly typed, PDF'd, and electronically submitted to the Architect/Engineer with accompanying schematic diagrams of systems tested.
2. All test reports shall be submitted with project name and Balancing Contractor's name printed thereon.
3. A copy of the report shall be incorporated into the O&M manual for the project as a dedicated section.

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
 - d. Gibson Services.
 - e. Midwest Balance
 - f. Synergy Test and Balance
 - g. Bledsoe Test and Balance
 - h. Technical Systems Group – Terre Haute
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 ensure 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. Installed clean filters within the equipment. Do not continue testing of unit until clean filters have been provided.
 - 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 VFD 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. Adjust all main supply and return air ducts to proper design CFM.
5. Adjust all zones to proper design CFM, supply and return.
6. Test and adjust each diffuser, grille and register to within $\pm 10\%$ of design requirements.
7. 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.
8. 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.
9. The Balance Contractor shall list all controls requiring adjustment by Temperature Control Contractor and assist Control Contractor with required settings.
10. All diffusers, grilles and registers shall be adjusted to minimize drafts in all areas.

B. Record Data

1. Air Systems - record the following minimum data:
 - a. CFM delivery
 - 1) All equipment nameplate data
 - b. CFM delivered or returned at each diffuser, register, or grille.

- C. 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 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 23 05 93

SECTION 23 31 13 – METAL DUCTS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:

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

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.

1. Static-Pressure Classes:

- a. Supply Ducts: 2-inch wg.
- b. Return Ducts: 2-inch wg.

2. Leakage Class:

- a. Round 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 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 sheet metal 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: 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.

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 2-1, "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 2-2, "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."
- E. Exposed ductwork in finished areas shall have "paint-grip" finish. Ductwork will be field painted.

2.2 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. Linx Industries.
 - 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
 - i. JTD Spiral Inc.
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure showing, "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 showing, "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 showing, "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.

2.3 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.

2.4 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.

2.5 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," Figure Showing 5-1, "Rectangular Duct Hangers Minimum Size," and Figure showing 5-2, "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: Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
- F. See 20 00 10 Common Work Results for Fire Suppression, Plumbing and HVAC for attachment to existing structure.

2.6 DUCT SCHEDULE

- A. Fabricate supply, return, outdoor air, and relief air ducts with galvanized sheet steel unless noted otherwise on drawings or within specifications.
- B. Ductwork exhausting high moisture airstreams, shower rooms, and locker rooms shall be fabricated from aluminum.
- C. All commercial dishwasher ductwork shall be all welded watertight stainless steel below the ceiling or where exposed. Ductwork above ceilings may be all welded watertight stainless steel or aluminum. Ductwork to slope back to dishwasher for positive drainage.
- D. Exhaust ductwork from fume hoods and science labs shall be fabricated from stainless-steel or 3 mil PVC coated sheet steel unless noted otherwise.
- E. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.
- F. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure showing, "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 showing, "Vanes and Vane Runners," and Figure showing, "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 showing, "Vanes and Vane Runners," and Figure showing, "Vane Support in Elbows."
 - 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure showing, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table showing, "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.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "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 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Rectangular Main to Round Branch: 45-degree entry. No spin-in type fittings allowed.
 - b. Round Main to Round Branch: 45-degree entry.

H. Escutcheons:

1. For all duct penetrations thru walls into finished areas duct shall have neat shop fabricated picture frame escutcheon on finished side of wall.
 - a. This applies to both round and square duct work.
 - b. Externally insulated ducts to have escutcheon oversized by thickness of insulation.
 - c. Ducts without insulation to have escutcheon tight to exterior of duct.
 - d. Escutcheon to be fastened to wall and not duct.
 - e. Escutcheon to be of quality finish and paintable.

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. Contractor shall remove all labels and stickers from inside of ductwork prior to installation.

- C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- D. Install round ducts at 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, cover the opening between the partition and duct or duct insulation with sheet metal flanges (picture frames) 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 "Intermediate Level" standards as identified in SMACNA's "Duct Cleanliness for New Construction Guidelines." All ducts and air openings on equipment shall be covered and protected throughout construction until ready for use.

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 1-1, "Standard Duct Sealing Requirements," unless otherwise indicated.
- B. Seal Classes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table showing 1-1, "Standard Duct Sealing Requirements."

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter for, "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 showing 5-1, "Rectangular Duct Hangers Minimum Size," and Table showing 5-2, "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 interval 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.
- G. Install stiffener's, turning vanes, and/or air straighteners as required to stop objectionable duct oil canning, or fan surge to the satisfaction of the engineer.

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.

END OF SECTION 23 31 13

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METAL DUCTS
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SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Materials.
 - 2. Manual volume dampers.
 - 3. Flange connectors.
 - 4. Turning vanes.
 - 5. Duct-mounted access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.
 - 8. 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 1/4" = 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.
 - 2. 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.
- 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 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. METALAIR, Inc.
 - f. Nailor Industries Inc.
 - g. Ruskin Company.
 - h. Greenheck.
 - i. Vent Products Company, Inc.
 - j. United Enertech
 - k. Pottorff
 - l. NCA Mfg.
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames:
 - a. Hat-shaped, galvanized-steel channels, 16 ga. 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.
 - a. 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.
 6. 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 standoff bracket for insulated duct mounting.
- D. Remote Operated Balance Dampers
1. Provide cable or electronic operated balance dampers where required to adjust volume dampers above inaccessible ceilings or behind walls.
 2. Cable length as required for access via remote adjuster behind an adjustable cover plate for flush finish installation. Refer to A-series drawings for ceiling construction. Cover plate primer coated cover for field painting unless noted otherwise. Like DuroDyne, Young Regulator, or approved equal.
 3. Dampers may be electronic balancing damper actuated by hand-held damper positioner that plugs into a connector. Connector plug-in to be inconspicuously mounted and wired to damper. System to have damper position indication. Like Young Regulator EBD with EBDP electronic balance damper positioner tool.

2.3 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.
 4. Duro Dyne Inc.
- B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

- C. Material: Galvanized steel.
- D. Gauge and Shape: Match connecting ductwork.

2.4 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. 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 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.5 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.
 - 11. Pottorff
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - 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.

2.6 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 1. Minimum Weight: 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.

2.7 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.

2.8 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 volume dampers at points on supply/return systems where branches extend from larger ducts. Install volume dampers at all locations as required for balancing whether shown or not. Dampers specified on backs of grilles shall not be used for balancing unless approved by Engineer.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.

- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. 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.
- F. Connect flexible ducts to metal ducts with draw bands plus sheet metal screws.
- G. 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. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

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SECTION 23 37 13 – DIFFUSERS, REGISTERS, GRILLES AND LOUVERS

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-, floor- and wall-mounted diffusers, registers, and grilles.

This Section includes but is not limited to:

- 1. Ceiling Diffusers
- 2. Grilles and Registers

- B. Related Sections include the following:

- 1. Division 23 Section "Air Duct Accessories" for 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 CEILING DIFFUSERS

- A. Round Ceiling Diffuser:

- 1. Manufacturers:
 - a. Price Industries
 - b. Titus TMRA
 - c. Nailor Industries
 - d. MetalAire
 - e. Krueger

2. Material: Steel.
3. Finish: Primer for field painting.
4. Face Style: Four cone
5. Mounting: Duct connection.
6. Pattern: Fully adjustable.
7. Dampers: Butterfly type in neck of diffuser adjustable through face of diffuser.
8. Accessories:
 - a. Plaster ring (when applicable).

2.2 GRILLES AND REGISTERS

- A. Manufacturers:
 1. Price Industries
 2. Titus
 3. Nailor Industries
 4. MetalAire
 5. Krueger
- B. Capacity, size, and noise criteria as Scheduled (Return and Exhaust). Additional sizes may be required as indicated and noted on individual Drawings.
- C. Material: Heavy gauge steel or heavy gauge aluminum. Provide aluminum construction for installations in shower rooms and corrosive environments.
- D. Finish: Baked enamel, white (unless noted otherwise on Drawings).
- E. Mounting: Countersunk screws
- F. Frame: 1-1/4" wide.
- G. Metal plaster frames: for grilles mounted on plaster, masonry, fiber or metal construction surfaces.
- H. Panel mounted where installed in T-bar ceilings unless noted otherwise.
- I. Volume Damper: Opposed blade operable through face of grille.
- J. Deflecting Blades: 3/4" spacing
- K. Return Grilles: Similar to Titus 350 Series - single deflection blades fixed at 35°/45° down (unless noted otherwise on Drawings).

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 if not of panel dimension. 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 23 37 13

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DIFFUSERS, REGISTERS,
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SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General, Supplementary, and Special Conditions apply to all electrical work.

1.02 DESCRIPTION OF WORK

- A. Section 260500 applies to all electrical materials, equipment, installations and services supplied under any portion of the work.
- B. All work must meet or exceed all Local, State and Federal Codes and ADA Guidelines.
- C. All Electrical Contractor or Electrical Sub-contractor work shall be performed by a licensed and bonded Electrical Contractor with at least five (5) years of successful installation experience on projects with electrical work similar to this project.
- D. The Electrical Contractor or Electrical Sub-contractor shall coordinate the Basic Requirements as applicable to any equipment, installations and services of an electrical nature.
- E. It is the intention of this Division of the Specifications and the accompanying drawings to describe and provide for the furnishing, installing, testing and placing in satisfactory and successful operation all equipment, materials, devices and necessary appurtenances to provide a complete electrical system.
- F. The Contract drawings indicate the extent and the general location and arrangement of equipment, conduit and wiring. The General Contractor and their Electrical Sub-contractor shall study the plans and details and shall coordinate with all other trades to prevent conflict and interference with other installations.
- G. The Electrical Contractor or the Electrical Sub-contractor is responsible for installation of a complete and operating electrical system in accordance with the intent of the Drawings and Specifications.
- H. Any minor changes in location of equipment and conduits from those shown on the plans shall be made without extra charge if so directed by the Owner prior to installation.
- I. All equipment shall be installed such that maintenance and service may be properly accomplished. If necessary, the Owner may at their option require the contractor to demonstrate the service on any piece of equipment to determine sufficient service space exists. If service space is not adequate, the equipment shall be relocated at no additional cost to the Owner so that sufficient service space is achieved.

1.03 PERMITS AND FEES

- A. This work shall include the procurement of and payment for all permits and fees for the performance of the electrical work.

1.04 SUBMITTALS

- A. The following items that shall be submitted for approval prior to ordering. Submit individually by the appropriate Specification Section number.

1. Raceway (unless special raceway is specified a letter on Company letterhead stating the products to be used are in conformance with the Specifications is acceptable as a Submittal. Check with Engineer/Owner)
2. Wire (unless special wire is specified a letter on Company letterhead stating the products to be used are in conformance with the Specifications is acceptable as a Submittal. Check with Engineer/Owner)
3. Wiring Devices and Covers
4. Lighting Fixtures
5. Disconnect Switches
6. Motor Starters
7. Panelboards and Switchboards
8. Fire Alarm
9. Others as required by the related Division 26 Section.

B. Submission of the above information shall be electronically in ISU approved PDF Format.

1.05 PROJECT CLOSEOUT

- A. On Electrical Prime Projects one set of all Project documents shall be submitted electronically in PDF Format on a USB Flash Drive. The following is a list, but not limited to, of required documentation to be included on the USB flash drive:
 1. Bid Form
 2. Award Letter and Contract for Construction
 3. Meeting minutes and supporting documentation.
 4. Reviewed submittals and reviewed shop drawings
 5. All Change documentation, e.g. ASI, RFI, CCD, RFP, CP, CO, etc.
 6. Pay Applications
 7. Installation instructions and schematic drawings
 - a. Complete parts list with manufacturer's model numbers.
 - b. Complete wiring diagrams showing all connections and internal wiring. Factory typical wiring diagrams are not acceptable.
 8. Operating and maintenance instructions.
 9. Warranty and guarantee information
 10. Substantial Completion documents to determine start of Warranty Period
- B. When individual Specification Sections call for close-out submission they may be combined on a master Project close-out USB flash drive with itemized files and sub-files for each Section.
- C. Additionally, submit one hard copy of the O&M's in a 3-ring binder and unfolded Record Drawings.
- D. Prior to release of final payment, Indiana State University must receive a complete set of record drawings in AutoCAD 2010 on a CD or DVD. The Design Engineer and the Indiana State University Department of Facilities Management engineering staff must approve these drawings.

1.06 COPPER REQUIREMENTS FOR ELECTRICAL EQUIPMENT

- A. All current-carrying components (phase, neutral and ground) of all electrical equipment shall be copper. No CUAL allowed without prior approval of Owner.
- B. Exceptions: molded case circuit breakers with in-built lugs and safety switches.

1.07 UNDERGROUND UTILITIES

- A. All underground utility lines shall be buried a minimum of 36" below finished grade.
- B. Place 3" of compacted red sand below all buried utility lines and cover with 12" of red sand.
- C. Remainder of the trench shall be back filled with new topsoil free of debris, compacted in 6" lifts to 98% standard proctor using the water jet method.
- D. Install the appropriate 6" wide marker tape a minimum of 12" above any buried utility line.

1.08 NEUTRAL RULES

- A. Neutral rules and requirements for multi-circuit branch raceway installations.
 - 1. A separate dedicated neutral shall be installed for every phase conductor in a multi-circuit 120-volt or 277-volt raceway.
 - 2. Neutrals shall be marked in such a way as to prevent the accidental crossing of neutrals at device locations.
 - 3. Neutrals in 120-volt applications shall be white, gray in 277-volt applications.
 - 4. This includes pre-wired raceway systems such as ISODUCT and systems furniture.
 - 5. No sharing of neutrals is allowed.
- B. Over sizing of neutral conductors shall not be allowed in lieu of the preceding rules and requirements.
- C. THESE RULES SUPERCEDE ANY OTHER NEUTRAL INSTRUCTIONS EITHER WRITTEN OR IMPLIED IN ANY OTHER SPECIFICATION SECTION OR SHOWN ON DRAWINGS.

1.09 RACEWAY SYSTEMS INSTALLATION SUMMARY

- A. Provide conduits, cable trays, surface raceways, boxes, fittings and supports to form a complete, coordinated, and continuously grounded raceway system.
- B. No more than three (3) single phase (120volt and 277volt) circuits shall be installed in a conduit raceway system.

1.10 RACEWAY REQUIREMENTS

- A. Conduits indoors in general areas shall be electrical metallic tubing (EMT) with steel set screw or compression fittings.
- B. Conduits indoors in hazardous areas, encased in concrete floorslabs or subjected to water, physical damage or abuse shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC) with cast or malleable iron threaded fittings and bushings.
- C. Conduits indoors for medium voltage distribution circuits or for fire pump feeders shall be galvanized rigid steel conduit with cast or malleable iron threaded fittings and bushings.
- D. Conduits outdoors shall be galvanized rigid steel or intermediate metal conduit with cast or malleable iron threaded fittings and bushings.
- E. Conduits encased in concrete underground shall be Type DB PVC for IT applications and Schedule 80 for MV applications both with matching fittings.
- F. Conduits direct buried underground shall be Schedule 40 PVC with matching fittings.

- G. Conduits in steam tunnels shall be galvanized rigid steel or intermediate metal conduit with cast or malleable iron threaded fittings and bushings. Exceptions to this requirement are tunnel segments inside building (i.e., mechanical rooms) where EMT may be used.
- H. Final connections to recessed lighting fixtures and under counter lights shall be 1/2" minimum flexible metallic conduit, manufactured wiring systems, or galvanized steel Type MC Cable all with steel fittings.
 - 1. Manufactured wiring systems shall
 - a. Only be used above accessible ceilings.
 - b. Shall not be used in walls or above permanent ceilings.
 - c. Shall contain a dedicated, separate, grounding conductor.
 - 2. Type MC cable conductors shall be color coded to match the building color-coding scheme. Type MC Cable shall be terminated with steel setscrew connectors that have integral insulating bushings. Self-locking, twist-in type fittings are not acceptable.
- I. Final connections to motors, transformers and equipment subject to vibration or removal for maintenance shall be 1/2" minimum liquid tight flexible metallic conduit with steel liquid tight fittings. Transformer connections may be non-liquid tight flexible metallic conduit in electrical rooms only.
- J. Connections to recessed power receptacles and light switches in areas with accessible ceilings:
 - 1. In new 'metal stud and gypsum board partitions (walls)' and in existing 'metal stud and gypsum board partitions (walls)', where the wall is not being otherwise opened up, the final connections may be made with type MC Cable. This MC Cable, shall:
 - a. Be run to a box immediately above the accessible ceiling, and the box size shall not exceed 4-11/16" square.
 - b. Conduit shall be used for the entire run, from this junction box, to the power source, load (lights), etc.
 - c. No more than three circuits may be run through any given junction box.
 - d. Individual conductors making up the MC cable shall be stranded copper, with separate grounding conductor, and steel corrugated armor. Individual conductors shall be color coded as required in section 16120.
 - e. The MC Cable is terminated using UL listed hardware intended for the cable and boxes being used, (and rated for commercial and industrial environments).
 - f. The MC Cable shall be secured in the wall cavity as required by NEC.
 - g. The MC Cable shall be as short as it is necessary to serve the need and meet the Code
- K. In areas with non-accessible ceilings devices shall be installed with standard conduit; run back in a continuous installation to a junction box located at an access point in the ceiling
- L. Connections to other recessed devices, (including communication outlet boxes, junction or pull boxes, etc) shall be with standard conduit of the type appropriate for the wall construction.

1.11 CABLE TRAY REQUIREMENTS

- A. Power and telecommunications cable trays shall be aluminum, ladder type, of the sizes shown on the drawings.
- B. Center spline telecommunications cable tray may only be used where shown.
- C. Changes in cable tray direction or elevation shall be made using standard fittings from the same manufacturer as the cable tray.
- D. Barriers shall be installed in cable trays where shown to separate circuits of different voltage levels.

1.12 SURFACE RACEWAY REQUIREMENTS

- A. When conduits in finished areas cannot be concealed in walls or above ceilings, surface raceways may be used where permitted. Boxes and fittings shall match and be from the same manufacturer as the raceways.
- B. Raceway shall be metal and white in color unless otherwise noted on the drawings.
- C. Contractor shall verify with the Owner if the use of metal surface raceway is acceptable.

1.13 BOX REQUIREMENTS

- A. Provide sheet steel outlet boxes, extensions, and plaster rings for EMT, flexible metal conduit, and MC cable.
- B. Provide cast or malleable iron outlet boxes and covers for galvanized rigid steel conduits, intermediate metal conduits, and liquidtight flexible metal conduits.
- C. Boxes shall be sized for all conductors and devices to be contained within. Box extensions shall not be used to correct for undersized boxes. A single extension may be used as follows only if all free conductors extend at least 3 inches outside of the extension opening.
 - 1. On boxes being flush mounted in masonry walls.
 - 2. On existing boxes in walls that are being furred out.
 - 3. On existing boxes for connecting to an existing circuit.
 - 4. On fire alarm, security and clock system boxes where required by the system manufacturer's instructions.
- D. Plaster rings shall not be considered box extensions, but their capacities may be included in box fill calculations.

1.14 SUPPORT REQUIREMENTS

- A. Mechanical Areas and Tunnels
 - 1. Surface mounted equipment shall be secured to steel channels.
 - 2. Surface mounted raceway 1½" and smaller and boxes maybe attached directly to surfaces.
 - 3. Multiple raceway runs maybe attached to
 - a. A trapeze system with approved straps
 - b. Trapeze shall be attached to the structure by steel channels and threaded rod.
 - 4. Vertical surface race way 1½" maybe attached by:
 - a. Below 8' by one or two hole straps
 - b. 8" and above with pipe hangers ("Minerallac style hangers")
 - 5. The channels and raceway shall be attached with toggle bolts to hollow tile, block or similar surfaces, and attached with screws or bolts and expansion shields to solid masonry or concrete.
- B. Finished Areas Above Suspended Ceilings
 - 1. Raceway and boxes maybe attached directly to surfaces with appropriate straps or hangers.
 - 2. Multiple raceway runs maybe attached to
 - a. A trapeze system with approved straps
 - b. Trapeze shall be attached to the structure by steel channels and threaded rod.
 - 3. The channels and raceway shall be attached with toggle bolts to hollow tile, block or similar surfaces, and attached with screws or bolts and expansion shields to solid masonry or concrete.
 - 4. Attachment of raceway to ceiling grid support wires or rods is not permitted.
- C. Finished Areas Inside Walls
 - 1. Raceway and boxes shall be attached to structural members with devices specifically designed for raceway/box attachment to the type of structural member used.

D. Finished Areas Exposed

1. Surface raceway shall be attached to finished surfaces utilizing the factory approved method of attachment.
2. Tape is not acceptable for attachment of non-metallic surface raceway.

PART 2 - PRODUCTS

2.01 CONDUITS

- A. Electrical metallic tubing shall be thin wall steel tubing, electro-galvanized or hot dipped galvanized inside and outside. Fittings and bushings shall be galvanized steel set screw type with two screws per connection for sizes over 2".
- B. Galvanized rigid steel conduit and intermediate metal conduit shall be hot dipped galvanized inside and outside, in 10' lengths and threaded on both ends. Fittings and bushings shall be cast or malleable iron, and hot dipped galvanized inside and outside.
- C. PVC conduit and fittings shall be Type DB for encasement in concrete for IT applications, Schedule 40 for direct burial, concealed and exposed work, and Schedule 80 in MV Duct Banks. Fittings shall be of the same type and from the same manufacturer as the conduit. PVC conduit shall be UL Labeled for 90 degrees C cables. Approved Manufacturers:
 1. Cantex
 2. Carlon
 3. National Pipe & Plastic.
- D. Flexible metallic conduit shall be galvanized steel or aluminum. Fittings shall be of steel with cadmium or galvanized finish. Fittings shall be machine screw clamp type, single or two-piece. Self-locking, twist-in type fittings are not acceptable.
- E. Liquid tight flexible metallic conduit shall consist of a flexible, galvanized steel core, a continuous copper ground strip and a polyvinyl chloride jacket. Fittings shall be steel liquid tight grounding type from the same manufacturer as the conduit.

2.02 CABLE TRAYS

- A. Ladder type cable tray shall be aluminum, of the width shown, with 4" rail height, 13/16" minimum rung width, and 9" maximum rung spacing. The tray with a 10' span shall be capable of sustaining a working load of 145 pounds per lineal foot with a load deflection of 1.0" when tested in accordance with NEMA VE1-3.01. Approved Manufactures:
 1. B-Line
 2. Chalfant
 3. Cope
 4. Globetray
 5. Husky
 6. Mono-Systems
 7. Square D
 8. Wiremold.
- B. Center spline cable tray shall be aluminum, of the width shown, with top mounted rungs, 3" load depth, 13/16" minimum rung width, and 9" maximum rung spacing. The tray with a 10' span shall be capable of sustaining a working load of 145 pounds per lineal foot with a load deflection of 1.0" when tested in accordance with NEMA VE1-3.01.
- C. Tray fittings including horizontal and vertical bends, tees, crosses, reducers, splice plates and expansion joints shall be from the same manufacturer and of the same product line as the tray. Bends, tees, crosses and reducers shall have a 13/16" minimum rung width, a 9" maximum rung spacing, and a 12" minimum bend radius.

- D. Tray fasteners shall be galvanized or zinc plated steel.

2.03 SURFACE RACEWAYS

- A. Where surface raceways are called for on the drawings, or when conduits in finished areas cannot be concealed in walls or above ceilings, surface raceways shall be used. Boxes and fittings shall match and be from the same manufacturer as the surface raceway.
- B. Surface raceways shall consist of a base and cover, sized for the number of conductors contained within, complete with all connectors, fittings, bushings, boxes, covers and mounting hardware.
- C. Raceways shall be 600 volt rated, and be in compliance with the applicable paragraphs of NEC Article 352.
- D. They shall be non-flammable, and UL labeled, under UL 5, or UL 5A (as applicable).
- E. The completed raceway system shall be vandal resistant.
- F. Shall accept receptacles, cover plates, telephone/data outlets and other standard wiring devices as specified elsewhere in these specifications.
- G. The coverplates used for wiring devices and telecommunication outlets shall be of the 'overlapping' type, and shall therefore cover the 'cut-end' of the raceway cover.
- H. The raceways shall have "scuff" resistant finish, and the raceways shall be paintable.
- I. All components of the raceway system exposed to view shall be of the same color and shade.
- J. Barriers shall be provided when necessary to separate conductors of different voltages, or services.
- K. Surface raceways shall be steel or plastic as noted below, and as noted on the drawings:
- L. Type Standards Manufacturers
 - 1. Metallic
 - a. Metallic raceways shall be of .040" thick (minimum) zinc plated or galvanized steel.
 - b. The acceptable levels of quality are, generically,
 - 1) Like "Wiremold V500 and V700" for smaller single channel raceway applications,
 - 2) Like "Wiremold V3000" for larger single channel raceway applications, and
 - 3) Like "Wiremold V4000" for larger multi-channel raceway applications.
 - c. Manufacturers include Wiremold, Hubbell, Thomas and Betts, or Mono-System.
 - 2. Plastic
 - a. Plastic raceways shall be of a material meeting all of the requirements of UL 5A, (including flammability, resistively structural strength, etc.).
 - b. The acceptable levels of quality are, generically,
 - 1) Panduit LD series, or Carlon Series 30 for smaller single channel raceway applications;
 - 2) Panduit Type T-70, or Carlon "Premiere", for larger single channel raceways, and smaller multi-channel raceways; and
 - 3) Panduit Twin 70 or Carlon "Prestige", for larger multi-channel raceway applications.
 - c. Manufacturers include Panduit, Carlon, Hubbell, Mono Systems, and Wiremold.
- M. Use vertical surface raceways from junction boxes above the ceiling, to the horizontal portion of the surface raceway. Locate vertical section as close to room corners (or 'vertical breaks' in mid wall) as is possible. Use of exposed vertical conduits is not acceptable.

2.04 BOXES

- A. Boxes for fixtures, outlets, switches, equipment connections and wire pulling shall be
 - 1. Cast or formed from carbon steel sheets of commercial grade steel not less than 14-gauge,

2. One-piece construction, zinc, or cadmium plated,
 3. Tapped for mounting plates and covers as required.
- B. Pull and junction boxes shall be
1. Fabricated from galvanized or painted code gauge cold rolled carbon steel sheets.
 2. Welded construction with flat removable covers fastened to the box with machine screws.
 3. Seams and joints shall be closed and reinforced with flanges formed of the same material from which the box is constructed or by continuous welding which will provide equivalent strength to flange construction.
 4. Preferably not provided with 'knockouts'.
- C. Box covers shall be fastened in place by machine screws or hinges and latches. Self-tapping or sheet metal fasteners are not acceptable.

2.05 SUPPORTS

- A. Hangers and brackets shall be made of steel pipe, channel iron, angle iron or prefabricated steel channel. Prefabricated steel channel shall be by B-Line, Hilti, Powerstrut or Unistrut.
- B. Anchors shall be lead shield anchors or plastic expansion anchors for small loads, and expansion or epoxy anchors for large loads. Powder-driven anchors shall not be used.

2.06 LABELS AND DIRECTORIES

- A. Equipment nameplates shall be engraved .125 inch (1/8") thick 'Lanaloid' (Lanacoid) plastic. White, with black letters. The engraved letters shall be at least one quarter inch (1/4") high.
- B. Receptacles and lighting switch covers shall be labeled using clear adhesive backed nylon or Mylar tape with black text permanently laminated to the tape.
- C. Panel directories shall be typed on supplied card stock with panel, or card stock similar in thickness and material as those supplied with the panels. Install supplied clear plastic cover, or one of like material.

PART 3 - EXECUTION

3.01 GENERAL

- A. All work shall conform to all applicable Codes and Construction Standards.
- B. All installations shall be warranted for a period of one (1) year against defects in material and workmanship.
- C. The Owner reserves the right to relocate any device fifteen (15) feet prior to installation at no additional cost.
- D. Material Storage
1. All materials shall be new and in original factory packaging.
 2. All material shall be kept dry and clean.
 3. The Owner reserves the right to reject any material not properly stored.
- E. Contractor shall swab clean the interior of all raceway prior to pulling wire.
- F. Device plate screw slots shall be oriented vertically.

3.02 RACEWAYS

- A. Size conduits in accordance with the NEC, but not less than the sizes shown on the drawings. Minimum power, fire alarm and control conduit size shall be 3/4". Minimum telecommunications conduit size shall be 1".

- B. Install concealed and exposed conduits and cable trays parallel to or at right angles to building lines. Conduits shall not be embedded in concrete slabs except where specifically shown. Install surface raceways as close to room corners or trim features as possible to make the surface raceways less obvious.
- C. Make directional changes in primary power distribution conduits above ground with sweeps and long radius elbows, and underground with 20' minimum radius bends.
- D. Conceal conduits wherever possible and practical. When conduits cannot be concealed in finished areas, use surface raceways with matching boxes from the same manufacturer as the raceways.
- E. Metal conduits, fittings, enclosures and raceways shall be mechanically joined together in a firm assembly to form a continuous electrical conductor providing effective electrical grounding continuity.
- F. Provide expansion fittings at the intervals specified in the manufacturer's instructions.
- G. Conduits entering panels located outdoors, in parking structures, in steam tunnels and on cooling towers shall enter from the sides, back, or bottom. Conduits shall not enter from the top.
- H. Separate raceways from uninsulated steam pipes, hot water pipes, and other hot surfaces by a minimum of 4" horizontally or 12" vertically. Separate raceways from ventilation ducts and insulated pipes so that they do not come into contact with each other.
- I. Low voltage signal circuits shall be separated or shielded from power circuits to prevent the induction of noise into the signal circuits.
- J. EMT entering sheet metal enclosures and outlet boxes shall be secured in place by a connector with a locknut. Rigid conduit shall be secured with locknut inside and outside and a bushing. Sufficient thread on the connector or conduit shall extend into the enclosure so that the bushing will butt tight into the connector or conduit. Bushings shall not be used as jamb nuts or in lieu of locknuts.
- K. Flexible metallic conduit to motors and similar equipment shall not exceed 3'-0" in length, and shall have adequate slack to absorb the maximum vibration. Flexible conduit connections to lighting fixtures shall not exceed 6'-0" in length.

3.03 MOUNTING HEIGHTS

- A. Except where shown otherwise, install equipment and devices at the following heights:
 - 1. Receptacles (Wall): 18" A.F.F. to center
 - 2. Receptacles (Above Counter): 48" A.F.F. to center or 4" minimum above countertop or backsplash.
 - 3. Receptacles (Unfinished Area): 48" A.F.F. to center
 - 4. Surface Raceway Receptacle Strips: 42" A.F.F. to bottom
 - 5. Light Switches: 48" A.F.F. to center
 - 6. Telephone Outlets (Wall Phone): 48" A.F.F. to center
 - 7. Telephone/Data Outlets: 18" A.F.F. to center
 - 8. Clock Outlets: 88" A.F.F. to center
 - 9. Fire Alarm Pull Stations: 45" A.F.F. to center
 - 10. Fire Alarm Horn/Strobes: 80" A.F.F. to bottom or 1' below finished ceiling whichever is lower.
 - 11. Card Readers: 48" A.F.F. to card slot
 - 12. Security System Controls: 48" A.F.F. to center
 - 13. Thermostats/HVAC Controls: 48" A.F.F. to center
 - 14. Panelboards: 72" A.F.F. to top

15. Safety Switches/Motor Starters: 72" A.F.F. to top (except top of handle shall not exceed 78" A.F.F.)
16. Motor Control Pushbuttons: 60" A.F.F. to center
17. Verify with the Owner for heights not otherwise listed.

3.04 SUPPORTS

- A. Provide 4" thick concrete housekeeping pads for floor-mounted equipment.
- B. Support all electrical items independently of supports provided by the other trades.
- C. Support conduits and boxes using steel conduit straps or 1/4-inch minimum diameter threaded rod hangers. Suspended ceiling hangers or hanger wire shall not be used (except to support flexible metallic conduit and manufactured wiring systems).
- D. Support cable trays with support brackets or 3/8" diameter minimum threaded rod hangers at intervals not exceeding 8'-0" for straight runs. Additional supports shall be provided at tray fittings.
- E. Hangers shall be of sufficient strength that their deflection at mid span does not exceed 1/240 of the hanger span length after the cables are installed.
- F. Route flexible metallic conduit, manufactured wiring systems and Type MC cable parallel to or perpendicular to building lines, and in a neat and workmanlike manner. Coil the excess manufactured wiring systems and Type MC cable, and support independently of the ceiling grid system at intervals not exceeding 3 feet.

3.05 PENETRATIONS, SLEEVES AND FIRE SEALS

- A. Cut floor and wall penetrations neatly and to the minimum size required for installation of the equipment and raceways.
- B. Provide galvanized steel pipe sleeves for all conduits penetrating floors, exterior walls and roofs.
 1. Extend floor sleeves above the floor a minimum of 2 inches.
 2. Embed sleeves in new concrete or step-core concrete and grout sleeves into existing concrete with epoxy grout.
 3. Seal floor sleeves using fire-sealing systems approved by a Nationally Recognized Testing Laboratory.
 4. Seal exterior wall and roof penetrations water tight.
- C. Patch both sides of wall penetrations cut for electrical equipment and raceways to seal against the passage of air, sound and fire.
 1. Seal cable tray penetrations in fire rated walls using fire sealant bags approved by a Nationally Recognized Testing Laboratory.
 2. Seal conduit penetrations in fire rated walls using firesealing caulk approved by a Nationally Recognized Testing Laboratory.
 3. Seal conduit penetrations in non-rated walls using masonry materials that match the wall construction.
 4. Fire seal between recessed outlet boxes located on opposite sides of a fire rated wall if the box openings are over 16 square inches and the boxes are less than 24 inches apart.

3.06 EXPANSION FITTINGS

- A. Provide expansion fittings at all building expansion joints.
- B. Provide expansion fittings, in accordance with manufacture recommendations, in all areas subject to swings in temperature of more than 15 degrees C.
- C. Install expansion fittings in all locations where expected expansion difference is 1/4", or more, between boxes

3.07 IDENTIFICATION

- A. Provide nameplates and labels in accordance with Article 2.6.
 - 1. Lanaloid labels shall be mechanically secured in place with sheet metal screws and/or bolts and nuts
 - 2. Labels shall be neatly centered. Place labels in like positions on similar equipment.
- B. Color code wiring as noted in Section 26 05 19 3.01 B
- C. Color code junction boxes and box covers of
 - 1. Emergency power circuits with red paint
 - 2. Fire alarm circuits with red paint.
 - 3. Temperature control circuits with blue paint.
 - 4. Phone and Data circuits with orange paint.

END OF SECTION 260500

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SECTION 26 05 02 – SELECTIVE ELECTRICAL DEMOLITION

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Demolition of electrical items and associated materials as indicated herein or as indicated on the drawings.

1.02 SECTION INCLUDES

- A. Removal of designated equipment and devices.
- B. Removal of designated construction.
- C. Disposal or storage of removed materials.
- D. Identification of utilities.
- E. Refer to items as indicated.

1.03 SUBMITTALS FOR CLOSEOUT

- A. Project Record Documents: Accurately record actual locations of terminated utilities and subsurface obstructions.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable code for demolition work, safety of structure, dust control, products requiring electrical disconnection and re-connection.
- B. Obtain required permits from authorities.
- C. Do not close or obstruct egress width to any building or site exit.
- D. Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.
- E. Conform to procedures applicable when hazardous or contaminated materials are discovered.

1.05 SCHEDULING

- A. Perform work between the hours of 7 a.m. and 7 p.m.

1.06 PROJECT CONDITIONS

- A. Conduct demolition to minimize interference with adjacent and occupied areas.
- B. Maintain protected egress and access to the Work.

PART 2 – NOT USED

PART 3 – EXECUTION

3.01 PREPARATION

- A. Protect existing materials which are not to be demolished.
- B. Notify affected utility companies before starting work and comply with their requirements.
- C. Utilize OSHA lockout/tag-out procedures for disconnecting means.
- D. Label all wiring to remain (phase and device fed) to assure proper re-connection.
- E. Mark location and termination of utilities.

3.02 DEMOLITION

- A. Disconnect, remove, cap, identify designated utilities to remain and demolish in an orderly and careful manner.

- B. Remove demolished materials from site except where specifically noted otherwise.
- C. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

3.03 PROTECTION OF SALVAGED ITEMS

- A. Remove, store and protect the materials and equipment scheduled to be re-used.
- B. Protect wiring to be re-used by means of a Junction Box
 - 1. Junction Box shall be of sufficient size to permit reconnection of existing wiring to new wiring per NEC Requirements.
 - 2. In outdoor locations the junction box shall be NEMA 3R or a custom junction box with welded seams and gasketed cover.

END OF SECTION 26 05 02

SECTION 26 05 19 – LOW VOLTAGE WIRE AND CABLE

PART 1- GENERAL

1.01 DESCRIPTION OF WORK

- A. Extent of electrical wire and cable work is indicated by the Project drawings.
- B. Types of wire, cable and connectors in this section include the following
 - 1. 600 volt insulated copper conductors
 - 2. Twist on insulated metal spring connectors
 - 3. Compression connectors
 - 4. Split Bolt connectors

1.02 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable of types sizes and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installers: Firm with at least five (5) years of successful installation experience with projects utilizing electrical wiring and cabling work similar to those required for this Project.
- C. NEC Compliance: Comply with NEC requirements as applicable to construction, installation and color coding of electrical wires and cable.
- D. U.L. Compliance: Comply with applicable requirements of UL Standard 83, "Thermoplastic-Insulated Wires and Cables", and UL Standard 486A, "Wire Connectors and Soldering Lugs For Use With Copper Conductors".
- E. UL Labels: Provide wire, cable and connectors which are UL listed and labeled.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Deliver wire and cable properly packaged in factory-fabricated type containers or wound on NEMA Specified type non-returnable wire and cable reels.
- B. Store wire and cable in a clean dry space. Protect products from weather, damaging fumes, construction debris and traffic.
- C. Handle wire and cable carefully to avoid abrading, puncturing, or tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wire and cable is maintained.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be used on this Project include, but not limited to, the following:
 - 1. Low Voltage Wire:
 - a. American Insulated Wire and Cable
 - b. Southwire Company
 - c. Others as Approved

2. Electronic Cable
 - a. Belden
 - b. Alpha
 - c. Anixter
3. Twist on insulated metal spring connectors
 - a. Ideal
 - b. Thomas and Betts Corp
 - c. 3M Company
4. Compression
 - a. Square D / Anderson
 - b. Thomas and Betts

2.02 DESCRIPTION THHN / THWN

A. Conductor:

1. Bare, soft annealed copper per ASTM B-3.
2. Sizes 14 - 10 AWG: Solid, bunched, unilay concentric combination unilay or compressed stranded (class C) alternate ASTM B-787, ASTM B-3 or ASTM B-8 and UL-83.
3. Sizes 8 - 2 AWG: Concentric, compressed stranded (class C) alternate ASTM B-787, ASTM B-8, UL-83 and UL-1063.
4. Sizes 1 AWG - 750 KCMIL: Concentric, compressed stranded (class B) ASTM B-8, UL-83 and UL-1063.

B. Insulation:

1. High dielectric polyvinyl chloride (PVC) per UL-83 and UL-1063.
2. Overall Jacket: Nylon per UL-83 and UL-1063.

C. Cable Identification:

1. Ink print on jacket for Sizes 14 - 10 AWG (solid conductors): "(size) AWG Type THHN or THWN GAS AND OIL RES II 600V(UL) or AWM VW-1---(Company Name).---C-UL Type T90 NYLON or TWN 75"
2. Ink print on jacket for Sizes 14 AWG - 750 KCMIL (stranded): "(size) AWG (or KCMIL) Type MTW or THHN or THWN or GAS AND OIL RES II 600V (UL) or AWM---(Company Name).- --C-UL Type T90 NYLON or TWN 75."
3. Also "VW-1" and "FT1" on sizes 14 through 6 AWG and "for CT USE SUN RES" on sizes 1/0 AWG and larger in black.

D. Cables conform to the following standards:

1. UL-83 for THHN-THWN, UL-1063 for MTW (stranded conductors only)
2. Federal Specification J-C-30B, NEMA WC-5, UL-758 for AWM Styles 1316 through 1321, 1408 through 1414, 1452 and 1453.

2.03 ELECTRONIC CABLE - COMMUNICATION AND SIGNAL

- A. Shall conform to the recommendations of the manufacturers of the communication and signal systems; however, not less than what is shown.
- B. Wiring shown is for typical systems. Provide wiring as required for the systems being furnished.

- C. Multi-conductor cables shall have the conductors color coded.

2.04 CABLES AND CONNECTORS

- A. General: Provide electrical cables and connectors of Manufacturer's standard materials, as indicated by published product information.
- B. Provide copper conductors with conductivity of not less than 98% at 68° F (20° C).
- C. Electronic cable shall be Plenum rated and as recommended by the Equipment Supplier
- D. Connectors shall be for copper to copper connections
- E. Insulation: All connectors shall be fully insulated to match insulation type and rating of conductors being spliced.

PART 3 – EXECUTION

3.01 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL and NECA's "Standard of Installations", and in accordance with recognized industry practices.
- B. Feeder phase identification from left to right or front to back facing front of equipment shall be one of the following:

Phase A	Phase B	Phase C	Neutral	System
X	Y	Z	N	Any voltage
BLACK	RED	BLUE	WHITE	120/208 volt feeders
BROWN	ORANGE	YELLOW	GRAY	277/480 volt feeders

- C. Install all wiring in conduit except as indicated on the drawings or directed by Owner.
- D. Pull conductors together where more than one is being installed in a raceway.
- E. Use pulling compound or lubricant where necessary. Compound must not deteriorate conductor or insulation. Use of soap is not permitted as a pulling lubricant.
- F. Pulling means must not damage cable or raceway.

3.02 COMPRESSION CONNECTORS

- A. Use only compression indenter tools designed for the type of connector used.
- B. For multiple indentations start at center and indent outward.

3.03 FIELD QUALITY CONTROL

- A. Prior to energizing, test all cables and wires with "Megger" to determine insulation resistance levels to ensure insulation integrity.
- B. Prior to energizing, test wires and cables for electrical continuity and for short circuits.

END OF SECTION 26 05 19

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SECTION 26 05 26 – GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide grounding for all systems and equipment.

1.02 GROUNDING SYSTEM REQUIREMENTS

- A. Each ground rod shall have a maximum resistance to ground of 10 ohms before connection to the other ground rods. If reading is above 10-ohms, drive one extension. Further testing of that individual rod is not needed.
- B. The total grounding system with all connections completed shall have a maximum resistance to ground of 2 ohms for primary services or 5 ohms for secondary services.

1.03 CONNECTION REQUIREMENTS

- A. Provide exothermic weld type, or Burndy Hyground, ground connections for concealed, underground, and concrete encased ground connections, for ground connections to structural steel, connections between sections of the main ground bus and all connections to the substation room ground bus bars.
- B. Exposed ground connections (except connections to structural steel and substation room ground bus bars) may be made with copper or bronze compression ground fittings or bolted compression ring lugs.
- C. Provide exothermic weld type, or Burndy Hyground ground connections for splices and taps of grounding conductors No. 8 AWG and larger. Exposed splices and taps shall be taped.

PART 2 - PRODUCTS

2.01 GROUND RODS

- A. Unless shown otherwise, ground rods shall be 3/4" diameter by 10' long, copper clad steel. Ground rods shall be capable of being extended when additional length is required.

2.02 GROUNDING CONDUCTORS

- A. Grounding conductors for direct burial underground, for encasement in concrete, and for grounding of unit substations shall be No. 4/0 AWG minimum, bare, stranded copper.
- B. Grounding conductors for general use shall be stranded, copper conductor, sized in accordance with the NEC unless shown otherwise on the drawings, and insulated with green NEC Type THHN insulation rated 90 degrees C, 600 volts.

2.03 GROUND CONNECTIONS

- A. Ground connections shall be Burndy Hyground, Cadweld, Thermo-weld or Thomas & Betts Blackburn only.

PART 3 - EXECUTION

3.01 INSTALLATION REQUIREMENTS

- A. Ground duct banks and manholes in accordance with Specification Section 26 05 13.
- B. Provide bare copper grounding conductors from duct banks, manholes, unit substations, primary switches, transformers, switchgear, panelboards, motor control centers and control panels to the building grounding system. Equipment rated above 480 volts or 600 amps shall be grounded by a minimum of two independent grounding conductors.
- C. Bond transformer, UPS system, central battery/inverter system, emergency generator, and separately derived electrical system neutrals to the building grounding system.

- D. Ground motors rated 460 volts and below by motor feeder equipment grounding conductors. Stranded copper grounding conductors connected to building steel shall also bond motors rated over 460 volts.
- E. Provide green insulated equipment grounding conductors in all service, feeder, and branch circuits for connection of load devices to the power source ground. Raceways shall not be used as equipment grounding conductors.
- F. Equipment grounding conductors shall not be daisy-chained.
- G. Bond equipment-grounding conductors in boxes and enclosures where the grounding conductors are terminated or spliced.
- H. Bond conduits, cable trays, wireways, surface raceways, boxes, and enclosures together, and to the building grounding system. Provide bonding bushings and bonding jumpers to bond conduits where they enter a box or enclosure.
- I. Ground the lightning protection system with separate ground rods. The building grounding system ground rods shall not be used. After completion of both systems, the lightning protection system shall be bonded to the building grounding system.
- J. Protect separately routed grounding conductors subject to damage or physical abuse by Schedule 40 PVC nonmetallic conduits. Grounding conductors shall not be routed in metallic conduits except when routed with phase conductors.

END OF SECTION 26 05 26

SECTION 26 05 33 – RACEWAY AND BOXES

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section specifies raceways and boxes for building and structure electrical systems under 600 volts.
- B. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.
- C. Related Sections:
 - 1. Division 01 - General Requirements
 - 2. Applicable sections of Division 26 - Electrical

PART 2 – PRODUCTS

2.01 GENERAL INFORMATION

- A. All boxes, brackets, bolts, clamps, etc., shall be galvanized or electro-galvanized.
- B. All hardware used outdoors shall be hot dipped galvanized.

2.02 CONDUIT

- A. Rigid galvanized conduit shall be installed in poured concrete slabs, walls and partitions. Rigid or I.M.C. shall be installed in damp locations and inaccessible places.
- B. All rigid conduit, I.M.C. and E.M.T. shall be hot dipped galvanized or electro-galvanized.
- C. E.M.T. may only be installed exposed, above suspended ceilings, or in partitions.
- D. Flexible steel conduit may be used for short runs to individual pieces of equipment.
- E. Flexible sheathed metallic conduit shall be used for runs less than 6' in length to individual pieces of equipment in mechanical rooms, penthouses, etc.
- F. MC Cable is permitted in existing walls where installation of EMT is not possible to devices
- G. No E.M.T. or aluminum conduit shall be used in concrete, direct burial or in corrosive locations.
- H. Aluminum conduit may only be used in sizes 1-1/2 inch and larger. No aluminum conduit will be permitted in concrete. When aluminum conduit is used, all bends shall be galvanized steel.
- I. Size and type of conduit shall comply with the National Electric Code. Where conduits are indicated on the drawing to be larger than required by Code, the larger conduit shall be used.
- J. Minimum conduit size shall be 3/4 inch in all runs.

2.03 PULL AND JUNCTION BOXES

- G. All pull boxes shall be galvanized sheet steel, sized as required, with thickness not less than no. 14 gauge.

2.04 OUTLET BOXES

- A. All outlets, except as otherwise specified, shall consist of approved galvanized steel boxes of pattern adapted to the special requirements of each outlet, securely fastened in place in an approved manner.

PART 3 – EXECUTION

3.01 CONDUIT

- A. Conduit shall be concealed in all new walls and run above suspended ceilings.

- B. Use Wiremold type metal raceway where necessary to run exposed on existing walls and/or ceilings in finished areas as shown on the drawings.
- C. All conduit shall be fastened or suspended from structural members, slabs, or walls only. It shall not be run on or fastened to tee bars of suspended lay-in ceilings.
- D. All conduit shall be supported by approved hangers at spaced per NEC.
- E. All exposed conduit shall be run parallel to the structural members of the building in a neat manner, securely fastened in place.
- F. When metal conduit extends below the bottom of a slab on the ground, the slab shall be thickened in the area of the conduit so as to encase the conduit in concrete by at least 2 inches on all sides. The responsibility for and expense of this work shall be borne by the Contractor.

3.02 OUTLET BOXES

- A. Recessed outlet boxes for single gang or 2-gang installations shall be 4" square with appropriate device ring or plaster ring for the required number of devices.
 - 1. All device rings and plaster rings shall be installed vertically unless instructed otherwise by the A/E or Owner.
 - 2. All plaster rings shall not extend past flush with wall surface or be recessed more than 1/4" from wall surface.
 - 3. For installations of more than two devices use the appropriate wall box for the number of devices required. If approved by the Owner the use of gangable wall boxes is allowed.
 - 4. For surface installations in Mechanical Area or similar locations 4" square boxes shall be used with 1/4" raised cover.

3.03 PULL AND JUNCTION BOXES

- A. Pull boxes shall not be installed in inaccessible locations.

END OF SECTION 26 05 33

SECTION 26 09 23 – LIGHTING CONTROLS

PART 1 – GENERAL

1.01 SCOPE

- A. The Contractor shall furnish and install a lighting control as specified and as shown on the contract drawings.

1.02 RELATED SECTIONS

- A. Section 26 05 00 Common Work Results for Electrical
- B. Section 26 05 19 Low Voltage Wire and Cable
- C. Section 26 05 33 Raceway and Boxes
- D. Section 26 51 00 Interior Lighting

1.03 SUBMITTALS -- FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Architect/Engineer and Owner
 - 1. Manufacturer's product cut-sheet
- B. Submit electronically in PDF format.

1.04 SUBMITTALS -- FOR INFORMATION

- A. When requested by the Engineer the following product information shall be submitted:
 - 1. Descriptive bulletins
 - 2. Product sheets.
- B. Submit electronically in PDF format.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. One (1) paper copy and one (1) USB flash Drive of the equipment operation and maintenance manuals shall be provided.
- B. Operation and maintenance manuals shall include the following information:
 - 1. Instruction books and/or leaflets
 - 2. Recommended renewal parts list
 - 3. Drawings and information required by section 1.06.

PART 2 – PRODUCTS

2.01 TIME CLOCK

- A. Manufacturers
 - 1. Paragon

2. Tork

B. Ratings

1. Like Paragon Model EC71st /120V Electronic Sun Tracker
2. 120-volt ac control voltage
3. Single Channel control
4. Contact Rating, 15 amp
5. NEMA 1 enclosure

2.02 PHOTOCONTROL

A. Manufacturers

1. Tork
2. Precision

B. Ratings

1. Weatherproof Lexan® housing
2. Photocell: 1 inch cadmium sulfide light sensitive element.
3. Turn on: 1 to 3 foot-candles. External light level slide allows field adjustment between 3 to 10 foot-candles.
4. Turn on / turn off ratio 1:3
5. Minimum 15 second time delay.
6. Single-pole, single-throw switch. Contact position at night normally closed.
7. Temperature Range -40 to 158 degree F
8. ½"-14 threaded stem.

2.03 LIGHTING CONTACTOR

A. Manufacturers

1. ASCO
2. Cutler Hammer
3. Square D

B. Ratings

1. 30 amp minimum
2. Number of poles as required
3. Control/coil voltage 120 volt
4. Electrical held
5. Installed in NEMA 1 enclosure or as required for location.

2.04 OCCUPANCY SENSORS

A. Wall Mounted

1. Wall Mounted occupancy sensors shall be a multi-technology (Ultrasonic & PIR) wall switch that turns lights on and off based upon occupancy and ambient light levels. Type 2 sensors shall contain two separate relays and manual override controls for dual level switching of light fixture. Sensors shall have built-in light level sensor, adjustable time delays, zero crossing switching, and smart technology. Provide necessary device box. Type 1 sensors shall be Hubbell Building Automation #LHMTS1 or pre-approved equal. Type 2 sensors shall be Hubbell Building Automation #LHMTD2 or pre-approved equal. Color of devices shall be as selected by owner but generally shall match color of wiring devices.

B. Ceiling Mounted

1. Ceiling Mounted occupancy sensors, indicated by OS on plans, shall be a multi-technology (ultrasonic & PIR) sensor that turns lights on and off based upon occupancy. Sensor shall have adjustable time delays, zero crossing switching, and smart technology. Provide necessary back-box. Sensor shall be Hubbell Building Automation #OMNIDT2000 or pre-approved equal.

C. Power Packs and Relays

1. The power packs shall provide both the 24VDC power supply to operate sensors as well as the 20-amp line voltage relay to control the load. Power pack shall be mounted to a junction box located above accessible ceiling. Housing shall be plenum rated. Power packs shall be Hubbell Building Automation #UVPP Universal Voltage Power Pack, or pre-approved equal.

2.05 WALL BOX DIMMERS

- A. Wall box dimmers shall be Leviton Renoir II series or approved equal.
- B. Shall be compatible with light fixture/driver and shall be capable of multi-location applications.

2.06 COMBINATION WALL BOX DIMMER AND OCCUPANCY SENSOR

- A. Wall box device providing both digital PIR occupancy sensor and 0-10V dimming shall be Hubbell LHDMIRS-3 series or approved equal.
- B. 3 buttons provide on/off, raise and lower light levels.

2.07 ELECTRONIC WALL BOX TIMERS

- A. Timer shall be like Hubbell DT300 or Legrand TS-400
 1. Multiple timer intervals
 2. Energy code presets for Title 24, IECC, and ASHRAE 90.1
 3. Visual and audio turnoff warning
 4. 3 Way and Multiple Way Switching
 5. No Neutral Required
 6. No Load Requirement
- B. Do not use in unconditioned spaces where temperature may fall below 30 degrees F.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.
- B. Protect the equipment from damage and keep clean and dry during construction.
- C. **Installation of in wall switch replacement occupancy sensors must be approved by the Owner.**
- D. Install power packs above accessible ceilings and locate near door to room. If space has no ceiling, install power pack within a minimum 4" square junction box and locate near the door to the room, as neatly as possible. Coordinate with manufacturer.

END OF SECTION 26 09 23

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SECTION 26 24 16 - PANELBOARDS

PART 1 – GENERAL

1.01 SCOPE

- A. The Contractor shall furnish and install the panelboards as specified and as shown on the contract drawings.

1.02 RELATED SECTIONS

- A. Section 26 09 23 – Lighting Control System
- B. Section 26 43 13 – Transient Voltage Surge Suppression

1.03 REFERENCES

- A. The panelboards and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA and UL as follows:
 - 1. UL 67 – Panelboards
 - 2. UL 50 – Cabinets and boxes
 - 3. NEMA PB1
 - 4. Fed. Spec. W-P-115C
 - 5. Circuit breaker – Type I class I
 - 6. Fusible switch – Type II class I.

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Engineer:
 - 1. Breaker layout drawing with dimensions indicated and nameplate designation
 - 2. Component list
 - 3. Conduit entry/exit locations
 - 4. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
 - 5. Cable terminal sizes
 - 6. Product data sheets.

1.05 SUBMITTALS – FOR CONSTRUCTION

- A. The following information shall be submitted for record purposes:
 - 1. Final as-built drawings and information for items listed in paragraph 1.04
 - 2. Installation information
 - 3. Seismic certification and equipment anchorage details.

- B. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

1.06 QUALIFICATIONS

- A. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers and fusible switches.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of Uniform Building Code (UBC) for zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, UBC: a peak of 2.15g's (3.2–11 Hz), and a ZPA of 0.86g's applied at the base of the equipment. The tests shall fully envelop this response spectrum for all equipment natural frequencies up to at least 35 Hz.
- E. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
 - 1. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon approved shake table tests used to verify the seismic design of the equipment.
 - 2. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.
 - 3. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.07 REGULATORY REQUIREMENTS

- A. The panelboards shall be UL labeled.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.09 OPERATION AND MAINTENANCE MANUALS

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.
- B. Submit electronically in PDF format

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Cutler-Hammer
- B. Square D
- C. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 RATINGS

- A. Panelboards rated 240V AC or less shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 22,000 amperes RMS symmetrical.
- B. Panelboards rated 480V AC shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 65,000 amperes RMS symmetrical.
- C. Panelboards shall be labeled with a UL short-circuit rating. When series ratings are applied with integral or remote upstream devices, a label or manual shall be provided. It shall state the conditions of the UL series ratings including:
 - 1. Size and type of upstream device
 - 2. Branch devices that can be used
 - 3. UL series short-circuit rating.

2.03 CONSTRUCTION

- A. Interiors shall be completely factory assembled devices. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
- B. Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Doors over 48 inches in height shall have auxiliary fasteners.
- C. Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.
- D. Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.
- E. A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.
- F. All locks shall be keyed alike.

2.04 BUS

- A. Main bus bars shall be copper sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.
- B. A system ground bus shall be included in all panels.

- C. Full-size (100%-rated) insulated neutral bars shall be included for panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200%-rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors.

2.05 BRANCH CIRCUIT PANELBOARDS

- A. The minimum short-circuit rating for branch circuit panelboards shall be as specified herein or as indicated on the drawings. Panelboards shall be fully rated. Panelboards shall be like Cutler-Hammer type Pow-R-Line 1a, Pow-R-Line 2a or Pow-R-Line 3a.
- B. Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
- C. Circuit breakers shall be thermal-magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame and through 100-ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be UL listed as type SWD for lighting circuits.
 - 1. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.
- D. Circuit breakers shall have a minimum interrupting rating of 22,000 amperes symmetrical at 240 volts, and 42,000 amperes symmetrical at 480 volts, unless otherwise noted on the drawings.

2.06 DISTRIBUTION PANELBOARDS – CIRCUIT BREAKER TYPE

- A. Distribution panelboards with bolt-on devices contained therein shall have interrupting ratings as specified herein or indicated on the drawings. Panelboards shall be fully rated Panelboards and shall be like Cutler-Hammer type Pow-R Line 3a or Pow-R-Line 4B. Panelboards shall have molded case circuit breakers as indicated below.
- B. Where indicated, provide circuit breakers UL listed for application at 100% of their continuous ampere rating in their intended enclosure.
- C. Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

2.07 ENCLOSURE

- A. Enclosures shall be at least 20 inches wide made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.
- B. Enclosures shall be provided with blank ends.
- C. Where indicated on the drawings, branch circuit panelboards shall be column width type.

2.08 NAMEPLATES

- A. Provide an engraved nameplate for each panel section.
- B. Owner shall provide label information

2.09 FINISH

- A. Surfaces of the trim assembly shall be properly cleaned, primed, and a finish coat of gray ANSI 61 paint applied.

PART 3 – EXECUTION

3.01 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

3.02 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.03 QUALITY CONTROL

- A. Prior to energizing the Contractor shall:
 - 1. Torque all connections per the Manufacturer's recommendations.
 - 2. With a 1000 volt Megger test all phase and neutral bus for shorts and grounds.

END OF SECTION 26 24 16

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SECTION 26 27 26 – WIRING DEVICES

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. Types and locations of wiring devices are indicated by the Project drawings.
- B. Types of wiring devices in this section include the following
 - 1. Receptacles
 - 2. Switches
 - 3. Cover plates

1.02 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of wiring devices, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installers: Firm with at least five (5) years of successful installation experience with projects utilizing wiring device work similar to those required for this Project.
- C. NEC Compliance: Comply with NEC requirements as applicable to construction, installation and coding of wiring devices.
- D. UL Labels: Provide wiring devices that are UL listed and labeled.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Deliver wiring devices properly packaged in factory–fabricated type containers.
- B. Store wiring devices in a clean dry space. Protect products from weather, damaging fumes, construction debris and traffic.

PART 2 – PRODUCTS

2.01 GENERAL

- A. General use receptacles shall be heavy-duty 20-amp duplex 2 pole 3 wire grounding type.
- B. All switches shall be specification grade quiet switches, 120-277 volt 15 amp.
- C. Device colors shall be a selected by the Owner but generally all devices shall be white on painted walls and brown on wood walls unless for special application.
- D. Devices on emergency circuits shall be red.
- E. All exterior receptacles and any receptacle within six (6) feet of any water shall be GFCI.

2.02 MANUFACTURERS AND CATALOG NUMBERS

- A. Hubbell, legrand, Leviton and Pass & Seymour are the only acceptable manufacturers.
- B. The following is an approved list of receptacles by type (based on Hubbell).
 - 1. 20 amp duplex- # HBL5362 or approved equal
 - 2. 20 amp isolated ground- #IG5362 (orange) or approved equal
 - 3. 20 amp single- # HBL5461 or approved equal
 - 4. 20 amp duplex with two USB charging ports- # USB20X2 or approved equal

5. 20 amp GFCI - # GFR5362SG or approved equal
- C. The following is the approved list of switches by type 15 amp (based on Hubbell).
1. Single pole toggle switch-# HBL1201 or approved equal
 2. 2 pole toggle switch - # HBL1202 or approved equal
 3. 3 way toggle switch-# HBL1203 or approved equal
 4. 4 way toggle switch- # HBL1204 or approved equal
 5. Single pole key switch with key- # HBL1201L
 6. 2 pole key switch with key- # HBL1202L
 7. 3 way key switch with key- # HBL1203L
 8. 4 way key switch with key- # HBL1204L
 9. Maintained contact 3 position, 2 circuit, center off, single pole, double throw 20 amp- # HBL1385
 10. Momentary contact 3 position, 2 circuit, center off, 20 amp- # HBL1557
- D. All interior device cover plates are to be polycarbonate type (thermoset plastic not allowed), color to match device color unless otherwise noted.
- E. All exterior device cover plates shall be weatherproof type unless otherwise noted.

PART 3 - EXECUTION

3.01 INSTALLATION OF WIRING DEVICES

- A. General: Install wiring devices as indicated, in compliance with applicable requirements of NEC, NEMA, UL and NECA's "Standard of Installations", and in accordance with recognized industry practices.
- B. Install all wiring in approved boxes or enclosures.
- C. For vertically install receptacles with ground up and on horizontal receptacles the ground on the left.
- D. Verify proper orientation of all switches
- E. Cover plates must cover all openings around devices and boxes.
- F. All devices must be installed plumb with the surroundings
- G. All device cover plate screws slots shall be vertical.

END OF SECTION 26 27 26

SECTION 26 51 00 – INTERIOR LIGHTING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General, Supplementary, and Special Conditions apply to all lighting installations.
- B. Section 26 05 00 Common Work Results Electrical
- C. Section 26 05 33 Raceway and Boxes
- D. Section 26 05 19 Low Voltage Wiring
- E. Section 26 09 23 Lighting Controls

1.02 REQUIREMENTS OF WORK

- A. The Basic Electrical Requirements apply to all electrical materials, equipment, installations and services supplied under Dimmer package.
- B. The Electrical Contractor shall obtain a Bill of Materials from the Lighting Supplier(s) listed herein or proposed for substitution. The Bill of Materials shall be submitted with the Contractor's bid and shall include, but not limited to, the following.
 - 1. All lighting fixtures
 - 2. All fixture accessories
 - 3. Number, fixture type and luminaire type to be provided
- C. The Electrical Contractor (Sub-Contractor) and the Lighting Supplier(s) are responsible for the installation of a complete and operating lighting system in accordance with the intent of the Contract Documents.

1.03 SUBMITTALS

- A. The following items shall be submitted for approval prior to ordering.
 - 1. Lighting Fixtures
- B. All submittals shall be submitted electronically in PDF format

1.04 INSTALLER QUALIFICATIONS

- A. A firm with at least five (5) years of successful installation experience on projects with electrical works similar to this project.

PART 2 – PRODUCTS

2.01 FIXTURE SCHEDULE

- A. See fixture schedule on Drawing E601

PART 3 – EXECUTION

3.01 GENERAL

- A. All equipment shall be installed in a workmanlike manner and shall conform to industry Standards for this type on installation.

- B. All fixtures shall be plumb and square with ceilings and walls
- C. Support for fixtures in or on a grid type ceiling. Use grid for support.
 - 1. Install grid support wires on all four corners of each fixture.
 - 2. Install support wires or support chains, minimum of two, independent of the ceiling grid to each fixture not more than 6 inches from the corner on diagonally opposite corners of each fixture.
- D. Flange mounted fixture installation shall be per Manufacturer's instruction.

3.02 TESTING

- A. "Megger" all wiring prior to energizing.
- B. Test all switches and sensors for proper operation
- C. Verify proper operation of each fixture.
- D. Test each emergency fixture by interrupting the power to the fixture.

3.03 CLOSEOUT

- A. Prior to final acceptance and Project closeout the Contractor shall:
 - 1. Clean all fixtures and lenses inside and outside
 - 2. Replace any burned out lamps or LED arrays.

3.04 WARRANTY

- A. As Specified on each individual fixture listed herein.
- B. In lieu of a specific fixture warranty, all parts and labor on this Project shall be warranted for a period of one (1) year after start-up and Owner acceptance.

END OF SECTION 26 51 00

SECTION 27 00 00 - GENERAL REQUIREMENTS BY OWNER

Telecommunications Equipment Rooms - General:

1. All ER's and TR's shall have access doors from public spaces.
2. All telecommunications room floors are to be clean and sealed before data racks, patch panels, or other equipment is installed.
3. Room layout and equipment layout within racks shall be approved by Owner before any equipment is installed.
4. All ER's and TR's shall have **24/7/365 temperature and humidity control**. Typically this shall be a separate unit from building HVAC systems. Main data wiring center will typically have a 7,000 watt heat load from the data switch gear. This heat load needs to be considered in unit sizing. ER and TR HVAC units shall be capable of operation below zero degrees Fahrenheit external temperature.
5. No lines that do or may carry any liquid shall be installed in or pass through ER's and TR's.
6. No electrical switch gear shall be installed with any ER or TR.
7. ER's and TR's shall not be shared spaced used for any other purpose.
8. There shall be no less than 60 inches clearance between the back of any row of racks and the nearest wall or row of racks. There shall be no less than 42 inches clearance between the front of any row of racks and the nearest wall. There shall be no less than 42 inches clearance at the end of any row of racks on the end opposite the starting wall of the row. There shall be no less than 6 inches clearance between the start of any row of racks and the nearest wall. (this includes wire management)

Telecommunications and Networking Requirements -General:

1. There shall be a Cat6A outlet anywhere a wall mounted TV or video display is shown.
2. There shall be a Cat6A wall mounted telephone outlet at ADA height in each classroom, conference room, and lab specifically for an ENS (Emergency Notification System) phone. This is stand alone and separate from any general use telephone(s) in the room. Where appropriate these shall be installed near the teaching station or at the front of the room.
3. There shall be a wireless access point connection in the ceiling per 25 students in a given area such as classrooms, labs, etc. All wireless access point locations shall have one CAT6A connection. **In areas with high ceilings wireless access points shall be installed no higher than twelve feet above finished floor.** Wireless access point layout must be approved by Owner before installation.
4. There shall be a Cat6A wall mounted telephone jack installed at ADA height near the doorway in all mechanical rooms, electrical rooms, storage rooms, etc.
5. All jacks called out for Data and Voice shall be Electrical Ivory. Face plates shall also be Electrical Ivory unless contract specifies face plate color to be the same as electrical face plate color.
6. **Every space including hallways, restrooms, closets, stairwells, etc shall have a unique room number identifier.** Final room numbers shall be confirmed with the Owner before construction documents are issued. **Once construction begins room numbers shall not change.**
7. Please clarify any questions with Owner prior to bidding, construction, or installation.
8. Contractor shall maintain and provide to ISU a Microsoft Excel spreadsheet in electronic format of all connections installed with the following fields filled out. **NO DATA PORTS WILL BE ACTIVATED UNTIL THIS SHEET IS PROVIDED FULLY FILLED OUT TO OWNER:**
 - a. Room Number

- b. Jack Label
- c. Wire label
- d. IDF Room Number
- e. Rack Label for patch panel
- f. Patch Panel label
- g. Patch panel port
- h. Cable Length

Telecommunications and Networking Room -Architectural:

1. The (ER) minimum room size shall be 10' deep and 12' wide for the main equipment room.
2. The minimum size for a Telecommunications Room(s) (TR) shall be 10' deep and 8' wide.
3. The minimum ceiling height shall be 9 feet above finished floor (AFF).
4. To permit maximum flexibility and accessibility of cabling pathways, false ceilings are not permitted.
5. Walls SHALL extend to structural ceiling.
6. Ceiling, floor, and wall finish that minimizes dust shall be used.
7. Design ER/TRs to have fully opening (to 180 degrees recommended), lockable doors that are minimally 42 inch wide and 80 inches tall.
8. Door sills are not allowed because they impede the movement of equipment.
9. Removable center posts are permitted, if required.
10. Install doors to be removable.
11. Dust and Static Electricity; Avoid dust and static electricity by:
 - a. Installing tile instead of carpet.
 - b. Treating floors, walls, and ceiling to minimize dust.
12. Doors SHALL open outward.
13. Doors SHALL have locks with campus master "FM5" installed.

Telecommunications and Networking Rooms - Environmental Control:

Provide HVAC that will:

1. Maintain continuous and dedicated environmental control (**24 hours per day, 365 days per year.**)
2. If emergency power is available, consider connecting it to the HVAC system that serves the ER/TR.
3. Maintain positive pressure have have a minimum of one air change per hour in the ER/TR.
4. Dissipate the heat generated by active devices.
5. Provide 300ft cubed of 54 degrees conditioned air per 20 ampere (A) dedicated electrical outlet.
6. The temperature range should be 64 degrees to 75 degrees.
7. The humidity range should be 30% to 55% relative humidity.
8. Keep changes in temperature and humidity to a minimum.
9. ERs/TRs should be calculated using 7500 BTU/HR from communications equipment.

Fire Protection

1. If sprinkler heads are provided, install wire cages to prevent accidental operation.

2. For wet pipe systems, drainage troughs are required to protect equipment from any leakage that may occur.
3. To prevent water damage, consider using "dry pipe" sprinkler systems.

Lighting

1. Provide a minimum equivalent of 500 lux (50 footcandles) measured 3 feet AFF.
2. Coordinate closely with the rack/cabinet placements.
3. Locate light fixtures a minimum of 9 feet AFF.
4. Light fixtures SHALL be positioned to provide adequate light to front and rear of racks as well as backboards.
5. Emergency lighting is required. Place emergency lighting to ensure that the loss of power to normal lights will not hamper an emergency exit from the TR.
6. ER/TR shall not have motion and/or timer based lighting.ER/

Other Uses

1. ER/TRs should be dedicated to the telecommunications function and related support facilities. Equipment not related to the support of the ER/TRs (e.g. piping, duct work, and distribution of building power) should not be located in, or pass through, the ER/TR.
2. The ER/TR shall not be shared with building users or custodial services.

Power

1. On the wall at the end of each row of relay racks install two (2) 5-20 110vac outlets.
2. On the wall at the end of each row of relay racks install two (2) L6-30 208vac outlets per 224 data/voice outlets terminated in the relay racks. L6-30 208vac outlets are to be installed in pairs. One of each pair is to be on building commercial power. And one of each pair is to be on the building emergency generator power.
3. Make sure there are a minimum of two (2) quad 5-20 110vac outlets evenly spaced on each of the four walls.
4. All outlets in telecommunications rooms are to be on building emergency generator power except as noted in item #2 above.
5. All outlets must have labels indicating the circuit / breaker panel and if they are commercial or generator feed.
6. Consider providing emergency power to the ER/TR with automatic switchover capability.
7. Distribution panels that serve telecommunications equipment should be separate from those that serve lighting fixtures.
8. At least one electrical outlet shall be on normal power, and one electrical outlet shall be on emergency power.
9. Outlets requirements on backboards as well as racks/cabinets as shown on the enlarged floorplans.

Data Communications Equipment

1. Owner shall provide network electronics – Network Switches and Access Points.
2. Ceiling mount Access Point identification and installation.
 - a. All locations shall have labeling consistent with wall plate labeling specified in 27.11.16.0.

- b. Optimal mounting height is 8 to 12 feet in height from the floor. Exceptions need to be approved by the owner.
- c. Access points that mount to ceiling grid / drop ceilings shall have the label placed on the grid at the location of the terminated cable. 10' service loops only apply to these types.
- d. Access points that mount to hard ceilings will have a duplex box mounted flush with the ceiling and the network cable terminated and through the box. No wall plate is required. No extra service loop required.
- e. Access points that mount in open concept ceilings will have an appropriate conduit and box to mount the Access point to. Should the ceiling exceed 12' in height a conduit with a quad box shall be mounted and extended down from the structure to the desired height. The Box and Conduit can be painted as desired to match the decore. The final height of the should be even or slightly below any other hanging objects such as lights, ventilation etc. to offer optimal wireless coverage.
- f. All ceiling access points and necessary brackets will be provided by the owner and the contractor will hang the access points. Installation shall be in accordance with the designated location and methods required by the specific mounting type. Installation shall not occur until after the cable is tested / certified and while lifts and ladders are still available to mount the equipment.
- g. The contractor will add the cable labels to the face of each access point after mounting so that they are easily identifiable in addition to the labeling already provided by the owner.
- 3. Office Wall mount Access points identification and installation.
 - a. All locations shall have labeling consistant with wall plate labeling specified in 27 11 16 0.
 - b. All locations shall have a duplex wall box and have 2 network drops provided to the location. No wall plate is required.
 - c. All wall mount access points and necessary brackets will be provided by the owner and the contractor will mount the access points in accordance to the designated location and methods required by the specific mounting type, after the cable is tested / certified.
 - d. The acces point will have the first network drop connected to the Pass-Thru port and the second to the access point port.
 - e. The contractor will add the cable labels to top of the Access points after mounting so that they are easily identifiable in addition to the labeling already provided by the owner.
- 4. General area mount Access Point identification and installation.
 - a. All locations shall have labeling consistant with wall plate labeling specified in 27 11 16.0.
 - b. Optimal mounting height is 8 to 12 feet in height from the floor. Exceptions need to be approved by the owner.
 - c. All locations shall have a duplex wall box and have 1 network drop provided to the location. No wall plate is required.
 - d. All wall mount access points and necessary brackets will be provided by the owner and the contractor will mount the access points in accordance to the designated location and methods required by the specific mounting type, after the cable is tested / certified.
 - e. In some locations protective guards (plexiglass shields) may be required and will be provided by the owner to be installed by the contractor.

Voice Communications Equipment

- 1. Viking E-1600-65A phones shall be installed in all areas of refuge as designated by ISU Public Safety. These areas may include those such as elevator lobbies, stairwell access areas, etc. Owner shall confirm these locations prior to installation.

Requirements for ER/TR data commucation equipment Installation

1. The owner will not install the final set of equipment in an ER/TR until the following conditions are completed per the specifications. It will take 3 to 5 days to install and test equipment in each ER/TR once turned over.
 - a. HVAC is operational
 - b. All plywood and significant construction in the room is completed.
 - c. All copper terminations are completed, tested and labeled per the specifications.
 - d. Fiber uplinks to either the appropriated ER or Core networking location is terminated and tested.
 - e. All Power and lighting is installed, labeled and completed. Additionally the power will not be or minimally interrupted.
 - f. ER/TR is cleaned and floor is mopped and sealed.
 - g. ER/TR is lockable with final specified key.
2. Interim temporary switches can be installed for critical infrastructure like HVAC and similar systems. Equipment will be a small 8 port switch that will be mounted to the plywood covered wall. However the following must be met and 1 to 3 days are required to install and test equipment in each ER/TR as required.
 - a. Fiber or copper uplinks to either the appropriate ER or Core networking location is terminated and tested.
 - b. Plywood is mounted on the wall nearest the end of the rack row.
 - c. Power and lighting is installed and active.
 - d. ER/TR is lockable / secured during non-working hours.
3. Construction related infrastructure network activation requests must be directed to the owner project liaison for proper request processing. Typically HVAC, cameras and similar systems. They can only be completed when either option 1 or 2 above for "Requirements for ER/TR data communication equipment Installation" are completed.

Occupant / General Network Access

1. Once the final set of equipment is installed in the ER/TR and the access points are installed / mounted. The wireless should become active in 1 to 3 business days.
2. Network wired ports are activated on request of the occupant. The owner (user support consultant) will work to coordinate identifying and activating the necessary ports through the owner Help Desk system.
3. By default only one (1) network port will be activated per single person office as identified. Second port can be active on request with reasonable justification.
4. All activation requests, if not coordinated by the owner (user support consultant), must be directed through the owner Help Desk by the occupants.
5. Each building is assigned unique sets of IP addresses. Therefore all occupants moving between buildings will be required to re-register their wired devices for a new IP address before it will function.
6. Port activation SLA is typically 1 working day unless there are multiple activities occurring (i.e. start of the semester etc.) that may extend this delivery time. It will be on a first come first serve best effort process.
7. Occupants should plan to bring any existing network cables currently connected to their devices from their previous location. Should the occupant need a different length cable they can request one through the owners help desk. All office patch cables must be CAT5e or higher.
8. Network jack locations are designated in the construction plan. Should occupants disagree with the location and want to add an new jack they must:

- a. If the building has not been turned over and while the project is still under way, then they must work with the owner Facilities Management team and request a change order to the project with justification to have the additional network drop added or relocated.
- b. If the building has been turned over and the project is officially completed, then they must request any additional network jacks through the owner defined processes and are subject to installation fees per the owner specifications.

END OF SECTION 27 00 00

SECTION 27 00 10 - GENERAL REQUIREMENTS FOR COMMUNICATIONS

PART 1 GENERAL REQUIREMENTS

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. Supplementary to Division 1, Refer to Division 27 Section(s) for additive information where applicable.

1.2 SUMMARY

- A. The following items are additional requirements for Division 27 "Communications" Work.
- B. If after reviewing all documents and drawing there is any questions or doubt, or if a conflict or discrepancy is found between the documents and the drawings, contact the Owner in writing for clarification before proceeding. Clarification will be issued by Addendum.
- C. Each Item below has the Division 01 00 00 specification section number (in parenthesis) of the article where the base requirements are found. The additional requirements are to be considered additive to the Division 01 00 00 section and apply only to Division 27 work.
- D. Each Division 27 Specification Section may add additional requirements specific to that Section.

1.3 REQUIREMENTS

- A. (01 25 00 Substitution Procedures)
 - 1. Substitutions
 - a) All products provided as Work of this Project shall be in compliance with, and meet the physical, functional, and operational requirements of the products as outlined in Part II of each Division 27 specification Section.
 - b) Product Substitutions
 - 1) Substitution requests must be received by the Owner as required by Division 1.
 - 2) No substitutions will be accepted without prior approval. Only changes issued in an Addendum will be allowed.
 - 3) See Substitution Submission below.
 - c) Standard of Quality
 - 1) A Standard of Quality will be set by applying a Manufacturer and Catalog number to each item in Part II of each applicable specification section.
 - 2) A standard of quality item has the physical, functional, and operational attributes to provide the designed functionality.
 - 3) Additional approved manufacturer(s)
 - i) Listing as an additional approved manufacturer for an item is not an assurance that the manufacturer has products that meet the requirements; at minimum, the written description must be met along with any key attributes used in the Project design.
 - ii) When a listed "additional manufacturer" has a product that meets the written description and has the physical, functional, and operational attributes, that product may be used in place of the product that was listed as the standard of quality without submission for prior approval.
 - (A) If such a substitution is made, the requirements for items by the "same manufacturer" shall be adhered to.

- (1) Requirements for "system" type warranties requiring the same manufacturer or manufacturing "partnership" items for warranty application shall be adhered to.
 - (B) It will be the sole responsibility of the Contractor to provide adequate design compensation for fulfillment of the intent of the Specification for any change in Scope due to an "approved manufacturer's" product change from this Section (i.e., required rack space, box size, support requirements, etc.).
 - (1) Adequate compensation shall be determined by the Owner.
 - 4) Where 2 or more Manufacturers and Catalog numbers are listed, one of the two products must be utilized. Item listed first is Owner's preferred product.
- B. (01 25 13 Product Substitution Procedures)
 - 1. Substitution Submission
 - a) Each item submitted must meet the physical, functional, and operational attributes of the Standard of Quality item.
 - b) All requests for substitutions shall be accompanied by a complete system brochure and/or individual product data sheets.
 - 1) Contractor shall state a reason for the substitution request (i.e. familiarity, availability, functionality, Brand specific training, Manufacturer's warranty issue, etc.)
 - 2) Contractor shall provide comparison list of features, functions and specifications where proposed substitute product differs from specified product.
 - 3) Each request must reference the Specification Section number and paragraph and include a description of any deviation from the specified functional requirements of the equipment and/or system(s).
 - 4) A demonstration of the proposed equipment and/or system(s) may also be requested. This information must be submitted in compliance with Division 1 Section "Substitutions."
 - c) Failure to provide all information may result in the substitute product being rejected.
 - d) Owner reserves the right to reject any substitute.
 - 2. Substitution Responsibility
 - a) Contractor shall be responsible for all additional costs, both direct and indirect, including costs for additional equipment, materials and labor necessary to properly integrate a substitute product, including additional costs which may be incurred by other trades, the Owner, Architect or Owner. (i.e., required rack space, box size, support requirements, etc.).
- C. (01 26 13 Requests for Interpretation)
 - 1. Contradictions, discrepancies, or conflicts
 - a) This Contractor shall carefully study and compare the Contract Documents and shall at once report to the Authority as set forth in 01 31 00 "Project Management and Coordination" any error, inconsistency or omission discovered.
 - b) In the case of a contradiction, conflict, or discrepancy between Division 27 Sections and Divisions 0 and/or 1.
 - 1) Division 27 Specifications will be considered additive. It is not intended that Division 27 Sections supersede any legal or contractual requirements set forth in Division 0 or 1.
 - c) In the case of a contradiction, conflict, or discrepancy between T Series Drawings and/or Division 27 Specification Sections
 - 1) If during the Bid period the Contractor discovers a contradiction, discrepancy, or conflict of information on any Drawing, between any two drawings,

between Drawings and specification Sections, within any Division 27 Section, between related Sections, between individual parts of a Section, or within any part of any Section; the contradiction, discrepancy, or conflicting information shall be called to the attention of the Owner in writing and will be clarified by Addendum.

- 2) A contradiction, discrepancy, or conflict of information that has not been clarified in writing at Bid time will be considered to be the more costly of the available options.
- 3) If a contradiction, discrepancy, or conflict of information is discovered after award of Contract; the discrepancy or conflict will be submitted to the Owner in writing for evaluation. The result will be clarified by a Change Order. This Change Order will be of \$0 or will require a deduct to change the requirement to a less costly option if so decided by the Owner.
 - i) If Contractor performs any construction activity knowing it involves a recognized contradiction, discrepancy, or conflict in the contract documents without such notice to the Owner or Owner, the Contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the cost required for correction.

D. (01 31 13 Project Coordination)

1. Coordination

- a) Coordination shall commence immediately upon award of contract. Failure of this contractor in coordinating (including providing and extracting related information to and from other trades for review) in a timely manner, shall not result in any subsequent additional reimbursement, special allowances or additional construction time being made for any facet of the project. Work fabricated or installed before properly coordinating with all other trades shall be done at the Contractor's own risk.
- b) Sequence, coordinate, and integrate installations of communications materials and equipment with the Division 26 electrical contractor any all other applicable trades for efficient flow of the Work.
- c) The contract document drawings are an outline to indicate the approximate location and arrangement of required work. The drawings shall be followed as closely as possible in coordination and in execution of the work.
- d) This contractor shall work in harmony with all building contractors and sub-contractors, so as not to cause any delays in pouring concrete, building masonry walls, etc. This contractor shall consult the Architectural, Plumbing, HVAC and Structural plans in all instances before installing his work so that his work will not interfere with those branches.
- e) This contractor shall participate in coordination efforts and in preparation of coordination drawings prior to fabrication or installation of any equipment, materials, etc. Coordinate actual clearances of all installed equipment.
- f) Conflicts in equipment and materials shall be corrected prior to installation. Should there be a conflict with the drawings of other trades, this contractor shall work with the trades to correct the conflict while coordinating the project (prior to installation). If the conflict cannot be resolved, refer the matter to the owner's representative for a final decision as to method or material. This contractor shall refer to drawings of all other trades for details, dimensions and locations of other work and route their work so as not to conflict with any other branch. Any work installed or equipment placed in position by this contractor creating a conflict shall be readjusted to the satisfaction of the owner's representative at the expense of this contractor.
- g) Plans are diagrammatic indicating design intent and indicating required size, points of termination and, in some cases, suggested routes of raceways, etc. However, it is not intended that drawings indicate fully coordinated conduit routing, all

necessary offsets, etc. All cable assemblies, etc. shall be run as straight as possible and symmetrical (perpendicular to or parallel with) with architectural items and in a consistent elevation. Work installed diagonal to building members shall not be permitted.

- h) The Contractor shall coordinate his work with all other trades and locate equipment accordingly. This Contractor shall refer to coordination drawings of the other trades. Any communications work fabricated or installed before the above referenced coordination with all other trades shall be done at the respective contractors' risk.
 - i) It is intended that all apparatus be located symmetrical with architectural elements and shall be installed at exact height and locations as shown on architectural drawings. If a device height or location is in question it shall be the responsibility of this Contractor to immediately seek clarification from the Owner.
- E. (01 31 16 Multiple Contract Coordination)
- 1. Coordinate work with Division 26 Contractor (where applicable); prior to Division 26 Contractor's installation of outlet boxes, conduit, conduit stubs, raceways and any other provisions in support of Division 27 Contractor's work.
 - 2. Coordinate with all other Contractor's and the Owner, as applicable and necessary to ensure a clean, professional looking and operating systems.
- F. (01 31 19.16 Site Mobilization Meetings)
- 1. The Contractor shall fully inform himself regarding all peculiarities and limitations of space available for installation of all work and materials furnished and installed under the contract. He shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible. Although the locations of equipment and conduit may be shown on the drawings in certain positions, the architectural details and conditions existing at the job site shall guide the Contractor, coordinating his work with that of others. Provide all offsets as required to provide a neat workmanlike arrangement
- G. (01 33 23 Shop Drawings, Product Data, and Samples)
- 1. Submittals required after Award of Contract but before starting Work include:
 - a) Complete BOM list
 - 1) BOM shall include the following information for each product:
 - b) Product Information Sheets "Datasheets": Include catalog information, sizing, and technical data on each item to be used on the Project.
 - 1) Each product datasheet must reference the specific paragraph for which the product is being submitted. Each product must be listed in the exact same order as it appears in the Section for which the products are being submitted.
 - i) Datasheets shall each include a clearly identifiable label applied in upper corner of each sheet that clearly references the specification section and drawing (as applicable) to which it applies. Labels shall be consistently affixed in the same location on all sheets unless the labels will obstruct pertinent technical information.
 - 2) All datasheets shall be original manufacture datasheets, first generation printed copies of manufacturer's electronic datasheet (i.e. printed copy of a PDF file), or high quality photocopy of original manufacturer's datasheets.
 - i) Fax versions of product datasheets or any photocopies thereof are not acceptable.
 - ii) Submit original printing or "clean" reproductions.
 - 3) Where datasheets depict multiple products, versions or options, the Contractor shall highlight (indicate with an arrow) all applicable model(s), version(s) and option(s) applying to the specific product the Contractor will be providing. Exact catalog number must be indicated. The submitted items must be from "approved materials" as specified in each Specification Section.

- 4) Product datasheets shall be "approved" by the Owner before delivery to the Project site. Any product not approved through the submittal process is at the sole risk of the Contractor.
 - i) A copy of "Approved" datasheets shall be included in O & M manual requirements
 - 5) Required Information
 - i) Complete Bill of Materials (BOM) List
 - (A) The manufacturer's name (Brand) and full model number shall be used. (Distributor and Contractor assigned names and model numbers are unacceptable).
 - ii) Manufacturer Product Datasheet for each product.
 - (A) Product datasheets shall be manufacturer originals, or first generation printed versions of manufacturer's official electronic product sheets.
 - (B) Manufacture model shall be highlighted on each sheet.
 - (C) Datasheets shall be organized to match the order and organization of this section
2. Submission Format
- a) Submit Shop Drawings and Product Data Sheets in a bound form
 - 1) Submittals shall be supplied in an appropriately sized 3-ring binder(s). Separate binders shall normally be used for each Division 27 Contract.
 - 2) Manuals shall be bound in hard cover, 3 ring binders with clear plastic "pocket" covers to insert Project Information on the exterior of the Binder.
 - 3) Maximum individual Binder spine size shall be 3"; utilize multiple binders as required.
 - b) Submittal Manuals shall include the information listed below and be assembled as follows:
 - 1) Binder shall be marked on the cover and spine with the following information
 - i) Project Information
 - (A) Title of Project
 - (B) Name and address of Owner, Contractor, Architect, Owner
 - (C) "Submittals for " (specification Section(s)
 - (D) Date of Submittal
 - 2) Organization
 - i) The binder is subdivided into specification sections.
 - ii) Each Binder shall be organized as follows
 - (A) Master Tab 1: Project and contact information
 - (B) Master Tab 2: (First) Specification Section
 - (1) Section 1: Title Page
 - (2) Specification section name & number
 - (3) Contractor/Subcontractor Information Including:
 - (4) Name, address and phone
 - (5) Project manager name and phone
 - (6) Section 2: Bill of Materials
 - (7) Section 3: Product Datasheets
 - (8) Section 4: 11 x 17 inch reduced scale versions of full size shop drawings. Drawings shall be folded, punched and inserted into the binder.
 - (C) Master Tab 3 through (x): Additional Specification Section(s)
 - (1) Repeat Sections 1-5 above for each Specification Section.
 - iii) Division 27 submittals may not be combined with submittals from any other Division.
 - 3) Full-size shop drawings shall be printed to scale and bound along the left edge of the drawings with the Title block on the right edge.

- 4) The Contractor shall provide a record of shop drawings using AutoCAD Release 2000 or higher.
 - i) Detail drawings may be submitted in Visio 2000 format.
3. Submission
 - a) Provide minimum of (5) copies of all submittal items.
 - 1) Two copies of all Submittals will be retained by the Owner.
 - 2) Three copies will be returned.
 - i) One copy of approved Submittals will be required to prepare Record Drawing for the O&M (Owner's) Manual.
 - ii) One Copy for the Project site
 - iii) One Copy for the Contractor's records
 - 3) Provide additional quantities as may be required by other applicable sections (including Division 1), as requested by the Owner, and as required by the Contractor for its own purposes.
 - b) Timetable
 - 1) Contractor shall make all Submittal submissions as soon as practical after award of Contract.
 - 2) Provide submittals in adequate time so as not to negatively impact the completion of the project or the schedule of other trades.
 - i) Contractor shall allow a minimum of 2 weeks in its schedule for the Owner's review of submittals.
4. Review of shop drawings does not relieve the Contractor of responsibility for correct ordering of material and equipment. Contractor review should ensure that equipment will fit in available space.
 - a) PARTIAL OR INCOMPLETE SUBMITTALS WILL BE REJECTED PRIOR TO FULL REVIEW.
 - b) Unacceptable submittal items:
 - 1) Fax copies of datasheets
 - 2) Datasheets that are not legible.
 - 3) Datasheets that do not clearly depict and/or enumerate all specification requirements.
 - 4) Non-manufacture datasheets (i.e. from a distributor)
 - 5) HTML web page printouts that are not the manufacturer's official product datasheet.
 - 6) Identification of products by Contractor or Distributor assigned part numbers, catalog numbers or private label brand names.
- H. (01 41 13 Codes)
 1. Building Codes:
 - a) National Electrical Code (NFPA 70)
 - b) Life Safety Code (NFPA 101)
 - c) Uniform Building Code (Or adopted State Code)
 - d) Federal Communications Commission (FCC) Part 68
 - e) State specific agencies:
 - 1) Administrative Building Council
 - 2) State Board of Health
 - 3) State Fire Marshal
 - f) Local Codes (City, County, etc.)
 - g) Local Utility Company requirements
- I. (01 41 26 Permits)
 1. Contractor shall obtain and pay for all permits or certificates of inspection and approval required for his branch of the work.

- a) Permits shall be posted in a prominent place at the building site properly protected from weather and physical damage.
- J. (01 42 16 Definitions)
 - 1. Wherever the words "Contractor", "This Contractor" or "Subcontractor" appears in Division 27 specifications, it shall refer to the Division 27 Communications Contractor (or Subcontractor of the Communications Contractor where applicable).
 - 2. A reference to Owner shall be referring to the Owner's Representative involved in the design of the System(s). The Owner may or may not be affiliated with the Architect and or Engineer for the Project. All information exchanged between the Contractor(s) and the Owner shall be within the information exchange process of the Project. (i.e. through a Construction Manager, General Contractor, Architectural Firm, etc.)
 - 3. Wherever the words "Designer", "Consultant" or "Engineer" appears in Division 27 specifications or its related drawings, it shall be interpreted to mean the specifying authority responsible for the creation of the Division 27 specifications and related drawings.
 - 4. Wherever the word "Install" appears on the drawings or in these Division 27 specifications it shall mean to supply all labor, tools and incidental materials necessary to handle, store, mount, terminate, program, configure and adjust product as necessary to fulfill project requirements.
 - 5. Wherever the word "Provide" appears on plan drawings or in Division 27 specifications, it shall be interpreted to mean that the Contractor shall "Furnish and Install", including all necessary accessories, miscellaneous materials and labor necessary to render the respective system fully operational.
 - 6. Wherever the word "Work" appears in Division 27 specifications or on communication technology drawings, it shall be interpreted to mean any and all labor, materials, accessories, services, etc. necessary to fulfill project requirements.
 - 7. Wherever the word "Furnish" appears on the drawings or in these Division 27 specifications it shall mean to supply the specified labor or specified product (context dependant), including all associated shipping, storage and warranty expenses.
 - 8. Wherever the words "Site", "Project Site", or "Premises" appears in Division 27 specifications or its related drawings, it shall be interpreted to mean all real estate, buildings and structures where work will be performed and where products will be installed and reside.
 - 9. Wherever the phrase "or Approved equal" appears in Division 27 specifications or its related drawings, the contractor shall interpret this to mean that pre-bid approval of specific models of equipment is required before submission of the Contractor's bid.
 - 10. Wherever the phrase "or Equal from", or "or Equal by" appears in Division 27 specifications or its related drawings, the Contractor shall interpret this to mean that the Contractor may supply any product manufactured by the given list of manufacturer's meeting or exceeding the overall quality, functional, technical performance, construction, finish and general fit and fitness as the "Standard of Quality" design product. The final authority as to whether a product is equal shall remain with the Owner. Pre-bid approval is highly recommended.
 - 11. Wherever the phrase "Additional Approved Manufacturer(s)" appears in Division 27 specifications or its related drawings, the Contractor shall interpret this to mean that the Contractor may supply any product manufactured by the given list of manufacturer's meeting or exceeding the overall quality, functional, technical performance, construction, finish and general fit and fitness as the basis of design product. The final authority as to whether a product is equal shall remain with the Owner.
 - 12. Wherever the phrase "Standard of Quality" appears in Division 27 specifications or its related drawings, the Contractor shall interpret this to mean that the listed Manufacturer

and Catalog number for each item has the physical, functional, and operational attributes to provide the designed functionality.

13. Substantial Completion:

- a) The point at which the following has been completed:
 - 1) All specified work, and;
 - 2) All punch-list items that affect the full and complete use of the system, and;
 - 3) Successful acceptance testing by the Owner, and;
 - 4) Successful inspection and demonstration of the work to the Owner's representative, and;
 - 5) Contractor's delivery of a request for "Letter of Substantial Completion"
 - i) The request shall include the Specification Section(s) completed, confirmation of completion of the items listed above, and the requested Substantial Completion date (no more than 7 calendar days prior to this Letter).
 - 6) Contractor has received a Letter of substantial Completion for the Owner.

14. Nominal Operating Levels: The standard signal voltage/power reference level which a manufacturer has designed its product's inputs and outputs to operate at to achieve the manufacturer's specified performance levels.

15. Wherever the words "This Division" appears in Division 27 specifications or its related drawings, it shall be interpreted to mean these Division 27 specifications and all of its related drawings.

16. Wherever the words "Low Voltage", or "Low-Voltage" appears in Division 27 specifications or its related drawings, it shall be interpreted to mean less than or equal to 70.7 volts, AC or DC.

17. Wherever the words "High Voltage", or "High-Voltage" appears in Division 27 specifications or its related drawings, it shall be interpreted to mean greater than 70.7 volts, AC or DC.

K. (01 43 00 Quality Assurance)

1. Quality Assurance

- a) Requirements
 - 1) Contractor shall have a minimum five (5) years experience in the installation of Communication Technology system(s) of similar size, type, scope and contract value.
 - 2) The Prime Contractor or his subcontractor responsible for this Section shall have a Registered Communications Distribution Designer (RCDD) on staff that will be ultimately responsible for this Project. The RCDD must have sufficient experience in this type project as to be able to lend adequate technical support to the field forces during installation, the warranty period, and any extended warranty periods or maintenance contracts. If in the opinion of the Owner, the RCDD does not possess adequate qualifications to support the Project, the Owner reserves the right to require the Contractor to assign an RCDD who, in the Owner's opinion, possesses the necessary skills and experience required of this Project.
 - 3) The lead technician(s) on the Project shall carry a current BICSI Technician Certificate or have five years of experience in projects of similar scope.
 - 4) The lead technician(s) on the Project shall have a thorough understanding of the following:
 - i) American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 568B Commercial Building Telecommunications Cabling Standard.
 - ii) American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 569A

- Commercial Building Standard for Telecommunications Pathways and spaces.
- iii) American National Standards Institute/Telecommunications Industry Association – ANSI/TIA/EIA 606 The Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.
 - iv) American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
- 5) Contractor shall be a (factory trained) certified installer for all connectivity products.(cable and terminations).
- i) This minimum requirement shall apply to each Division 27 section independently. If Contractor is incapable of meeting the percent of product value requirement for each section, Contractor shall use a Subcontractor that can meet the percent of product value requirement, in whole, for all products and work of that section for which This Contractor is not qualified.
 - ii) The specific Contractor or Subcontractor meeting the requirements for a specific section shall be responsible for the supply of the products, supplemental engineering services and submittals as well as performing all technical labor associated with the installation, training and warranty servicing of work of that section.
- 6) Contractor shall have substantial business operations located within a 100 mile radius of the project site with a full-time employee staff actively engaged in the supply, installation and service of systems and equipment of the type and scope herein specified.
- 7) Contractor shall have full-time employee service staff based within a 100 mile radius of the project site.
- 8) Contractor shall provide any additional information requested by the Owner as determined appropriate by the Owner to validate a Contractor's (or its Subcontractor's) ability to perform and warranty the specified work in the quality, manner and time frame required.
- 9) In the absence of a requirement to provide a performance bond the Designer reserves the right to require a financial disclosure of the Contractor and any Subcontractor for the purpose of aiding the Designer in determining the ability of the Contractor or Subcontractor to perform.
- 10) Designer reserves the right to disqualify the use of any Subcontractor that This Contractor plans to use if the Subcontractor fails to meet the quality assurance requirements. Should this occur, This Contractor shall be required to choose another Subcontractor that does meet these quality assurance requirements.
- i) An equipment vendor not performing the technical labor associated with installation of the work of a given section shall not be considered a Subcontractor.
- 11) Superintendent/Project Manager
- i) This Contractor shall furnish the services of an experienced superintendent/Project Manager who shall be constantly in charge of the work, together with the qualified Foremen and specialists as required to properly install, connect, adjust, start, operate and test the work involved.
 - ii) The superintendent's/Project Manager's qualifications shall be subject to the review and acceptance by the Owner/Owner. Unless the Owner/Owner grants prior special permission, the same communication Superintendent/Project Manager shall be utilized

- throughout the duration of the project and be responsible for the complete scope of the Contract.
- b) Documentation to be submitted upon request pre or post bid for evaluation includes:
- 1) A complete material list by specification section for each specification section:
 - i) Include description, the manufacturer being used, and the manufacturer's part number.
 - ii) Submission of this list does not constitute acceptance by the Owner or relieve the Contractor from providing approved items in the proper quantities to fulfill the Scope of this Project.
 - 2) References:
 - i) A minimum of five reference accounts at which similar work, both in scope and design for each system specified, has been completed by the Contractor within the last four years.
 - (A) The list shall include contact names and telephone numbers for each.
 - (B) Each listed Project shall include a Summary of Work.
 - (C) Each listed Project shall include initial and final contract amounts.
 - (D) Each listed Project shall include initial Contract award date and completion date.
 - (E) Each listed Project shall identify the name of Contractor's project manager and lead technician responsible for the project.
 - 3) List of test equipment:
 - i) Proposed equipment for use in verifying the installed integrity of copper and fiber optic cable systems on this Project.
 - 4) Technical resume:
 - i) Provide experience of the Contractor's Superintendent/Project Manager and onsite installation supervisor (Foreman) who will be assigned to this Project.
 - 5) List of technical product training:
 - i) Training attended by the Contractor's personnel that will be working on this Project.
 - 6) Subcontractors list for Work of this Project.
 - i) List Scope of Work for each Subcontractor
 - ii) List References for each subcontractor
 - iii) Technical resume as described above for each subcontractor
 - iv) List of technical product training as described above for each subcontractor.
 - 7) Each specification section may detail additional Quality Assurance requirements in the PART I, Quality Assurance paragraph.
 - i) Submit each item identified in each Specification Section.
 - (A) Manufacturer Certification documentation as requested in each Section.
 - 8) Documentation substantiating the Contractor's factory authorization and warranty service status for all products specified and all other major products proposed for use by the Contractor.
 - 9) Financial Disclosure.
- c) Failure to supply a complete quality assurance submittal; failure to supply accurate references or references which yield favorable performance marks; or failure to supply other quality assurance information required shall be taken as a statement of the Contractor's inability to perform and shall be grounds for the Owner and/or Owner to reject the Contractor's bid.

L. (01 62 00 Product Options)

1. The contract documents are prepared on the basis of a single specific product as the "design equipment," even though other manufacturers' names and models may be listed as acceptable, or equal. The first manufacturer make and model for each product is the "design equipment" or "Standard of Quality".
 - a) This section is designed to provide the Contractor with a minimum standard of quality and functionality for the products used for telecommunications infrastructure.
 - b) This standard will be considered in force for the original response as well as for any additions or changes to this Project. Due to this, there may be items listed in the Products section that are not required under the scope of this contract.
 - c) Project design is based on the "Standard of Quality" listed products' physical, functional, and operational attributes. The use of any product not listed as the Standard of Quality must be compared for full functionality to the listed Product.
 - d) When several materials, products or items of equipment are specified by name for one use, the first item shall be considered Owner's preferred product. Contractor may select any one of those specified for requested approval. It shall be the responsibility of the Contractor to provide an item that meets or exceeds the qualities and functional characteristics of the device specifically listed by brand name and model number.
 - e) The Contractor is responsible for any other ancillary changes required to meet the Project objectives when utilizing substitutions. Approval of items submitted during the submittal process does not relieve the Contractor of this responsibility.
2. Product acceptability and substitutions are determined by criteria as required this section under "Substitutions".
3. Materials installed shall be new, full weight and of the best quality. All similar materials shall be of the same type and manufacturer. All materials, apparatus and equipment shall bear the Underwriter's Laboratory, Inc. label where regularly supplied, or required by Code.
4. In the event that a specified product is discontinued by the manufacturer and is no longer available for purchase, the Contractor shall provide replacement product of equal or greater value, performance and function. The replacement product shall be from the same manufacturer as the specified equipment unless written approval to use an alternate manufacture is obtained from the Owner.

M. (01 65 00 Product Delivery Requirements)

1. Product Procurement
 - a) The Contractor shall not procure, deliver or install any product until after the contractor's submittal has been reviewed by the Owner and the submittal has been returned to the Contractor's marked "No Exceptions", "Exceptions Noted" or "Exceptions Noted, Submit Record Copy" or "Approved". Advance procurement, delivery or installation of product prior to the return of submittal is entirely at the Contractor's own risk. Contractor should schedule its work and procurement accordingly.
 - b) Prior to procurement of any equipment or materials, Contractor shall review the model numbers, compatibility and interoperability of all products.
 - c) Prior to procurement, Contractor shall, through coordination with other trades and through field measurements and project site inspections, verify that products to be supplied can be physically installed as planned.
 - d) No claim for additional payment will be considered for the return of any equipment determined incompatible, or procured without adhering to the aforementioned conditions, including claim for reimbursement of manufacturer's "restock" fees.

- e) Contractor shall factor all of these conditions into its bid and plan its scheduling and resource needs accordingly to ensure that all work shall be performed according to the Owner's schedule and requirements of this contract.
- N. (01 66 00 Product Storage and Handling Requirements)
 - 1. Product Delivery, Storage and Handling
 - a) Receipt of materials
 - 1) The Contractor is responsible for receiving, handling, storing, and protecting all materials used on this Project until Substantial Completion.
 - b) Upon request, submit a schedule of equipment and materials required to complete installation, quantity ordered, order date, and promised delivery date.
 - c) Deliver equipment and materials in accordance with factory shipping requirements.
 - 1) Pack components in factory-fabricated protective containers.
 - 2) Units shall be delivered in sections of such size as will pass through available openings.
 - d) Until ready for installation, store products in original factory containers.
 - 1) Products shall be stored in a clean, dry space and as additionally recommended by the product manufacturer.
 - 2) Keep products out of the weather and away from construction traffic and debris, including drywall finish dust.
 - 3) Do not exceed structural capacity of the floor or platform on which the products are stored.
 - e) Until final acceptance of the system, protect all supplied products from damage resulting from moisture, fumes, dirt, dust and debris or any other source of potential damage.
 - f) Handle all products with care before, during and after installation so as to prevent damage.
 - 1) Replace any products damaged prior to final acceptance with new replacement products.
 - i) Replacement shall be done at not charge to the owner.
 - 2) Contractor is responsible for the safety and good condition of the materials and equipment installed until final acceptance by the Owner.
 - g) Save original product shipping containers and related packaging materials for major products until final acceptance.
 - 1) Prior to disposal, check with owner to determine if the owner wishes any of the packaging materials.
 - 2) Deliver specified packaging materials to the owner as requested.
- O. (01 71 00 Examination and Preparation)
 - 1. Examination of the Site
 - a) Contractor shall visit the Site to familiarize himself with the local conditions under which the work is to be performed and correlate his observations with the requirements of the Contract Documents. No allowance shall be made for claims for concealed conditions which the Contractor, in exercise or reasonable diligence in observations of the Site and review of the local conditions under which the work is to be performed, learned or should have learned of, unless otherwise specifically agreed by Owner and Owner in writing.
 - b) Before ordering any materials or doing any work, the Contractor shall verify all measurements and be responsible for correctness of same. No extra charge or compensation will be allowed for duplicate work or material required because of an unverified difference between an actual dimension and the measurement or size indicated in the drawings or specifications. Any discrepancies found shall be submitted in writing to the Project Manager and Owner for consideration before proceeding with the work.

- c) This Contractor must verify all dimensions locating the work and its relation to existing work, all existing conditions and their relation to the work and all man made obstructions and conditions, etc. affecting the completion and proper execution of the work as indicated in the Contract Documents.
- P. (01 73 19 Installation)
- 1. Work and workmanship
 - a) Provide all required labor, materials, equipment and Contractor's services necessary for complete installation of systems required to comply with the requirements of authorities having jurisdiction, as indicated on Drawings, and as specified.
 - b) Work shall be functional and complete in every detail, including any and all items required to complete the system, whether or not these items have been enumerated or shown on the Drawings.
 - c) Special attention shall be given to access to working and controlling parts. Adjustable parts shall be within easy reach. Removable parts shall have space for removal.
 - d) Each Contractor shall be fully knowledgeable of the details of all Work to be performed by other trades and take necessary steps to integrate and coordinate his Work with other trades.
 - e) Wherever tables or schedules show quantities of materials, they shall not be used as a final count. These figures serve only as a guide for the Contractor. Each Contractor shall be responsible for furnishing all materials on the Drawings or as specified.
 - f) The Consultant and Owner's Representative have full power to condemn or reject any Work, materials or equipment not in accordance with these Specifications and Construction Drawings or the manufacturer's specifications or drawings approved by the Owner or Consultant.
 - g) Work or equipment that is rejected shall be removed and replaced to the satisfaction of the Owner at the Contractor's expense. Work or equipment that is rejected shall be so stated in writing by the Owner or Consultant.
 - h) Such decisions that the Owner or Consultant may make with respect to questions concerning the quality, fitness of materials, equipment, and workmanship shall be binding upon the parties thereto.
 - i) All Work shall fully comply with these specifications and related Drawings and all manufacturers recommended installation practices.
 - j) All Work shall be performed with the best practices of the trade for performance, functionality, safety, endurance, and aesthetics.
 - k) Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the schedule.
 - l) Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible, as appropriate to the application.
 - m) Set all equipment to accurate line and grade, level all equipment and align all equipment components.
 - n) Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.
 - o) No equipment shall be hidden or covered up prior to inspection by the owner's representative. All work that is determined to be unsatisfactory shall be corrected immediately.

- p) All work shall be installed level and plumb, parallel and perpendicular to other building systems and components.
 - q) Install all equipment and materials in strict accordance with manufacturer's written instructions. Bring any conflicts between the manufacturer's written instructions and these specifications to the attention of the Designer for recommendations.
 - r) Upon completion of installation of equipment and communication circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with re-testing.
- Q. (01 73 29 Cutting and Patching)
- 1. Where demolition of existing surfaces are required by the Work, the same shall be restored to at least as good a condition as they were before.
 - 2. Contractor shall be responsible for painting, patching, repairing and replacing any building surface, furnishing, wall/floor/ceiling covering that is damaged or penetrated in the process of performing work on the project site.
 - 3. Additional work required to repair work performed under this Contract shall be at the expense of This Contractor.
 - 4. The Division 27 contractor shall do all cutting as required for the admission of Division 27 work. Unless directed otherwise in field, provide all related patching and painting to match surrounding methods, materials and colors. Any damage done by this contractor to the building during the progress of this contractor's work shall be made good at this contractor's expense. Perform cutting, fitting, and patching and materials as required to:
 - a) Uncover Work to provide for installation of ill-timed Work.
 - b) Remove and replace defective Work.
 - c) Remove and replace Work not conforming to requirements of the Contract Documents.
 - d) Remove samples of installed Work as specified for testing.
 - e) Install equipment and materials in existing structures.
 - f) Upon written instructions from the owner's representative, uncover and restore work to provide for observation of concealed work by owner's representative or by inspection authority having jurisdiction.
 - g) During cutting and patching operations, protect adjacent installations (structure, finishes, furnishings, etc.). Where applicable, provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to system components and components of other trades.
 - h) Patch surfaces and building components using new materials matching existing materials and using experienced Installers. Refer to Division 1 for definition of experienced "Installer" or determine qualifications as directed in field by owner's representative.
 - i) Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. All materials used for patching shall be installed to meet or exceed the smoke and fire rating of the respective surface being patched.
 - j) Neatly cut and drill all openings in walls and floors required for the installation. Secure approval of Owner's Representative before cutting and drilling in existing facilities. Neatly patch all openings cut.
 - k) Cutting and patching shall be held to a minimum by arranging with other contractors for all sleeves and openings before construction is started.
 - l) Provide factory-assembled watertight wall and floor seals, of types and sizes required; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body,

neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

- m) Pipe sleeves shall be fabricated from Schedule 40 rigid, heavy wall, full weight galvanized steel pipe; remove burrs. Use sleeves which are two standard sizes larger than conduit passing through respective sleeve.
 - n) Provide sleeve seals for piping which penetrates foundation walls below grade, exterior walls or roofs, caulk between sleeve and pipe with non-toxic, UL-classified caulking material to ensure watertight seal. Elsewhere modular provide mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
 - o) Install standard Schedule 40 black steel pipe sleeves two sizes larger than pipes passing through floors, bearing walls, fire walls and masonry construction. Sleeves through walls shall be cut flush with both faces. Sleeves through floor shall extend one inch above floor top elevation. Pipes penetrating roof shall use a pipe curb assembly equal to Pate Co. Furnish and set all forms required in masonry walls or foundation to accommodate pipes.
5. Grout
- a) Provide non-shrink, nonmetallic grout, premixed, factory-packaged, non-staining, non-corrosive, nongaseous grout, recommended for interior and exterior applications.
6. General Joint Sealer Application
- a) Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
 - b) Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.
 - c) Clean all affected surfaces, joints, etc. immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
 - d) Apply sealant primer to substrates as recommended by manufacturer. Protect adjacent areas from spillage and migration of sealant, using masking tape. Remove tape immediately after tooling without disturbing seal.
 - e) Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - f) Comply with recommendations of ASTM C 962 for use of elastomeric joint sealers.
 - g) Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
 - h) Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
 - i) Colors for exposed seals shall be as selected by the Owner's representative from manufacturer's standard colors.
7. Elastomeric Joint Sealers
- a) One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
 - b) One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and

nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Silicone Sealant shall be equal to the following:

- 1) "Dow Corning 790", Dow Corning Corp.
- 2) "Gesil N SCS 2600", General Electric Co.
- 3) A/D Fire Protection Systems.

8. Acrylic-Emulsion Sealants

- a) One-part, non-sag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications or interior and protected exterior locations involving joint movement of not more than plus or minimum 5 percent. Subject to compliance with requirements, provide one of the following:
 - 1) "Chem-Calk 600", Bostik Construction Products Div.
 - 2) "AC-20", Pecora Corp.
 - 3) "Sonolac", Sonneborn Building Products Div.
 - 4) "Tremco Acrylic Latex 834", Tremco, Inc.

R. (01 74 16 Site Maintenance)

1. During the progress of the work, the Contractor shall clean up after his men and leave the premises and all portions of the building in which he is working in a clean and safe condition. This cleaning shall occur on a daily basis.

S. (01 74 23 Final Cleaning)

1. Clean all parts of the apparatus and equipment. Exposed parts, which are to be painted, shall be cleaned of cement, plaster and other materials and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all corners and cracks scraped out.

T. (01 77 16 Final Closeout Review)

1. Project Closeout

- a) Contractor shall meet all provisions of Substantial completion as defined earlier in this section and in each related section.
- b) Final Payment
 - 1) Final payment of contract will not be made until receipt, review and acceptance, by the owner's representative, of all of the following:
 - i) Substantial Completion
 - ii) Completion of all punch-list items.
 - iii) Approved submittals, including shop drawings;
 - iv) Owner's manuals;
 - v) Record documentation;
 - vi) Certification of warranty;
 - vii) Certificate of final acceptance signed by the Owner and the Owner;
 - viii) Copies of all training sign-in sheets, signed by owner's representative;
 - ix) Signed delivery receipt indicating that the owner has received all training recordings produced to-date;
 - x) All additional applicable closeout provisions of Division 1;
- c) 100% of all closeout documents shall be supplied within 30 calendar days following the substantial completion.

U. (01 77 19 Closeout Requirements)

1. Acceptance Testing

- a) Upon the Designer's receipt of and approval of the Contractor's pre-test submittal, the Contractor shall contract the Designer to schedule acceptance testing. Contractor shall allow not less than 10-business days of advance notice to the Owner.

- b) In the presence of the Owner, the Contractor shall demonstrate the presence of all specified products, cabling and installation methods. The Contractor shall demonstrate the operation of the system (and any requested sub-component thereof) and shall be prepared to make any electronic, physical or software related adjustments to the system or any of its sub-components to the satisfaction of the Owner, as required to achieve full compliance with the specifications.
 - c) The contractor shall have available at the project site all test equipment, cables, tools and personnel necessary to demonstrate full compliance with these specifications as determined necessary by the designer.
 - d) During the acceptance testing the Contractor shall have a clean and fresh copy of the contractor's most up-to-date as-built record documentation, printed to scale.
 - e) This Contractor shall provide all required labor services required to completely verify and test the systems in the presence of the Owner.
 - f) Verify that each system, as a whole system, meets these Specifications and complies with all applicable standards.
 - g) Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense.
 - h) Should the Owner be required to return to the project site to perform acceptance testing more the once for any system the Contractor shall be responsible for all costs, up to \$1500 per day, plus travel and expenses, for each return trip to the project site. Payment of this may be required before final payment will be authorized.
2. Supplemental Engineering Services
- a) This Contractor is responsible for all supplemental engineering services specifically outlined in these specifications and otherwise required for the completion of the work specified. Contractor shall estimate its costs accordingly, taking into account all information provided.
 - b) In the event that the Owner is required to provide additional services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Owner is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Owner's expenses in connection with such additional services shall be paid by the Contractor and may either be deducted from any monies owed to the Contractor, or billed to the contractor, entirely at the discretion of the Owner. The contractor shall be billed at prevailing hourly rates.
 - c) In the event that the Owner is required to provide additional services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Owner is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Owner's expenses in connection with such additional services shall be paid by the Contractor. Costs will be calculated based upon the Owners prevailing rates.
- V. (01 78 13 Completion and Correction List)
- 1. Owner shall be furnished with a certificate of final inspection and approval prior to final acceptance of this branch of the work.
- W. (01 78 36 Warranties)
- 1. Warranty Period
 - a) Specified materials and workmanship provided shall be fully guaranteed by the Contractor for one year from the transfer of title via notice of substantial completion against any defects in materials or workmanship.

- i) Extended (additional) warranty(ies) may be required and will be identified in the individual Specification Section and will be considered additive to this base Contractor Warranty.
 - ii) Requirements for Manufacturer's Warranties, required by a Specification Section, shall run concurrent to this base Warranty by the Contractor but may exceed the Contractor's Warranty Period.
 - 2) Manufacturer's Warranties shall also begin on Substantial Completion; not on purchase of equipment or delivery of equipment to the site.
 - b) The Warranty shall begin upon Substantial Completion.
 - 1) Note: Delivery of closeout documents is not a conditional requirement to commencement of the warranty.
2. This warranty shall in no manner cover equipment that has been damaged or rendered unserviceable due to negligence, misuse, acts of vandalism, or tampering by the Owner or anyone other than employees or agents of the Contractor.
- a) The Contractor's obligation under its warranty is limited to the cost of repair of the warranted item or replacement thereof, at the Contractor's option.
 - b) Insurance covering said equipment from damage or loss is to be borne by the Contractor until full acceptance of equipment and services.
3. Individual specification sections may have additional warranty requirements for the work in that section. The warranty above will cover all materials and work where not covered by an extended warranty listed in the individual specification section.
4. Warranty Coverage
- a) Specified materials and workmanship provided shall be fully guaranteed by the Contractor against any defects in materials or workmanship.
 - 1) Contractor shall provide a full "System Warranty" which shall cover all materials, labor and related product shipping expenses for a period of five years from the date of Owner acceptance.
 - i) Supplied products with manufacturer's warranties of less than the System Warranty term shall be extended by the Contractor for the full specified term
 - 2) During this period the Contractor will remedy (at no cost to the owner) any problem with the system, or any of its related components that is the result of defective materials, settings, workmanship, or loss or programming.
 - 3) Any defective items or work shall be removed and replaced at the Contractor's expense to the satisfaction of the owner's representative and the Owner.
 - 4) During the Warranty Period, the Contractor shall respond by phone within four (4) business hours of notice by the owner of a problem. Within (1) business day or (72) contiguous hours, which ever comes first, the Contractor shall have qualified personnel onsite to remedy the problem if the problem cannot be quickly be remedied over the phone.
 - i) The contractor shall make available to the owner on-call emergency response service labor to the Owner. Cost for emergency service labor during the warranty period shall not exceed the Contractor's published emergency service rates, or two-times its standard rate, whichever is lower.
 - 5) The period of the Contractor warranty(ies) for any items herein are not exclusive remedies, and the Owner has recourse to any warranties of additional Scope given by the Contractor to the Owner and all other remedies available by law or in equity.
 - 6) Additional Warranty requirements may be added by an individual Specification Section.

- i) Scope of these extended (additional) warranty(ies) will be identified in the individual Specification Section and will be considered additive to this base Contractor Warranty.
 - ii) Requirements for Manufacturer's Warranties, required by a Specification Section, shall run concurrent to this base Contractor Warranty by the Contractor.
 - (A) Manufacturer's Warranties shall also begin on Substantial Completion; not on purchase of equipment.
- X. (01 78 39 Project Record Documents)
 - 1. Project Record Document requirements for Division 27 "Communications" shall be described in Section 27 01 00 "Operation and Maintenance of Communications Systems".
- Y. (01 79 00 Demonstration and Training)
 - 1. Training
 - a) Proper operation in many cases is a function of adequate training of key users on new systems.
 - 1) Each Division 27 section may specify special Training requirements.
 - i) Training requirements will be for a quantity of hours, allow for multiple trips.
 - 2) If no special requirements are specified in the individual section, allow for 4 hours and 2 trips to provide basic overview, operation and maintenance information.
 - 3) Each Specification Section will indicate any training criteria specific to that Section.
 - 4) Train Owner's maintenance personnel on the procedures and schedules involved in operating, general troubleshooting, and preventative maintenance of the system.
 - 5) All training sessions shall be audio and video recorded. Recordings shall be supplied in DVD formats and playable on standard consumer grade reproduction equipment. Recordings do not need to be professionally edited but shall have intelligible audio and a clear image of the subject trainer and any supplemental visual content critical to the training.
 - 6) Recordings shall be turned over and signed for by an owner's representative at the end of each training session.
 - 7) Contractor shall require all attendees to sign-in for each training session. The sign-in form shall summarize the training to be conducted, specification section and subsection being trained on, as well as the starting time and duration of training. Following training, a representative of the owner shall sign the form, acknowledging the same. Contractor shall retain the original copy of these forms and turn over a photo copy of the form to the owner's representative as evidence of training. Training conducted without this official record of training shall not be considered as part of the Contractor's training obligation.
 - b) Schedule training with the Owner's representative, at least 14 days in advance.
 - c) Contractor shall assume training will be conducted in a minimum of (2) separate sessions, on non-contiguous days and will require separate trips to the project site, and should be bid accordingly.
 - d) Owner shall have the right to use its allocated training for a period of 365 calendar days following acceptance of the system.

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SECTION 27 01 00 - OPERATION AND MAINTENANCE OF COMMUNICATIONS SYSTEMS

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. Supplementary to Division 1, Refer to Division 27 Section(s) for additive information where applicable.

1.2 SUMMARY

- A. Section Includes:
 - 1. Basic materials, methods and installation guidelines applicable to the installation of all communication systems.
 - a) This Section is a "Common Work Results" Section that includes information that is applicable and "Related" to all Division 27 Sections.
- B. Related Sections
 - 1. All Division 27 Sections.
- C. Related Drawings
 - 1. All Technology (T-Series) Drawings

1.3 RECORD DOCUMENTS FOR COMMUNICATIONS SYSTEMS

- A. The Operations and Maintenance Manual (Owner's Manual) paragraph below details the basic information required to be documented.
- B. Each specification section will detail applicable additional Record Document requirements in the PART I, Submittals paragraph under Close-out documentation.
 - 1. All Record Document information, except for full size floor plans and detail drawings, will be placed in the appropriate location in the Operations and Maintenance Manual described below.
 - 2. Full sized drawing sheets shall be supplied in triplicate and on electronic media.

1.4 OPERATIONS AND MAINTENANCE MANUALS (OWNER'S MANUAL)

- A. Prepare Operations and Maintenance Manuals in accordance with Division 1 Section "Maintenance and Operation." In addition to the requirements specified in Division 1, provide additional information as detailed in each Section and include the following information for equipment items:
 - 1. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions, regulation, control stopping, shutdown, and emergency instructions.
 - 2. Equipment Maintenance Manuals indicating routine preventative maintenance and troubleshooting, disassembly, repair, and reassembly, aligning and adjusting instructions.
- B. Schedule:
 - 1. A review copy of the O&M Manual shall be submitted to the Owner within 2 weeks of substantial completion of the Project.
 - 2. The corrected reproductions of the Manual shall be submitted within 2 weeks of the return of the review copy by the Owner.
- C. Construction

1. Manuals shall be bound in hard cover, 3 ring binder(s) with clear plastic "pocket" covers to insert Project Information on the exterior of the Binder.
2. Maximum individual Binder spine size shall be 3"; utilize multiple binders as required.
- D. Operations and Maintenance Manuals shall include the information listed below and be assembled as follows:
 1. Binder shall be marked on the cover and spine with the following information
 - a) Project Information
 - 1) Title of Project
 - 2) Name and address of Owner, Contractor, and Architect/Engineer
 - 3) Completion date of Project
 - b) Contents of Binder
 2. Section 1:
 - a) Index
 - 1) Provide additional information if multiple binders are utilized.
 3. Section 2 through x (Provide one (1) Tabbed Section for each Specification Section).
 - a) Each Specification Section Tab shall include the following information:
 - 1) Sub Tab 1
 - i) Specification Section Identification
 - 2) Sub Tab 2
 - i) Warranty Information
 - ii) Copy of "Substantial Completion" Document establishing warranty period.
 - iii) Punch List Final Inspection certificate
 - 3) Sub Tab 3
 - i) A listing of all materials and equipment that was submitted for approval shall be bound into this manual separated into individual sections (by the Division 27 Section number) for each system.
 - ii) A List of Drawings included as attachments to the O & M Manual.
 - (A) Full Size drawings shall be submitted with the Manual and a index including sheet Title and Number be placed in this Tab
 - 4) Sub Tab 4
 - i) A copy of the Shop Drawings "Product Information Sheets" for each item required to perform Work as specified
 - (A) Include a copy of the "stamped" and "approved" Product Information Sheets for each product utilized on the Project.
 - 5) Sub Tab 5
 - i) Manufacturer provided information (As Applicable)
 - (A) Installation instructions published by the manufacturer
 - (B) Operating instructions published by the manufacturer
 - (C) Maintenance Manuals furnished with the equipment
 - (1) Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and re-assembly; aligning and adjusting instructions.
 - (2) Parts list pertaining to that equipment
 - (D) Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - (E) Manufacturer's printed operating procedures including start-up, break-in, normal operating instructions, regulation, control, stopping, shutdown, and emergency instructions.

- (F) Emergency operating instructions or a list of service organizations (including addresses and telephone numbers) capable of servicing various parts of the system.
- 6) Sub Tab 6
 - i) Test reports (as applicable)
 - (A) Infrastructure
 - (1) Copper Backbone tests
 - (2) Fiber Optic Backbone Tests
 - (3) Horizontal cable tests
 - (B) Systems
 - (1) As required by the individual Specification Section
 - ii) Summary test reports shall be placed in the O & M manual.
 - (A) Provide an electronic copy (CD-ROM) of all test results
 - (1) Provide "Reader" software on the disk.
 - (B) Provide a single copy of each detailed test.
 - (1) Tests shall be placed in (a) binder(s) in the same order as submitted on the summary reports.
 - (2) Submit with final "Approved" O & M Manual submission.
- 7) Sub Tab 7
 - i) Items listed in individual Division 27 sections and as previously described in the Record Documents paragraph. (Additional Tabs to separate Section(s) requirements.

E. Distribution:

- 1. Provide one review copy for Consultant approval prior to reproduction.
 - a) Consultant will review, correct or approve, and return.
- 2. Provide (5) copies of the complete (corrected) manual.
 - a) Include one printed copy of test results as detailed above.
 - b) Provide 5 copies of all attachments (drawings; electronic test reports, etc.).

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

- A. Record Documents (A.K.A. AS-BUILTS)
 - 1. Shall be prepared as outlined above.
 - 2. Record actual site specific information
 - a) Make arrangements for providing two complete sets of communication prints which shall be used to provide record drawings which shall be separate, clean, prints reserved for the purpose of showing a complete picture of the work as actually installed (including routing of all conduit and cables).
 - b) Drawings shall serve as work progress report sheets and the Contractor shall make any notations, neat and legible thereon daily as work proceeds. The drawings shall be available for inspection at all times and shall be kept at the job at a location designated by the owner's representative.
 - c) Maintain the clean, undamaged set of prints of Contract Drawings as well as a set of submittal drawings and coordination drawings where applicable. Mark the sets to show the actual installation where the installation varies from the Contract Documents as originally shown. Record drawings shall include locations of underground and concealed items if placed other than shown on the Contract Documents. Do not permanently conceal any construction until this required information is recorded. Mark which drawing is most capable of showing conditions fully and accurately. Where shop drawings are used, record a cross-

reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.

- d) Record documents shall show changes in: size, type, capacity, etc., of material device or piece of equipment, location of device or piece of equipment; location of outlet or source of building service systems; routing of piping, conduit, or other building services. These drawings shall also record location of concealed equipment, communication service work, conduits and other piping/work by indication of measured dimensions to each line from readily identifiable and accessible walls or corners of building. Indicate all approved substitutions, contract modifications, and actual equipment and materials installed.
- e) Record documents shall include a detail diagram of all mounting devices and method of rigging those devices to the structure. Record documents shall include plan view drawings indicating cable paths, cable types identified, device identification, riser diagrams, system block diagrams and rack layouts. System block diagrams shall indicate device selection and location in signal flow schematically. Contractor shall provide legend defining all devices and symbols used.
- f) For communication work installed below slabs, pavements, grade, etc., these drawings shall also record location of nearby concealed water piping, sewers, wastes, vents, ducts, conduit and other piping, etc. by indication of measured dimensions to each line from readily identifiable and accessible walls or corners of building and from adjacent communication work. Show inverted elevation of underground communication work relative to work installed by other trades.
- g) Upon substantial completion of the work make arrangements for obtaining a complete set of CAD computer files for the project. All information from the print record drawings shall be neatly drafted/digitized (using pre-established layering system) into the applicable CAD drawing. Neatly erase and redraft work as required to reflect the work as actually installed. Perform drafting in a manner in which all work shall be shown in its actual locations, existing as well as new, by erasing inaccurate locations and redrawing proper routing/locations. This applies for all concealed work as well as work visible. All work shall be performed using AutoCAD Release 2000 or more recent release of AutoCAD.
- h) Affix near the title block on each drawing of the set of record drawing prints the Contractor's Company Names, signature of Contractors' Representative and current date. Deliver one set of prints to the Designer. Deliver the second set of prints, the original reproducibles, the CAD computer files and the marked-up field prints to the architect.
- i) All prints shall be signed and dated by the General Contractor, This Contractor and applicable Subcontractor.
- j) In addition to the above, provide "as-built" record documentation for shop drawings (and coordination drawings where applicable).

END OF SECTION 27 01 00

SECTION 27 05 01 - BASIC MATERIALS AND METHODS FOR COMMUNICATIONS

PART 1 MATERIALS AND METHODS

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. Supplementary to Division 1, Refer to Division 27 Section(s) for additive information where applicable.

1.2 SUMMARY

- A. Section Includes:
 - 1. Basic materials, methods and installation guidelines applicable to the installation of all communication systems.
 - a) This Section is a "Common Work Results" Section that includes information that is applicable and "Related" to all Division 27 Sections.
- B. Related Sections
 - 1. All Division 27 Sections.
- C. Related Drawings
 - 1. All Technology (T-Series) Drawings

1.3 QUALITY ASSURANCE

- A. Welding
 - 1. Welding shall be performed by persons licensed by the authority having jurisdiction where the work is performed. This shall apply to all work which is routinely regulated by said authority.
- B. High Voltage Wiring
 - 1. High voltage wiring and connections shall be performed by persons licensed by the authority having jurisdiction where the work is performed. This shall apply to all work which is routinely regulated by same authority.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 RELATED OPERATIONS

- A. Welding
 - 1. Onsite welding, where it is necessary, shall not be performed without the express written consent of the owner's representative. All project specifications governing welding shall apply, regardless of whether said specifications are referenced within the Division 27 specifications.
- B. High Voltage Wiring
 - 1. Review all high voltage provisions for This Contractor's work with the Division 16 electrical contractor. Coordinate specific device termination, loading and circuiting requirements with the electrical contractor.

3.2 INSTALLATION OF COMMUNICATIONS SYSTEMS

- A. General

1. All work installed in finished areas shall be concealed. All work installed in unfinished areas may be exposed at the discretion of the Owner's representative.
2. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings. Any exceptions to be approved by Owner.
3. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.
4. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
5. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
6. Verify all dimensions by field measurements. Take measurements and be responsible for exact size and locations of all openings required for the installation of work. Figured dimensions are reasonably accurate and should govern in setting out work. Where detailed method of installation is not indicated or where variations exist between described work and approved practice, direction of the owner's representative on job shall be followed.
7. The symbols used to indicate the purpose of which the various outlets are intended are identified in the Legend.
8. If during construction it becomes apparent that certain minor changes in layout will affect a neater job or better arrangement, such alterations shall be made as part of the contract. Owner's review shall be obtained before making such changes.
9. Workmanship throughout shall conform to the standards of best practice. Marks, dents or finish scratches will not be permitted on any exposed materials, fixtures or fittings. Inside of panels and equipment boxes shall be left clean.
10. Use caution not to exceed the allowed bending radius for respective cables and not to compromise the integrity of the cables during installation by pulling cable management devices too tightly, damaging cables, etc. Raceway/Cabling bending radii shall be minimum as directed by cable manufacturer. Use pulling compound or lubricant, where necessary; compound must not deteriorate conductor or insulation.

B. Cable

1. General

- a) Provide color-coded jackets to identify runs of different systems.
 - 1) See related specifications and drawings for applicable color coding.
- b) Neatly route cables parallel, perpendicular and plumb to building architectural lines.
- c) **Neatly comb out multiple cable bundled runs to remove tangling and crossing of cables within the bundles. Neatly dress all cable work and provide vertical and horizontal cable management** (or other approved method) for properly dressing all work at racks, control panels, backboards etc. See detail(s) if applicable.
 - 1) To avoid Alien Crosstalk, do not cinch UTP cables into tight bundles.
- d) Plenum-rated hook and loop one-inch-wide tape shall be used wherever wire ties are permitted and wherever plenum rated cable is used.
- e) Plenum-rated hook and loop one-inch-wide tape shall never be used in a manner that causes deformation of the cable jacket, damage to the cable, or has any adverse affect on the usability, specifications or longevity of the cable(s) on which it is applied.
- f) Plenum-rated hook and loop one-inch-wide tape (Velcro) type wire ties shall be used in plenum spaces; in equipment racks; in rack cabinets, and; in related equipment housing enclosures.

2. Support

- a) All cables shall be supported/anchored every 5 feet (or less) and within 12" of device boxes, outlets, racks/cabinets and cable tray.
- b) Use J-Hook type cable supports for all cables run outside of conduit or cable tray. Bridle rings shall not be used for Communications Technology cables.
- c) Use separate J-Hook cable support systems for cables belonging to different systems and for cables carrying different operating levels. See Cable Separation guidelines in this section.
- d) Loosely secure cables at each J-Hook.
- e) Cables shall not be directly or indirectly supported by a suspended ceiling or any other surface, support, material or structure not permissible for this use by all applicable codes and standards.
- f) Cable trays or messenger strand positioning
 - 1) Used to route cables in hallways
 - 2) Each must have a minimum twelve inches (12") vertical clear space above the top of the cable tray or messenger strand, and a minimum six inches (6") clear space below and on each side of the cable tray or messenger strand.

3. Cable Separation

- a) Cables carrying signals of different nominal operating level shall be kept separated to reduce the risk of undesirable cross-talk interference between cables.
 - 1) As a general rule, for each 25dB of nominal level voltage difference between cables, Contractor shall provide an additional 6 inches of physical separation between the cables. For example: cables with a 25dB voltage difference shall be separated by at least 18 inches. As the difference increases the distance shall increase proportionally.
 - 2) This guideline shall be used to govern the separation of low voltage Communications Technology cabling from AC power circuits as well. For example: A Microphone line running parallel to a 480v power line shall be separated by nearly 27-30 inches.
 - 3) Provide greater separation than this guideline where the contractor believes and/or determines it is necessary to prevent or remedy interference between cables.
- b) Keep length of parallel runs to a minimum. Cross cables of different nominal levels at 90 degrees.
- c) Provide additional separation as necessary to prevent and remedy any crosstalk which:
 - 1) Adversely affects the performance and usability of the system, or;
 - 2) Exceeds specific crosstalk performance specified in individual specifications.
- d) Contractor shall take all precautions necessary to keep low-voltage cable away from sources of EMI and RF interference. Where close proximity is absolutely necessary to satisfactory appearance, performance or installation of the Work, provide all necessary shielding necessary to ensure that ingress interference is minimal and has no negative impact of the Work.

4. Cable Termination

- a) The cables terminating at a device outlet shall be left not less than 10 inches to facilitate installation and servicing of devices. Longer working lengths shall be provided as appropriate to the application.
- b) All termination types shall correctly match the cable and device termination point. Connectors of the appropriate type, size, color and rating shall be used to match with the mating equipment

- c) Tools as recommended by each specific connector manufacturer shall be used in attachment of all connectors.
- d) Spade connectors.
 - 1) Spade type connectors shall be used on cable ends where screw-type terminal connectors are used.
 - i) All spade connectors shall be insulated. Provide heat shrink type insulation where solder-type or non-insulated spade connectors are used.
 - 2) Spade connectors used shall be rated by the manufacturer for the gauge, insulation, type and stranding of the cable to which it is applied. Spade connectors shall be sized to exactly match the stud size and spacing of mating termination connector.
 - 3) Tools as recommended by the specific connector manufacturer shall be used in attachment of the connector to the cable.
 - 4) When spade connectors are the required to be used for audio circuits operating at $\leq +8\text{dBv}$ nominal, solder type spade connectors only shall be permitted.
 - 5) No more than two spade connectors shall be permitted under a single terminal. Fewer should be used when recommended by the specific manufacturer's equipment or connector.
- e) Wire Nuts
 - 1) Wire nuts shall not be used in any audio circuit, except when necessary, in the following:
 - i) 25 Voltage Constant-Voltage loudspeaker circuits.
 - ii) 70 Voltage Constant-Voltage loudspeaker circuits.
 - 2) Wire nuts shall not be used in any data or voice communications or remote-control circuit.
 - 3) Wire nuts shall not be used in any circuit which radiates RF energy.
 - 4) Contractor must advise and gain prior approval of the Owner for any circuit which the Contractor desires to use wirenuts as the means of termination.
- f) Drain Wires, Non-insulated Ground Wires and Shields
 - 1) Drain or non-insulated ground conductors shall be insulated with appropriately sized heat-shrinkable insulated sleeving immediately upon exit from the jacket of the cable. Contractor shall use GREEN colored sleeving unless otherwise necessary to resolve specific color-coding conflicts on a given cable. This methodology shall apply to ALL methods of termination, including inline connectors, device plates, direct equipment terminations etc... Sleeving shall be applied to twisted and braided shields once the internal conductors have been combed out or otherwise removed from the center of the shield.
 - 2) Wherever a cable contains a non-insulated conductor within a jacketed cable, the conductors, as they exit the manufacturer's jacket, shall have a piece of heat shrinkable sleeving applied equally over the jacket and the exposed insulated conductors. The length of this sleeving shall be 1" for all cable diameters of .250" or less. For cables diameters larger than .250" the length of the sleeving shall be approximately equal to 4 times the diameter of the cable jacket. Note: This added sleeving is recommended but not mandatory when cable termination occurs fully within the confines of a fully insulated and strain relieved connector. Black shall be used unless otherwise necessary for specific cosmetic or cable identification purposes.
 - 3) A heat-gun of the appropriate temperature, size, type and rating for shrinking the tubing shall be used as recommended by the manufacturer of the sleeving used. Open flame (i.e. matches, cigarette lighters, torches) and direct metal conduction (i.e. soldering iron) methods to shrink the sleeving

- shall not be permitted. Sleeving which is burnt or otherwise marred shall be removed and replaced.
- 4) There shall not be any non-insulated exposed conductors within a device backbox, junction box, or equipment rack/cabinet.
- g) Unused Conductors
 - 1) Unused conductors shall not be "clipped" or removed from any jacketed cable. Conductors which are not required or used at the end of a jacketed cable shall be kept intact. Conductors shall be fully insulated from one and other to prevent shorts which could occur at either end of the cable. Conductor ends shall also be insulated to prevent shorts to other conductive materials which could come in contact with the conductor.
 - 2) Unused conductors shall be kept the same length as the longest conductor of the cable being used.
 - h) Cable and Conductor Nicks
 - 1) Attention shall be paid to the proper preparation of all cables and all conductors of these cables. There shall not be nicks to cable jackets, conductor insulation, or the conductors themselves.
 - 2) Special attention should be paid to nicked conductors. Should a conductor be nicked during preparation or termination the cable shall be reworked/replaced to remove the nick.
 - i) Cut, Disconnected, or Not Terminated Cables
 - 1) Any voice, data, or coaxial cable that is cut, disconnected, or not terminated at both ends shall be completely removed end to end. Any labels at either end shall be erased. Record drawings shall reflect the removal of these cables.

END OF SECTION 27 05 01

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SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
 - 1. Supplementary to Division 1, Refer to Division 27 Section(s) for additive information where applicable.

1.2 SUMMARY

- A. Section Includes:
 - 1. This Section includes requirements and minimum standards for:
 - a) Raceways
 - b) Fittings
 - c) Boxes
 - d) Penetrations
 - e) Pathway accessories
 - 2. This Section is a "Common Work Results" Section that includes information that is applicable and "Related" to all Division 27 Sections.
 - 3. This Section requires the addition of basic items, not specified elsewhere, to the installation of pathways.
 - a) Add the following to the pathways:
 - 1) Provide a pull rope in each installed pathway and leave a pull rope in the pathway after the cabling is installed.
 - 2) Provide proper identification, labeling, and documentation of key pathway locations and components.
 - 3) All pathways designed for fiber optic cables will require an innerduct for the installation of the fiber optic cable unless interlocking armored cable construction is utilized.
 - 4) Provide cable spillways where cabling will drop out of sleeve(s), unsupported for more than six inches:
- B. Related Sections
 - 1. All Division 27 Sections
- C. Related Drawings
 - 1. Technology (T-Series) Drawings

1.3 REFERENCES

- A. ANSI/TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces.
- B. ANSI/TIA/EIA-606-A – The Administrative Standard for the Telecommunications Infrastructure of Commercial Building.
- C. "TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL" published by the Building Industry Consulting Services International (BISCI).

1.4 GENERAL INFORMATION

- A. NFPA Compliance:
 - 1. Comply with NFPA 70 "National Electrical Code" for components and installation.
- B. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

- C. UL Compliance:
 - 1. Cable tray shall be UL certified.
 - 2. Sleeves shall be UL listed assemblies.
- D. All Work shall fully comply with these Specifications and related Drawings and all manufacturers' recommended installation practices.

1.5 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. The work covered by this Specification Section includes any and all requirements for this type work required for proper installation of work specified in each related Division 27 Specification Section and/or as shown on the Drawings.
 - 1. This Specification Section is a Materials and Methods Section for Division 27. All requirements herein are required by each related Section and will be enforced for each related Section.
 - 2. Pathways for Communications are to be provided to create a re-usable pathway for Communications cables.

1.6 SUBMITTALS

- A. General
 - 1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal. Product Data and Shop Drawings are not to be submitted separately.
 - 2. Samples shall be submitted with or immediately following submission of Product Data submittals.
- B. Items to be submitted for approval prior to commencement of work:
 - 1. Product Data
 - a) Manufacturer datasheets for all items
 - 1) Data sheets shall include
 - i) Manufacturer name
 - ii) Manufacturer model number (as it appears on manufacturer's product data sheet)
 - iii) Manufacturer product description
 - iv) Paragraph number of this section where the product is specified.
 - v) Picture or Drawing of item

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

- A. General
 - 1. Part II is designed to provide the Contractor with a minimum standard of quality and functionality for the products used for telecommunications infrastructure.
 - a) This standard will be considered in force for the original response as well as for any additions or changes to this Project. Due to this, there may be items listed in the "Products" section that are not required under the Scope of this Contract.

2.2 RACEWAYS

- A. Conduits
 - 1. Rigid steel conduit:
 - a) Threaded rigid steel conduit shall be manufactured from mild steel, zinc galvanized both inside and outside including threads. It shall be constructed in accordance with ANSI C80.1, Federal Specification WW-C-581; UL listed.
 - 2. Intermediate metallic conduit:

- a) Threaded intermediate metallic conduit shall be manufactured from mild steel, zinc galvanized both inside and outside including threads. It shall be constructed in accordance with ANSI C80.6, Federal Specification WW-C-581; UL listed.
- 3. Electric metallic tubing:
 - a) Electric metallic tubing shall be manufactured from mild steel, zinc galvanized both inside and outside. It shall be constructed in accordance with ANSI C80.2, Federal Specification WW-C-563; UL listed.
- 4. Flexible metallic conduit:
 - a) Flexible metallic conduit with neoprene jacket shall be spirally wound steel, strip zinc galvanized both inside and outside, integral ground conductor.
 - 1) Unless otherwise indicated, flexible metallic conduit provided for telecommunications cabling can only be provided as a pathway from the telecommunications outlet box to the ceiling space above and cannot exceed 6 meters.
- 5. Non-metallic raceways
 - a) Polyvinylchloride (PVC):
 - 1) PVC conduit shall be virgin C300 type, Schedule 40 or 80 (90° C). It shall be constructed in accordance with NEMA TC2 and Federal Specifications W-C-1094A.
- B. Surface raceways:
 - 1. Single compartment raceway:
 - a) Single compartment electrical ivory raceway as indicated, surface mounted base with cover.
 - 1) Provide appropriate elbows (Panduit RAFC10IW-X), tees (Panduit TFC10IW-X), entrance end fitting (Panduit DCEFXIW-X), etc. to follow wall layout.
 - 2) Standard of quality shall be Panduit Panway LDP-10IW8-A.
 - 3) Additional approved manufacturers: Wiremold, Hubbell
 - 2. Large Single compartment raceway:
 - a) Single compartment electrical ivory raceway as indicated, two piece surface mounted with snap on cover.
 - 1) Provide appropriate elbows, tees, entrance end fitting, etc. to follow wall layout. Provide wire T45WR-X retainers at a minimum of every three feet and as necessary to contain cabling.
 - 2) Standard of quality shall be Panduit Panway T-45.
 - i) Additional approved manufacturers: Wiremold, Hubbell
 - 3. Two compartment raceway:
 - a) Dual channel electrical ivory raceway as shown on the Drawings, two-piece surface mounted with snap on cover, compartment for power, and compartment for data.
 - 1) Provide appropriate elbows, tees, entrance end fittings, etc. as recommended by the manufacturer.
 - 2) Standard of quality shall be Panduit Panway Twin-70.
 - i) Additional approved manufacturers: Wiremold, Hubbell
- C. Telecommunications/power poles:
 - 1. Construction:
 - a) Two compartment.
 - b) 10 foot – 5 inch height and 2 ½ inches x 2 5/16 inch overall width.
 - c) Removable covers.
 - 2. Provide mounting hardware, entrance end fitting, and ceiling trim plate.
 - 3. Standard of quality shall be Panduit Pan-pole.
 - a) Additional approved manufacturer: Wiremold, Hubbell

D. Cable tray:

1. Wall Mounted

- a) Provide cable tray sized and located as indicated on the Drawings.
- b) Cable tray shall comply with NEMA 8B, 12B, or 12C. Cable tray and all fittings and accessories shall effect a complete structural system in the form of a rigid mechanical tray of compatible material and design, functional to support all cabling.
- c) Provide aluminum, rectangular tube, center spine with rungs perpendicular to the spine and spaced 6 inches on center.
- d) Prefabricated structure consisting of a longitudinal rail with transversely connected members (rungs) that project from one side; single or double tiered; aluminum alloy.
- e) Provide gray-colored manufacturer's rung caps on all rungs.
- f) Sections to be joined by bolted splice connectors.
- g) 4 inches overall depth per tier, 6 inches rung spacing.
- h) Rung ends shall be factory bent upward to a height as indicated on the Drawings.
- i) The rungs shall be positioned at the side of the spine at the top such that the spine is not part of the cable laying area (for example see Mono-Systems "top rung" cable tray).
- j) Provide all manufacturer recommended fittings and accessories for a complete and functional system as indicated.
 - 1) Accessories: Provide crosses, tees, angles, wyes, drops, rises, etc., and other accessories required for the installation specified.
- k) Standard of quality shall be Mono Systems 6114-0323 and 9114-0323.
 - 1) Approved manufacturers include: Allied Support Systems, B-Line.

2. Center Hung

- a) Provide cable tray sized and located as indicated on the Drawings.
- b) Cable tray shall comply with NEMA 8B, 12B, or 12C. Cable tray and all fittings and accessories shall effect a complete structural system in the form of a rigid mechanical tray of compatible material and design, functional to support all cabling.
- c) Provide aluminum, rectangular tube, center spine with rungs perpendicular to the spine and spaced 6 inches on center.
- d) Prefabricated structure consisting of a longitudinal rail with transversely connected members (rungs) that project from both sides; aluminum alloy.
- e) Provide gray-colored manufacturer's rung caps on all rungs.
- f) Sections to be joined by bolted splice connectors.
- g) 4 inches overall depth per tier, 6 inches rung spacing.
- h) Rung ends shall be factory bent upward to a height as indicated on the Drawings.
- i) The rungs shall be positioned at the side of the spine at the top such that the spine is not part of the cable laying area (for example see Mono-Systems "top rung" cable tray).
- j) Provide all manufacturer recommended fittings and accessories for a complete and functional system as indicated.
 - 1) Accessories: Provide crosses, tees, angles, wyes, drops, rises, etc., and other accessories required for the installation specified.
 - 2) Provide waterfall fittings in every location that cable is designed to exit the tray downward at the end of a run or between the rungs.
 - 3) Support with threaded rod and U-channel supports systems (See Accessories, Supporting Devices – Field Fabricated)
- k) Standard of quality shall be Mono Systems .
 - 1) Additional approved manufacturers include: Allied Support Systems, B-Line.

E. Telecommunications cabling support: Where necessary, provide additional cable support to create a re-usable pathway for Communications cables:

1. General
 - a) Primary pathways are those supporting the cabling infrastructure from the Equipment Rooms/Telecommunications Rooms through the corridors and chases to the secondary pathways.
 - b) Secondary pathways are those supporting the cabling infrastructure from the primary pathway to telecommunications outlets.
 - c) Cable supporting devices manufactured with small round surfaces (i.e. bridal rings) are not acceptable.
2. Primary pathways
 - a) Messenger Strand
 - 1) Anchors shall be securely mounted to building structure at each end.
 - 2) Tensioners shall be installed to connect strand.
 - 3) Additional supports shall be installed with threaded rod from the deck above to support the strand approximately 6-8" above suspended ceiling in all locations.
 - i) Support with threaded rod and U-channel supports systems (See Accessories, Supporting Devices – Field Fabricated)
 - ii) Properly sized.
 - (A) Multiples of strands (100 horizontal cables each) appropriate to handle the required cable quantities plus 25% spare capacity.
 - (B) Separate strand for Backbone cables.
 - iii) Provide minimum 1/4" steel strand with applicable hardware.
 - b) Open top cable supports
 - 1) Plenum rated
 - 2) Complies with UL, cUL, NEC, and ANSI/TIA/EIA requirements for structured cabling systems.
 - 3) Shall be mounted to building structure or suspended by threaded rod from the deck above approximately 6-12" above suspended ceiling.
 - i) Support with threaded rod and U-channel supports systems (See Accessories, Supporting Devices – Field Fabricated)
 - ii) Properly sized.
 - (A) Multiples of J-Hooks (80 cables each) appropriate to handle the required cable quantities plus 25% spare capacity.
 - (B) Multiples of J-Hooks (300 cables each) appropriate to handle the required cable quantities plus 25% spare capacity.
 - iii) Provide Erico CAT32/CAT64 or approved equal for all primary pathway cable support.
 - iv) Additional approved manufacturers: B-Line, Panduit
3. Secondary pathways (those extending from the primary pathways to the space above the telecommunications outlets).
 - a) J-hooks with galvanized finish to provide smooth surface and corrosion resistance.
 - b) Complies with UL, cUL, NEC, and ANSI/TIA/EIA requirements for structured cabling systems.
 - c) Accommodates up to 16 horizontal UTP cables.
 - d) Shall be mounted to building structure or suspended by threaded rod from the deck above approximately 6-12" above suspended ceiling.
 - 1) Support with threaded rod and U-channel supports systems (See Accessories, Supporting Devices – Field Fabricated)
 - e) Standard of Quality shall be Erico CAT12xx/CAT21xx
 - 1) Additional approved manufacturer(s): B-Line, Panduit

4. Small Secondary pathways
 - a) Mounting for up to ten 4 pair UTP cables may be supported from ceiling grid support wires (at least every 5').
 - b) Standard of quality shall be Erico CAT12TS
 - 1) Additional approved manufacturer(s): B-line, Panduit

2.3 FITTINGS

- A. Rigid steel or intermediate metallic conduit:
 1. Fittings shall be threaded zinc galvanized steel.
 2. At least one bushing shall be grounding type
 - a) Equipped with a ground lug
 - b) Provide on each conduit or sleeve where surface extends below ceiling line.
- B. Electric metallic tubing:
 1. Fittings shall be compression type.
 2. At least one bushing shall be grounding type
 - a) Equipped with a ground lug
 - b) Provide on each conduit or sleeve where surface extends below ceiling line.
- C. Flexible metallic conduit:
 1. Fittings shall be suitable for the specific application.
 2. Use oil-tight fittings with neoprene jacketed flexible metallic conduit.
- D. Non-metallic conduit:
 1. Fittings shall be of the same type and manufacturer as the raceway, connected in accordance with manufacturer's written instructions.
- E. Expansion:
 1. Expansion fittings shall be of a type suitable for the particular condition and shall be complete with bonding jumper.

2.4 BOXES

- A. Box Eliminator devices
 1. Standard outlet size brackets that securely clamp to drywall.
 2. Available in single and dual gang sizes.
 3. Standard of quality shall be Caddy by Erico MP-1
 - a) Additional approved manufacturer(s):
- B. Floor Boxes
 1. Shall be utilize only with prior Owner approval
 2. FSR type boxes; see Division 26 specifications for exact sizing.
 3. Separate Telecommunications and Electrical compartments.
 4. A minimum of two 1" conduits or a 1 1/4" conduit for Communications cables.
- C. Outlet boxes:
 1. General:
 - a) Stamped steel, code gauge, galvanized, minimum 2 1/2 inches deep.
 - b) Provide single or double gang outlet boxes as indicated in details on the Drawings.
 2. In masonry or tile walls:
 - a) Rectangular boxes, 4" square, with square corners minimum 2 1/2 inches deep where the box is at the end of the run.
 - 1) Provide 1" deep single or 2 device trim ring.

- b) Rectangular boxes, 4 11/16" square, with square corners minimum 2 1/2 inches deep where the box is in a continuing run.
 - 1) Provide 1" deep single or 2 device trim ring.
 - 3. In gypsum board walls
 - a) Single and dual gang outlet boxes with a depth of 3 to 3.5".
 - 4. Surface mounted and exterior use:
 - a) Single or dual gang Cast aluminum boxes with threaded hubs
 - 5. No through-wall boxes or utility boxes will be accepted.
 - 6. Where surface raceway is indicated, provide outlet boxes designed for use with the raceway by the same manufacturer as the surface raceway.
- D. Junction boxes:
- 1. Covers shall be screw attached (unless otherwise noted on the drawing) and of same type of material as the box. All covers shall be easily accessed.
 - 2. Boxes in exterior or moist locations shall meet NEMA 3R (at minimum)
 - a) The box must meet the NEMA requirements for the atmospheric condition in which the box is installed.
 - 3. Surface raceway boxes
 - a) Where surface raceway is indicated, provide junction boxes by the same manufacturer as the surface raceway.
- E. Pull boxes:
- 1. Required after every 100' or after 180 degrees of bends in a conduit run
 - 2. Shall be sized as follows:
 - a) One 4" conduit straight through pull:
 - i) 15" wide, 60" long, and 8" deep; minimum.
 - ii) Add 8" to the width for each additional conduit.
 - iii) Information about other trade sizes; reference EIA/TIA 569 standard.
- F. Splice boxes:
- 1. Required after every 100' or after 180 degrees of bends in a conduit run
 - 2. Used to hold splice hardware.
 - 3. Shall be sized as follows:
 - a) One 4" conduit straight through pull:
 - i) 42" wide, 66" long, and 11" deep; minimum.
 - ii) Add 7" to the width for each additional conduit.
 - iii) Information about other trade sizes; reference EIA/TIA 569 standard.
- G. Poke-thru systems:
- 1. Assembly consisting of disposable plate, barriered raceway, conduit adaptor, housing, base, barrier, and faceplate.
 - a) Provide Wiremold RC900-FF3 series multi-service poke-thru with 341-H/B assembly and FP2R faceplates as indicated.
 - 1) Additional approved manufacturers: Hubbell, Walker

2.5 ACCESSORIES

- A. Pull wires:
- 1. Pull wires shall be nylon type as manufactured by Arnco or approved equal.
 - 2. Provide in all empty conduits, sleeves, raceways, and all cabling pathways for future use.
 - a) Additional approved manufacturers: Greenlee, Condux
- B. Fiber optic innderduct:
- 1. NEMA TC 5, UL listed, corrugated, specifically designed for optical fiber cable pathways.

- a) Fiber optic innerduct shall be orange in color
 - b) Innerduct shall be 1-inch minimum inside diameter, and a minimum pulling strength of 600 pounds.
 - c) Each innerduct shall include a factory installed pull rope
 - d) Each duct shall be suited for the environment in which it is installed.
 - e) Standard of Quality shall be Carlon DF4X1C-xxxx for installation in Riser rated applications; and, Carlon CF4X1C-xxxx for installation in Plenum environments.
 - 1) Additional approved Manufacturers: Arnco, Endot, Opti-Com, Pyramid
- C. Cable spillways
- 1. Provide Bejed BJ-2049B-002 Spillway on four-inch sleeves; provide Bejed BJ-2049A-001 Cable Spillway on two-inch sleeves.
 - a) Additional approved manufacturers: B-Line, Panduit
- D. Labels
- 1. Standard of quality shall be Brady
 - a) Additional approved manufacturers: Panduit, Hellerman-Tyton
- E. Penetrations through floors and walls
- 1. Sleeves through floors and walls:
 - a) All penetrations through floors or walls to allow Division 27 cable or pathway to pass through will require a UL listed device for the purpose of penetrating the construction.
 - b) Penetrations through walls of spaces utilizing a chemical or pressure system for fire suppression must utilize Wiremold FS series penetration unless an alternate assembly is pre-approved by the Owner.
 - c) Refer the Penetration Sectional View Drawings for UL listed assemblies.
 - 1) Concrete, block, brick, and gypsum drywall construction providing a fire rating of greater than one hour for walls and floors will require a UL rated sleeve assembly installed to manufacturer's requirements allowing the penetration(s) to not degrade the designed fire rating of the wall or floor.
 - i) Standard of quality shall be as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's Threaded Penetrator system for all fire-rated penetrations.
 - ii) Additional approved manufacturers : Specified Technologies E-Z Path, Wiremold FS Series
 - 2) All other penetrations and gypsum drywall constructed walls providing a fire rating of one hour or less will require a UL rated sleeve assembly installed to manufacturer's requirements allowing the penetration(s) to not degrade the designed fire rating of the wall or floor.
 - i) Standard of quality shall be as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's Smooth Penetrator system for all fire-rated penetrations.
 - ii) Additional approved manufacturers : Specified Technologies E-Z Path, Wiremold FS Series
 - 3) All penetrations found to be improperly sleeved after the installation of cabling will be sleeved and firestopped to restore the proper aesthetics and required fire rating to the obstruction.
 - i) Standard of quality shall be as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's split-sleeve system for all fire rated penetrations.
 - d) Penetrations into fire rated walls with gypsum board construction.
 - 1) All penetrations required in gypsum board walls for installation of horizontal cabling, where conduit is not stubbed into the ceiling cavity for this purpose,

will require a sleeved penetration through the drywall membrane or the wall cap.

- i) Each penetration will require a UL listed sleeve assembly installed by an installer trained on proper installation of the sleeving device.
 - ii) Standard of quality shall be as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's Membrane Penetrator or Cap Penetrator system for all fire rated penetrations.
 - iii) Additional approved manufacturers : Specified Technologies E-Z Path, Wiremold FS Series
- 2) Standard of quality shall be Unique Fire Stop Products.
- i) Additional approved manufacturers : Specified Technologies E-Z Path, Wiremold FS Series

F. Supporting devices – Field Fabricated:

1. General

- a) Shop or field-fabricated supports or manufactured supports assembled from U-channel components.
- b) Steel brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- c) All steel components utilized to fabricate supports shall be of U.S. manufacture.

2. Coatings:

- a) Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.
- b) Where possible, supports shall have a finish similar to the device it is supporting.
 - 1) Where installed below the finished ceiling line, the support shall be painted to match the finish of the device it is supporting.

3. Material Types

- a) Concrete and masonry anchors:
 - 1) Shall be a guaranteed anchoring system with field training available.
 - i) Standard of quality will be as manufactured by Hilti or approved equal.
 - ii) All onsite personnel performing this work will be required to be manufacturer trained on the anchoring system being utilized, and upon request, to show proof of manufacturer's training certification.
- b) Raceway supports:
 - 1) Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- c) Fasteners:
 - 1) Types, materials, and construction features as follows:
 - i) Expansion anchors:
 - (A) Carbon steel wedge or sleeve type
 - ii) Toggle bolts:
 - (A) All steel springhead type
 - iii) Powder-driven threaded studs:
 - (A) Heat-treated steel, designed specifically for the intended service
- d) Conduit sealing bushings:
 - 1) Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- e) Cable supports for vertical conduit:

- 1) Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- f) Threaded Rod Stock (All-Thread Rod)
 - 1) Available in 1/4", 3/8", 1/2", and 5/8" sizes.
 - i) Utilize 1/2" for supporting of 12" ladder racks and cable trays.
 - ii) Utilize 5/8" for supporting of 24" ladder racks and cable trays.
 - 2) Rod lengths over 6' will require a "Rod Stiffener" installation for 1/2" and 5/8" rods.
 - i) A section of U-Channel stock is placed around the rod and stiffener clamp assemblies used to clamp to rod
 - (A) Place clamps a minimum of 6" from the top and bottom of the rod and every 18" in between.
 - (B) Standard of quality shall be B-Line SC228
 - (1) Additional approved manufacturer(s): Unistrut Diversified Products, GS Metals Corp., Haydon Corp., Kin-Line Inc.
- g) U-channel systems:
 - 1) 16-gauge steel channels, with 9/16 inch diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.
4. Slotted metal angle and U-channel systems:
 - a) Standard of quality shall be Unistrut Diversified Products
 - 1) Additional approved manufacturers: Allied Tube & Conduit, American Electric, B-Line Systems, Inc., Cinch Clamp Co., Inc., GS Metals Corp., Haydon Corp., Kin-Line Inc.

PART 3 EXECUTION

3.1 GENERAL

- A. Minimum raceway size shall be as necessary to comply with fill ratio of referenced standards, but in no case less than one and one quarter inch (1 1/4 inch).
- B. Provide specified pull wires in all cabling pathways.
- C. Ground and bond all systems in accordance with the NEC and ANSI/TIA/EIA 607.
- D. All installation material and practices shall fully comply with NFPA 70 "National Electrical Code" and ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces.
- E. Coordinate work with the building structural systems and electrical installation.
- F. All work shall fully comply with these Specifications and related Drawings and all manufacturers' recommended installation practices.

3.2 PATHWAY INSTALLATION

- A. Raceways
 1. Conduit Usage:
 - a) Rigid Galvanized Steel (GRC):
 - 1) All exposed conduit installed above grade outside the building envelope.
 - 2) All conduits installed in moist locations.
 - b) Electric Metallic Tubing (EMT):
 - 1) All conduits within the building envelope.
 - c) Polyvinylchloride (PVC):

- 1) Underground which may continue from underground through floor slab to Equipment Room/Telecommunications Room.
- d) Flexible Metal Conduit (FMC):
 - 1) Unless otherwise indicated, FMC can only be provided for secondary pathways from the ceiling space to the telecommunications outlet box.
 - 2) Maximum length shall not exceed 6 meters.
2. Conduit installation:
 - a) Provide all conduit terminations with locknuts and bushings. Provide conduits 1 ½ inches and larger with insulating bushings and locknuts inside and outside the enclosure.
 - 1) At least one bushing per conduit shall be grounding type
 - i) Equipped with a ground lug
 - ii) Provide on each conduit or sleeve where surface extends below ceiling line and install Bonding Conductor to TMGB.
 - b) Support conduits by pipe straps or trapeze hangers. Space supports not more than 8 feet on center. Secure supports by means of toggle bolts, inserts or expansion bolts.
 - c) Space wall brackets supporting conduits not more than 4 feet 6 inches on center. Secure supports by means of toggle bolts, inserts or expansion bolts.
 - d) Support conduits directly from structural systems not from ceiling suspensions systems.
 - 1) Provide additional support at junction or pull boxes.
 - e) Wherever possible, conceal raceways under floors, in walls, above ceilings or in furred spaces in finishes areas.
 - f) Support single conduits 1 ½ inches and larger by means of rod and cast ring hangers. Support multiple runs in similar manner or use common trapeze hanger.
 - 1) Trapeze hanger:
 - i) Unistrut P2000 or P4000, or equal by Allied Support systems or Superstrut, as required for span and loading.
 - ii) Provide end caps on hangers.
 - iii) Fasten conduits by means of heavy galvanized straps.
 - g) Provide two hole sheet metal pipe straps for all surface mounted conduit supports on walls up to a height of 8 feet above the finished floor. Pinch type hangers similar to minerallac type may only be used at heights greater than 8 feet.
 - h) Protect conduits during construction with temporary plugs or caps. Securely cap all conduit until wire or cable is installed.
 - i) Minimum conduit size is 1 inch.
 - j) Do not install conduit in concrete slab.
 - k) Provide expansion fittings where raceway crosses the building expansion joints. (O.X. Type AX, EX, EXDS, TX, EXE, or approved equal).
 - l) Route and maintain conduits as shown on the Drawings.
 - 1) If no specific routing information appears on the Drawings, the routing shown shall be considered diagrammatic.
 - i) In such a case, the Contractor shall coordinate his Work with the different trades so that interferences between conduit, cable tray, piping, equipment, architectural, and structural work shall be avoided.
 - (A) Should an interference arise, the Contractor shall inform the Consultant before proceeding with the Work.
 - (B) Should the Contractor fail to contact the Consultant and interferences develop, the Owner's Representative will decide which equipment, piping, etc. must be replaced, regardless of which was installed first. The relocation shall be performed at no expense to the Owner.

- m) There shall not be more than the equivalent of 180 degrees of bends in any single run of conduit between adequately sized pull.
 - n) Conduit bends
 - 1) Bends shall be made so that the conduit will not be flattened or kinked and the internal diameter of the conduit will not be reduced.
 - 2) The radius of the curve of the inner edge of any bend shall not be less than as indicated by the National Electrical Code and ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 3) In no case shall any conduit be bent or any fabricated elbow be applied to less than the allowable bending radius as specified by the cable manufacturer of the installed conductor.
 - 4) When necessary to make field bends, use tools designed for conduit bending.
 - i) Heating of metallic conduit to facilitate bending is not permitted.
 - o) A conduit run shall not be longer than 100' between pull boxes for conduit runs inside a building.
 - p) The Contractor shall not cut, burn, or drill any structural member to mount electrical equipment or to facilitate tray or conduit installations without having previously received approval, in writing, from the Architect/Engineer/Consultant.
 - q) Mount all conduits a minimum of 7 inches above any accessible type ceiling.
 - r) Maintain conduit runs at least 6 inches from insulated pipes, steam lines or any other hot pipes they pass. Where the lines are not insulated, the clearances shall be increased until the temperature of the conduit, with no live conductors enclosed, does not rise above the ambient temperature of the installation area.
 - s) Conceal all raceways except where otherwise indicated.
 - 1) Provide flashing and counter-flashing or pitch pockets for waterproofing of all raceways, outlets, fittings, etc. that penetrate the roof.
 - 2) Route all raceways parallel or perpendicular to the building lines with symmetrical bends.
 - 3) Provide sleeves in forms for new concrete walls, floor slabs, and partitions for passage of raceways.
 - i) Seal in an approved manner all raceway openings and sleeves through fire rated walls, floors, and ceilings after raceway installation.
 - t) Waterproof all sleeved raceways where required.
- B. Surface Raceway
- 1. Surface raceway installation
 - a) Provide surface raceways as indicated.
 - b) Coordinate installation with casework before installation. Field verify lengths to be installed before ordering equipment.
 - c) Install plumb and level.
 - d) Anchor all raceways to walls with the anchors designed for that particular wall construction. Secure raceway at a minimum of every 2 feet and not less than 6 inches from raceway ends.
 - e) Install raceway per the manufacturer's written recommendation, including necessary entrance, end and bend fittings.
 - f) Provide all of the manufacturer's recommended fittings and accessories.
 - g) Where surface raceway is provided for a secondary pathway from the outlet to the ceiling space, extend surface raceway into the ceiling space not less than 4 inches.
- C. Telecommunications/power poles
- 1. Mount straight and anchor to building structure above the ceiling line.
 - 2. Provide mounting hardware, entrance end fitting, and ceiling trim plate.

D. Cable Tray

1. Planning

- a) Contractor shall plan entire cable tray system layout and all components required to provide a complete system, verifying dimensions and right-of-way clearances as needed.
- b) Design
 - 1) Wall mounted
 - i) Where 12" capacity is indicated on the drawings a single tiered 12" rung size tray will be utilized.
 - ii) Where 24" capacity is indicated on the drawings a two tiered 12" rung size tray will be utilized.
 - 2) Suspended
 - i) Where 12" capacity is indicated on the drawings a double sided 6" rung size tray will be utilized.
 - ii) Where 24" capacity is indicated on the drawings a double sided 12" rung size tray will be utilized.

2. Coordination and positioning

- a) Coordinate positioning with other trades to assure maximum accessibility.
 - 1) Tray shall be mounted securely along the wall at a minimum of 6" (lower tier) above the ceiling line.
 - i) Where two 12" trays connect to a two tier unit, the upper tray may continue at 12" (upper tier) above the accessible ceiling.
 - ii) Where tray cannot be wall mounted, (transversing hallways, etc.) mount span securely to wall at each end and provide 1/2" threaded rod supports, anchored into the concrete deck above, every 4' at minimum.
 - 2) Minimum access should be 12 inches clear above the tray (each tier) and 12 inches clear beside the tray to facilitate moves, adds and changes for telecommunications cabling.

3. Installation

- a) Cable tray shall be routed as shown schematically by Contract Documents, run level and true to building lines.
- b) Changes in direction, changes in elevation, tees, crosses, and bends shall be made with manufactured fittings and accessories.
- c) Where conduits terminate above a cable tray, the conduit shall be provided with an insulating bushing.
- d) Mounting heights shall be sufficient to clear light fixtures, piping, and equipment and permit ready access through lay-in ceiling grids. Do not install less than 6 inches above ceiling.
- e) Cable tray shall be grounded by a separate stranded #6 AWG copper ground conductor attached to the building grounding electrode system and connected to nearest section of the cable tray with UL approved aluminum/copper termination.
 - 1) See "Grounding and Bonding" specification for further details.
- f) Cable tray shall be installed in accessible area. Provide raceway system of equivalent cross section area of cable tray where ceiling system is not accessible.
- g) Cable tray and all fittings and accessories shall effect a complete structural system in the form of a rigid mechanical tray of compatible material and design, functional to support all cabling.
- h) Transition cable tray system around physical obstructions using manufacturer's recommended turns, sweeps, transition products, and materials to create a complete continuous cabling pathway free of obstructions and maintaining specified clearances.

- i) Where physical discontinuity is necessary, mechanically support cabling over the discontinuity as specified. Bond the ends of the cable tray together electrically over any discontinuity.
 - 1) Fire-wall penetrations shall be made with 4" sleeves (4 per 12" of tray width minimum).
 - i) Utilize requirements of the NFPA NEC to determine correct construction and sizing of wall penetration if tray is to penetrate fire rated wall.
 - 2) Ground and bond the system in accordance with the NEC and ANSI/TIA/EIA 607.
 - 3) Do not use copper fittings or hardware to connect any bonding conductor to aluminum cable tray.
 - j) Provide support for cable trays at a minimum of 4' 6" on center and at all splices, tees, elbows, bends, intersections, and transitions.
 - 1) Support with threaded rod and U-channel supports systems
 - i) 12" width – 1/2" ATR; 24" width – 5/8" ATR
 - 2) Rod lengths over 6' will require a "Rod Stiffener" installation.
 - i) A section of U-Channel stock is placed around the rod and stiffener clamp assemblies used to clamp to rod
 - (A) Place clamps a minimum of 6" from the top and bottom of the rod and every 18" in between.
 - k) Install system free of all sharp edges, burrs, or projections.
 - l) Provide rung caps on rung ends as specified.
 - m) Provide waterfall fittings in every location that cable is designed to exit the tray downward at the end of a run or between the rungs.
 - n) Route parallel and perpendicular to building surfaces.
 - o) Mount cable tray in such a fashion as to be re-usable.
 - 1) Install as straight and flat as practical and perpendicular to building lines.
 - i) Utilize manufactured 45-degree transitions up and down to change elevations.
 - ii) Utilize manufactured 45 or wide sweep 90-degree fittings to change route.
 - (A) Mount cable tray at approximately 6-12" above accessible ceiling.
 - (B) Locate in a position to allow at least 12" clearance on each side of the cable tray for access.
 - 4. Install as a complete system in accordance with manufacturer's installation instructions indicated on the Drawings and to ensure electrical continuity of the system and adequate support for the cabling. Provide all manufacturer's recommended fittings and accessories.
 - 5. Supports shall be attached to building structure.
- E. Messenger Strand
- 1. Anchors shall be securely mounted to building structure at each end.
 - 2. Tensioners shall be installed to connect strand.
 - 3. Additional supports shall be installed with threaded rod from the deck above to support the strand approximately 6-8" above suspended ceiling in all locations.
 - a) Support with threaded rod and U-channel supports systems (See Accessories, Supporting Devices – Field Fabricated)
 - b) Properly sized.
 - 1) Multiples of strands (100 horizontal cables each) appropriate to handle the required cable quantities plus 25% spare capacity.
 - 2) Separate strand for Backbone cables.

F. Open top discreet cable supports (J-Hooks)

1. Primary pathways (corridors, vertical chases, etc.) plenum rated, adjustable cable support that complies with UL cUL, NEC, and ANSI/TIA/EIA requirements for structured cabling systems and accommodates up to 425 horizontal UTP cables or multiples of CAT32 (80 cables each) appropriate to handle the required cable quantities plus 25% spare capacity.
 - a) Install j-hook pathway, supporting at least every 5', as straight as possible perpendicular to building structure at approximately 12" above accessible ceiling.
 - b) Attachment of J-Hooks must be to building structure directly or utilize a minimum of 1/4" all-thread rod anchored into deck above.
2. Secondary pathways (those extending from the primary pathways to the space above the telecommunications outlets) J-hooks with galvanized finish to provide smooth surface and corrosion resistance that complies with UL, cUL, NEC, and ANSI/TIA/EIA requirements for structured cabling systems and accommodates up to 16 horizontal UTP cables.
 - a) Install j-hook pathway, supporting at least every 5', as straight as possible perpendicular to building structure at approximately 12" above accessible ceiling.
 - b) Attachment of J-Hooks must be to building structure directly or utilize a minimum of 1/4" all-thread rod anchored into deck above.
 - c) Exception: Cable routes of less than ten 4 pair UTP (or equivalent weight) may be supported with ceiling grid support wiring when utilizing a support manufactured for that purpose.
 - 1) Must be supported every 5'
 - 2) Cannot interfere with the removal of the ceiling tile
 - 3) Must be installed approximately 12" above ceiling

3.3 BOXES

A. Outlet boxes:

1. Provide outlet boxes flush with the surface unless otherwise noted and properly centered in ceiling tiles, wall finishes, or casework elements. Heights as indicated or to match existing outlet boxes.
 - a) Install all telecommunication video outlet with control for locations indicated to be wall hung TV's or monitors 8 feet above finished floor or 12 inches below finished ceiling, whichever is lower.
2. Provide outlet boxes of a type appropriate for the use and location. Gang adjacent devices in multiple gang boxes under a common finish plate.
3. Boxes shall be securely and rigidly attached and supported plumb, level, and true to building lines by any of the following methods:
 - a) Double bar installation for metal stud walls. Bar hanger punch, mounting clips, and retainer clips shall be used in strict accordance with manufacturer's instructions. Factory pre-punched stud holes shall not be used to support the bar hangers.
 - b) Steel stud installed behind box for support without caddy-type mounting clips for metal stud wall construction.
 - c) Caddy screw gun bracket installed behind box for support. Installation shall be per manufacturer's instructions.
4. Finish plates shall not span different types of wall finishes either vertically or horizontally. Plates shall cover mortar joints and cut openings completely.

5. Outlet, junction, and pull boxes and their covers shall have corrosion protection suitable for the atmosphere in which they are installed. Provide gaskets for all boxes installed outside or in other wet or damp locations (tunnels, crawlspaces, pits, etc.).
 6. Outlet boxes shall be protected from plaster. Debris shall be thoroughly cleaned from the box before installation of conductors.
 7. Floor boxes shall be installed flush and true with the floor.
 8. Finish plates:
 - a) Install a blank coverplate for each new or existing unused outlet box.
- B. Junction and pull boxes
1. Provide junction and pull boxes as indicated in the Contract Documents and as required.
 2. Provide junction and pull boxes in accessible spaces or behind access panels. Boxes located above snap-in or lay-in removable ceilings will be considered accessible.
 3. Provide junction and pull boxes where necessary to facilitate the installation of raceways and pulling of wire or cable.
 4. Provide junction and pull boxes sized in accordance with NEC and installed such that conduit entry will permit the longest radius for conductors contained therein.
 5. Provide junction and pull boxes such that conduits enter and exit across from each other on opposite sides of the junction box. Do not provide junction and pull boxes in place of conduit bends.
 6. Support all such boxes in accordance with the National Electrical Code.
- C. Mounting heights
1. Exceptions:
 - a) At junction of different materials in wall finishes.
 - b) Where outlet would occur in moldings, break in wall surface or unsuitable location in the tile, wood, or similar finish.
 - c) Where outlets would conflict with locations of wall-mounted equipment such as radiators, convectors, unit heaters, etc.
 - d) As noted otherwise.
 - e) Where electrical outlet on that wall is of different height.

3.4 PENETRATIONS THROUGH FLOORS AND WALLS

- A. General:
1. Provide, locate and set sleeves where conduit passes through floors, walls, and other concrete or masonry structural materials except where tunnels, chases or shafts are provided in the constructions.
 - a) Sleeves through poured-in-place concrete floors shall be set before the pour and shall be of a design that will seal against passage of water between sleeves and concrete floor.
 2. Provide bushings on all conduit sleeves.
 3. Extend all wall sleeves a minimum of 2 inches or as required to allow the installation of conduit bushings.
 4. Extend floor sleeves 4-6 inches above finished floors unless otherwise specified.
 5. The void between the sleeve wall and conduit shall be neatly filled with an approved fire stop material.
- B. Quantity and sizing:
1. Penetrations through floors, access through walls of Equipment Rooms and/or Telecommunications Rooms, and obstructions along a backbone or primary horizontal cabling route.

- a) Provide the required quantity of 4-inch sleeve assemblies as specified with a minimum of one 4-inch sleeve. Properly firestop after installation of the telecommunications cabling.
- b) Install sizes and quantities as specifically noted on the prints, or the quantity required so as to accommodate all planned cables, not exceeding a 40 percent maximum fill ratio in each sleeve, plus one spare 4-inch sleeve.
- 2. Penetrations through walls or along secondary horizontal cabling routes.
 - a) Provide a 2 inch or 4-inch sleeve assembly as specified with a minimum of one 2-inch sleeve. Properly fire stop after installation of the telecommunications cabling.
 - b) Install sizes and quantities as specifically noted on the prints, or the quantity required so as to accommodate all planned cables, not exceeding a 40 percent maximum fill ratio in each sleeve, plus one spare 4-inch sleeve.
- C. Construction:
 - 1. All penetrations through floors or walls to allow Division 27 cable or pathway to pass through will require a UL listed device for the purpose of penetrating the construction.
 - a) Concrete, block, brick, and gypsum drywall construction providing a fire rating of greater than one hour for walls and floors will require a UL rated sleeve assembly installed to manufacturer's requirements allowing the penetration(s) to not degrade the designed fire rating of the wall or floor.
 - 1) Each penetration will require a UL listed sleeve assembly installed by an installer trained on proper installation of the sleeving device.
 - 2) Each penetration shall have the accompanying certification paperwork completely filled out and attached to the building structure adjacent to the penetration.
 - 2. All other penetrations and gypsum drywall constructed walls providing a fire rating of one hour or less will require a UL rated sleeve assembly installed to manufacturer's requirements allowing the penetration(s) to not degrade the designed fire rating of the wall or floor.
 - a) Each penetration will require a UL listed sleeve assembly installed by an installer trained on proper installation of the sleeving device.
 - b) Each penetration shall have the accompanying certification paperwork completely filled out and attached to the building structure adjacent to the penetration. A copy of this paperwork will be required in the O & M Manual.
 - 3. All penetrations found to be improperly sleeved after the installation of cabling will be sleeved and firestopped to restore the proper aesthetics and required fire rating to the obstruction.
 - a) Each penetration will require a UL listed sleeve assembly installed by an installer trained on proper installation of the sleeving device.
 - b) Each penetration shall have the accompanying certification paperwork completely filled out and attached to the building structure adjacent to the penetration. A copy of this paperwork will be required in the O & M Manual.
 - 4. All penetrations required in gypsum board walls for installation of horizontal cabling, where conduit is not stubbed into the ceiling cavity for this purpose, will require a sleeved penetration through the drywall membrane or the wall cap.
 - 5. Each penetration will require a UL listed sleeve assembly installed by an installer trained on proper installation of the sleeving device.

3.5 SUPPORTS

- A. General:
 - 1. Coatings

- a) Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.
 - b) Concrete and masonry anchors
 - 1) Shall be a guaranteed anchoring system with field training available.
 - i) All onsite personnel will be required to be manufacturer trained on the anchoring system being utilized, and upon request, to show proof of manufacturer's training certification.
- B. Manufactured supporting devices:
- 1. Raceway supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
 - 2. Fasteners: Types, materials, and construction features as follows:
 - a) Expansion anchors: Carbon steel wedge or sleeve type
 - b) Toggle bolts: All steel springhead type
 - c) Powder-driven threaded studs: Heat-treated steel, designed specifically for the intended service
 - 3. Conduit sealing bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
 - 4. Cable supports for vertical conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
 - 5. U-channel systems: 16-gauge steel channels, with 9/16 inch diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.
- C. Fabricated supporting devices:
- 1. General: Shop or field-fabricated supports or manufactured supports assembled from U-channel components.
 - 2. Steel brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
 - 3. Raceway supports: Comply with the NEC and the following requirements.
 - a) Conform to the manufacturer's recommendations for selection and installation of supports.
 - b) Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs. provide additional strength until there is a minimum of 200 lbs. safety allowance in the strength of each support.
 - c) Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - d) Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - e) Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers for 1 ½ inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use ¼ inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

- f) Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
- g) In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- 4. Miscellaneous supports:
 - a) Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, pull boxes, junction boxes, and other devices.
 - b) Support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- 5. Conduit seals:
 - a) Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- 6. Fastening:
 - a) Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to; conduits, raceways, cables, cable traps, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
 - 1) Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 - 2) Holes cut to depth of more than 1 ½ inch in reinforced concrete beams or to depth of more than ¾ inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 - 3) Ensure that the load applied to any fasteners does not exceed 25 percent of the proof test load. Use vibration-and shock-resistant fasteners for attachments to concrete slabs.
- 7. Raceway supports: Hanger spacing shall be as required for proper and adequate support of raceway, but in no case shall be less than one hanger per 5 feet of raceway length.

END OF SECTION 27 05 28

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SECTION 27 05 50 - FIRESTOPPING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
 - 1. Supplementary to Division 1, Refer to Division 27 Section(s) for additive information where applicable.**

1.2 SUMMARY

- A. Section Includes:
 - 1. This Section is a "Common Work Results" Section that includes information that is applicable and "Related" to all Division 27 Sections.**
 - a) Refer to related Section 27 05 28 "Pathways for Communications Systems" for Sleeving requirements.
 - b) This Section includes firestopping for the following:
 - 1) Penetrations through fire-resistance/-rated floor and roof construction including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.
 - 2) Penetrations through fire-resistance/-rated walls and partitions including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.
 - 3) Penetrations through smoke barriers and construction enclosing compartmentalized areas involving both empty openings and openings containing penetrating items.
 - 4) Sealant joints in fire-resistance/-rated construction.
 - c) Label each firestopped sleeve with the label furnished with the sleeve assembly; each certification label shall be copied and added to the O & M Manual.
 - 2. System includes but is not limited to:**
 - a) Firestopping Compounds
- B. Related Sections
 - 1. All Division 27 Sections**
- C. Related Drawings
 - 1. Technology (T-Series) Drawings**

1.3 GENERAL INFORMATION

- A. Definitions:
 - 1. Firestopping**
 - a) A material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flames, smoke, and/or hot gasses through penetrations in fire-rated wall and floor assemblies.
- B. All Work shall fully comply with these specifications and related Drawings and all manufacturers recommended installation practices.

1.4 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. General:
 - 1. Provide firestopping systems that are produced and installed to resist the spread of fire, according to requirements indicated, and the passage of smoke and other gasses.**

2. **Firestopping may be factory installed in a re-usable sleeve assembly or may be a removable/ re-usable material(s) inserted into a sleeve assembly to provide adequate protection.**
 3. **Refer to related Division 27 Section "Pathways for Communications Systems" for Sleeving requirements.**
- B. Fire stopping requirements/locations are not indicated on drawings. It shall be the responsibility of this contractor to review all architectural and other drawings to determine fire/smoke rated walls and floors and rating requirements of same. This contractor shall provide all required fire stopping work associated with all Division 27 penetrations. Provide fire stop pillows, putty and/or sealant, as applicable, with minimum UL classification for 1 hour fire and cold side temperature ratings.
1. **At a minimum, provide firestopping to equal or exceed the rating of the wall or floor.**
 2. **Provide Fire Stop Putty equal to Nelson FSP #AA400 series, or by 3M Fire Protection Products; Fire Protection Services, Inc.; UL Classified for 3 hour fire and cold side temperature ratings, reusable when penetrating items are removed or added and requiring no special tools, mixing, curing or drying time.**
- C. System Performance requirements:
1. **Provide re-usable firestopping system(s) in all backbone pathway and major horizontal routes.**
 2. **F-rated through-penetration firestop systems:**
 - a) Provide through-penetration firestop systems with F rating indicated, as determined per ASTM E 814, but not less than that equaling or exceeding the fire-resistance rating of the constructions penetrated.
 3. **T-rated through-penetration firestop systems:**
 - a) Provide through-penetration firestop systems with T ratings, in addition to F ratings, as determined per ASTM E 814 where indicated and where systems protect penetrating items exposed to contact with adjacent materials in occupied floor areas. T-rated assemblies are required where the following conditions exist:
 - 1) Firestop systems protect penetrations located outside of wall cavities.
 - 2) Firestop systems protect penetrations located outside fire-resistive shaft enclosures.
 - 3) Firestop systems protect penetrations located in construction containing doors required to have a temperature-rise rating.
 - 4) Firestop systems protect penetrating items larger than a 4-inch (100 mm) diameter nominal pipe or 16 sq. in. (100 sq. cm) in overall cross-sectional area.
 4. **Fire-resistive joint sealants:**
 - a) Provide joint sealants with fire-resistance ratings indicated, as determined per ASTM E 119, but not less than that equaling or exceeding the fire-resistance rating of the construction in which the joint occurs.
 5. **For firestopping exposed to view, traffic, moisture, and physical damage, provide products that do not deteriorate when exposed to these conditions.**
 - a) For floor penetrations with annular spaces exceeding 4 inches (100 mm) or more in width and exposed to possible loading and traffic, provide firestop systems capable of supporting the floorloads involved either by installing floor plates or by other means.
 - b) For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

6. For firestopping exposed to view, provide products with flame-spread values of less than 25 and smoke-developed values of less than 450, as determined per ASTM E 84.

1.5 SUBMITTALS

A. General

1. Product Data and Shop Drawing submittals for work of this section shall be **SUBMITTED TOGETHER**, complete, as a single submittal. Product Data and Shop Drawings are not to be submitted separately.
2. Samples shall be submitted with or immediately following submission of Product Data submittals.

B. Items to be submitted for approval prior to commencement of work:

1. Product Data

- a) Manufacture datasheets for all items
 - 1) Data sheets shall include
 - i) Manufacturer name
 - ii) Manufacturer model number (as it appears on manufacturer's product data sheet)
 - iii) Manufacturer product description
 - iv) Paragraph number of this section where the product is specified.

2. Shop Drawings

- a) System block wiring diagram, detailed.

C. Quality Assurance / Control Submittals

1. RCDD Certification for the staff member responsible for this project.
2. Resume of the last 10 projects of the RCDD responsible for this project
3. BICSI Technician's certificate for each lead Technician(s) on the project

D. Closeout Submittal

1. Manufacturer's Material Safety Data Sheets (MSDS) for each item.
2. Product certificates signed by manufacturers of firestopping products certifying that their products comply with specified requirements.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

A. General

1. This section is designed to provide the Contractor with a minimum standard of quality and functionality for the products used for telecommunications infrastructure.
2. This standard will be considered in force for the original response as well as for any additions or changes to this Project. Due to this, there may be items listed in the Products section that are not required under the scope of this contract.

2.2 FIRESTOPPING, GENERAL

A. Compatibility:

1. Provide firestopping components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by firestopping manufacturer based on testing and field experience.

B. Accessories:

1. **Provide components for each firestopping system required to install fill materials and to comply with “System Performance Requirements” Article in Part 1. Use only components specified by the firestopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire-resistance-rated systems. Firestopping materials shall be asbestos-free and shall not contain flammable solvents. Accessories include but are not limited to the following:**

- a) Permanent forming/damming/backing materials including the following:
 - 1) Semi-refractory fiber (mineral wool) insulation
 - 2) Ceramic fiber
 - 3) Sealants used in combination with other forming/damming materials to prevent leakage of fill materials in liquid state
 - 4) Fire-rated formboard
 - 5) Joint fillers for joint sealants
- b) Temporary forming materials
- c) Substrate primers
- d) Collars
- e) Steel sleeves

C. Applications:

1. **Provide firestopping systems composed of materials specified in this Section that comply with system performance and other requirements.**

2.3 FILL MATERIALS FOR THROUGH-PENETRATION FIRESTOP SYSTEMS

A. Subject to compliance with requirements, provide one or more of the following types:

B. Ceramic-fiber and mastic coating:

1. **Ceramic fibers in bulk form formulated for use with mastic coating and ceramic fiber manufacturer’s mastic coating.**

- a) Standard of quality shall be 3M Fire Protection Products
 - 1) Additional approved manufacturer(s): Thermal Ceramics, FireMaster Bulk, FireMaster Mastic

C. Ceramic-fiber sealant:

1. **Single-component formulation of ceramic fibers and inorganic binders.**

- a) Standard of quality shall be 3M Fire Protection Products
 - 1) Additional approved manufacturer(s): Metacaulk 525, The RectorSeal Corporation

D. Endothermic, latex compound sealant:

1. **Single-component, endothermic, latex formulation.**

- a) Standard of quality shall be 3M Fire Protection Products
 - 1) Additional approved manufacturer(s): Fyre-Shield, Tremco Inc., Flame-Safe FS500/600 Series, International Protective Coatings Corp., Flame-Safe FS900/FST900 Series, International Protective Coating Corp., Cafco TYPS Type 1, Isolatek International, STI LC150, Specified Technologies, Inc.

E. Intumescent, latex sealant:

1. **Single-component, intumescent latex formulation.**

- a) Standard of quality shall be Fire Barrier CP 25WB Caulk, 3M Fire Protection Products
 - 1) Additional approved manufacturer(s): Metacaulk 950, The RectorSeal Corporation, Cafco TPS Type 1, Isolatek International, STI SSS100, Specified Technologies, Inc., Hilti

F. Intumescent putty:

1. **Nonhardening, dielectric, water-resistant putty containing no solvents, inorganic fibers, or silicone compounds.**
 - a) Standard of quality shall be Fire Barrier Moldable Putty, 3M Fire Protection Products
 - 1) Additional approved manufacturer(s): Intumescent Putty, General Electric Co., Flame-Safe FSP1000 Putty, International Protective Coatings Corp., Cafco TPS Types P and EP, Isolatek International, Hilti
- G. Intumescent wrap strips:
 1. **Single-component, elastomeric sheet with aluminum foil on one side.**
 - a) Standard of quality shall be Fire Barrier FS-195 Wrap/Strip, 3M Fire Protection Products
 - 1) Additional approved manufacturer(s): CS2420 intumescent wrap, Hilti Construction Chemicals, Inc., STI SSW Red, Specified Technologies, Inc.
- H. Pillows/bags:
 1. **Reusable, heat-expanding pillows/bags composed of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.**
 - a) Standard of quality shall be Firestop Pillows, Bio Fireshield, Inc.
 - 1) Additional approved manufacturer(s): KBS Sealbags, International Protective Coatings Corp., SSB Pillows, Specified Technologies, Inc., 3M Fire Protection Products
- I. Intumescent collars:
 - a) Standard of quality shall be Cafco TPS Type D, Isolated International
 - b) Additional approved manufacturer(s): STI SSC Collars, Specified Technologies, Inc., 3M Fire Protection Products

2.4 FIRE-RESISTIVE ELASTOMERIC JOINT SEALANTS

- A. Elastomeric sealant standard:
 1. **Provide manufacturer's standard chemically curing, elastomeric sealants for base polymer indicated that complies with ASTM C 920 requirements, including those referenced for type, grade, class, and uses; and requirements specified in this Section applicable to fire-resistive joint sealants.**
- B. Single-component, neutral-curing silicone sealant:
 1. **Type S, Grade NS, Class 25, exposure-related Use NT, and joint-substrate related Uses M, G, A, and (as applicable to joint substrates indicated) O.**
 - a) Additional movement capability:
 - 1) Provide sealant with the capability to withstand the following percentage changes in joint width existing at time of installation, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, and remain in compliance with other requirements of ASTM C 920 for uses indicated:
 - i) 50 percent movement in both extension and compression for a total of 100 percent movement.
 - ii) 100 percent movement in extension and 50 percent movement in compression for a total of 150 percent movement.
- C. Single-component, nonsag, urethane sealant:
 1. **Type S, Grade NS, Class 25, and Uses NT, M, A, and (as applicable to joint substrates indicated) O.**
- D. Products: Subject to compliance with requirements, provide one of the following:
 1. **Single-component, neutral-curing, silicone sealant:**

- a) Dow Corning 790, Dow Corning Corp.
- b) Dow Corning 795, Dow Corning Corp.
- c) Silpruf, General Electric Co.
- d) Ultraglaze, General Electric Co.
- e) Omniseal, Sonneborn Building Products Div. Chem Rex, Inc.
- f) Hilti
- g) FS-One

2. Single-component, nonsag, urethane sealant:

- a) Isoflex 880 GB, Harry S. Peterson Co., Inc.
- b) Isoflex 881, Harry S. Peterson Co., Inc.
- c) Vulkem 921, Mameco International Inc.
- d) Sikaflex-15LM, Sika Corp.
- e) NP-1, Sonneborn building Products Civ., Chem Rex, Inc.

2.5 FIRE STOPPING FOR ALL OTHER WALL AND FLOOR OPENINGS

- A. Provide Fire Stop Sealant shall be equal to Nelson #AA491 series, or by 3M Fire Protection Products; Fire Protection Services, Inc.; UL Classified for 3 hour fire and cold side temperature ratings, non-sagging, permanently flexible, non-toxic, non-shrinking, water/air/smoke-tight and easily re-penetrated. The following shall be considered equal.
 - 1. For Floor Openings: Instant Firestop; 305-SL.**
 - 2. For Wall Openings: Instant Firestop; 344-GG.**
 - 3. Mineral Felt: Instant Firestop; Type MW.**
 - 4. For Insulated Pipes: Instant Firestop; Type PI.**
 - 5. For Fill Areas: Instant Firestop; C-1000.**
- B. Apply sealant primer to substrates as recommended by manufacturer (if any). Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.
- C. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

PART 3 EXECUTION

3.1 PROJECT CONDITIONS

- A. Environmental conditions:
 - 1. Do not install firestopping when ambient or substrate temperatures are outside limits permitted by firestopping manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.**
- B. Ventilation:
 - 1. Ventilate firestopping compounds per manufacturers' instructions by natural means or, when this is inadequate, forced air circulation.**

3.2 SEQUENCING AND SCHEDULING

- A. **Do not cover up those firestopping installations that will become concealed behind other construction until the Architect/Engineer/Consultant has examined each installation**

3.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver firestopping products to the Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multi-component materials.
 - 1. **Coordinate the delivery date of firestopping materials with the scheduled date of installation to minimize amount of storage time required at the Project site.**
 - 2. **Store with a copy of the manufacturer's MSDS sheet.**
 - a) Submit a copy of each sheet to the site manager.
- B. Store and handle firestopping materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.
- C. **Damaged or expired materials shall be removed from the site and shall not be used in the Work.**

3.4 FIRE-TEST-RESPONSE CHARACTERISTICS: PROVIDE FIRESTOPPING THAT COMPLIES WITH THE FOLLOWING REQUIREMENTS AND THOSE SPECIFIED IN THE "SYSTEM PERFORMANCE REQUIREMENTS" ARTICLE IN THIS SECTION.

- A. Firestopping tests are to be performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is an agency performing testing and follow-up inspection services for firestop systems that is acceptable to authorities having jurisdiction.
- B. Through-penetration firestop systems are identical to those tested per ASTM E 814 under conditions where positive furnace pressure differential of at least 0.01 inch of water (2.5 Pa) is maintained at a distance of 0.78 inch (20 mm) below the fill materials surrounding the penetrating items in the test assembly. Provide rated systems complying with the following requirements:
 - 1. **Through-penetration firestop system products shall bear classification marking of qualified testing and inspecting agency.**
 - 2. **Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by UL in their "Fire Resistance Directory," by Warnock Hersey, or by another qualified testing and inspecting agency.**
- C. Fire-resistive joint sealant systems are identical to those tested for fire-response characteristics per ASTM E 119 under conditions where the positive furnace pressure differential is at least 0.01 inch of water (2.5 Pa) as measured 0.78 inch (20 mm) from the face exposed to furnace fire. Provide systems complying with the following requirements:
 - 1. **Fire-resistance rating of joint sealants**
 - a) As indicated by reference to design designations listed by UL in their "Fire Resistance Directory" or by another qualified testing and inspecting agency.
 - 2. **Joint sealants, including backing materials, bear classification marking of qualified testing and inspection agency.**
- D. Where no UL test firestop application exists, manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation.
- E. Firestopping systems and their locations in the Project are not specifically indicated in the Drawings.
- F. It is the sole responsibility of the Firestopping Contractor to install tested and approved systems that comply with all applicable codes, standards and/or agencies having jurisdiction.

3.5 INSTALLER QUALIFICATIONS:

- A. Engage an installer with not less than two years' experience in the installation of firestopping similar in material, design, and extent to that indicated for this Project.

3.6 SINGLE-SOURCE RESPONSIBILITY:

- A. Obtain through-penetration firestop systems for each kind of penetration and construction condition indicated from a single manufacturer.

3.7 PROVIDE FIRESTOPPING PRODUCTS CONTAINING NO DETECTABLE ASBESTOS AS DETERMINED BY THE METHOD SPECIFIED IN 40 CFR PART 763, SUBPART F, APPENDIX A, SECTION 1, "POLARIZED LIGHT MICROSCOPY."

3.8 COORDINATING WORK:

- A. Coordinate construction of openings and penetrating items to ensure that designated through-penetration firestop systems are installed per specified requirements.

3.9 EXAMINATION

- A. Examine substrates and conditions with installer present for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.10 PREPARATION

- A. Surface cleaning:
 - 1. Clean out openings and joints immediately before installation of firestopping to comply with firestopping manufacturer's recommendations and the following requirements:**
 - a) Remove all foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.
 - b) Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
 - c) Remove laitance and form release agents from concrete.
- B. Masking tape:
 - 1. Use masking tape to prevent firestopping from contact with the following:**
 - a) Adjoining surfaces that will remain exposed upon completion of Work.
 - b) Surfaces that would otherwise be permanently stained or damaged by such contact or cleaning methods used to remove smears from firestopping materials.
 - 2. Remove tape as soon as it is possible to do so without disturbing firestopping seal with substrates.**

3.11 GENERAL FIRE STOPPING MATERIAL APPLICATION

- A. Clean all affected surfaces, joints, etc. immediately before applying fire stopping to comply with recommendations of manufacturer.
- B. Comply with fire stop material manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
- C. Install fire stop materials, including forming, packing, and other accessory materials, to fill openings around services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.
- D. Caulk between sleeves and pipes with rockwool and caulk around sleeves with sealing compound. Material must meet all applicable fire ratings required.
- E. Patch shall be equal to rockwool, firestop, caulk or approved "rated" patch.
- F. Where a smoke and/or fire-resistance classification is indicated on architectural drawings or otherwise, provide the following as applicable.

- G. Fire stop pillows, putty and/or sealant with minimum UL classification for 3 hour fire and cold side temperature ratings for all penetrations.
- H. Access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating required; Provide UL Label on each fire-rated access door.
- I. Wall and Floor Opening Fire Stopping for Open Cable Tray or J-Hook Paths
- J. Provide Fire Stop Pillows equal to Nelson FSP #AA500 PLW or #AA501 PLW or by Fire Protection Services, Inc.; 3M Fire Protection Products as required, UL Classified for 3 hour fire and cold side temperature ratings, quickly removable and reusable, non-toxic and requiring no special tools.
- K. Wall & Floor Opening Fire Stopping for Work Likely to Require Ongoing Moves, Adds and Changes
- L. All Work shall comply with manufacturer's written installation instructions.
 - 1. **Seal all holes to ensure a flame/gas/smoke resistant seal.**
 - 2. **Do not permit UL firestop systems to hamper the performance of fire dampers in ductwork.**

3.12 INSTALLING THROUGH-PENETRATION FIRESTOPS

- A. General:
 - 1. **Comply with the "System Performance Requirements" Article in Part 1 and the through-penetration firestop manufacturer's installation instructions and drawings pertaining to products and applications indicated.**
- B. Install forming/damming materials and other accessories of types required to support fill materials during their application and in the position needed to produce the cross-sectional shapes and depths required to achieve fire ratings of designated through-penetration firestop systems. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for through-penetration firestop systems by proven techniques to produce the following results:
 - 1. **Completely fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.**
 - 2. **Apply materials so they contact and adhere to substrates formed by openings and penetrating items.**

3.13 INSTALLING FIRE-RESISTIVE JOINT SEALANTS

- A. General:
 - 1. **Comply with the "System Performance Requirements" Article in Part 1, with ASTM C 1193, and with the sealant manufacturer's installation instructions and drawings pertaining to products and applications indicated.**
- B. Install joint fillers to provide support of sealants during application and at the position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability and develop fire-resistance rating required.
- C. Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint width at optimum sealant movement capability. Install sealants at the same time joint fillers are installed.
- D. Tool nonsag sealants immediately after sealant application and before skinning or curing begins. Form smooth, uniform beads of configuration indicated or as required to produce fire-resistance rating, as well as to eliminate air pockets, and to ensure contact and adhesion of sealants with sides of joint. Remove excess sealant from surfaces adjacent to joint. Do

not use tooling agents that discolor sealants or adjacent surfaces or that are not approved by the sealant manufacturer.

3.14 FIELD QUALITY CONTROL

- A. Do not proceed to enclose firestopping with other construction until examinations are completed.
- B. Where deficiencies are found, repair or replace firestopping at no additional expense to the Owner so that Work complies with requirements.

3.15 CLEANING

- A. Remove excess fill materials and sealants adjacent to openings and joints as Work progresses. Use methods and cleaning materials approved by manufacturers of firestopping products and products in which openings and joints occur. Return all surfaces to their original condition.
- B. During and after the curing period, protect firestopping from contact with contaminating substances and from damage resulting from construction operations or other causes so that they are without deterioration or damage or at time of Substantial Completion.
 - 1. **If damage or deterioration occurs, cut out and remove damaged or deteriorated firestopping immediately and install new materials to produce firestopping complying with specified requirements.**

END OF SECTION 27 05 50

SECTION 27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
 - 1. Supplementary to Division 1, Refer to Division 27 Section(s) for additive information where applicable.

1.2 SUMMARY

- A. Section Includes:
 - 1. Labeling of Communications Systems
 - 2. Labeling of Life Safety and Security Systems
 - a) This Section is a "Common Work Results" Section that includes information that is applicable and "Related" to all Division 27 Sections.
 - 3. System includes but is not limited to:
 - a) Labels
- B. Related Sections
 - 1. All Division 27 Sections
- C. Related Drawings
 - 1. Technology (T-Series) Drawings

1.3 REFERENCES

- A. "TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL" published by the Building Industry Consulting Services International (BISCI).

1.4 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. Furnish and install labeling for all Communication products, including but not limited to:
 - 1. Patch panels
 - 2. Device plates
 - 3. Cabling
 - 4. Equipment racks
 - 5. Building Distribution Frame <BDF>/Entrance Facility <EF>
 - 6. Equipment room(s) <ERxxxx>
 - 7. Telecommunications room(s) <TRxxx>
 - 8. Structured cabling, including horizontal and backbone cabling
 - 9. Communications cabling cross-connects
 - 10. Communications backboards
- B. Labeling system shall be an ANSI/TIA/EIA-606 compliant system - The Administrative Standard for the Telecommunications Infrastructure of Commercial Building Identification System.
 - 1. See Drawings for graphical representation.

1.5 SUBMITTALS

- A. General

1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal. Product Data and Shop Drawings are not to be submitted separately.
2. Samples shall be submitted with or immediately following submission of Product Data submittals.
- B. Product Data
 1. Manufacture datasheets for all labels
- C. Shop Drawings
 1. Labeling system diagram, detailed.
- D. Quality Assurance
 1. RCDD Certificate for the Contractor's staff member(s) with ultimate responsibility for ensuring Contractor compliance with work of this section.
 2. BISCO Technician Certificate for the technicians performing work of this section
- E. Closeout Submittals
 1. A diagram of the labeling scheme used on the Project.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Brady
- B. Panduit
- C. Hellerman/Tyton
- D. Brother

2.2 GENERAL

1. This section is designed to provide the Contractor with a minimum standard of quality and functionality for the products used for telecommunications infrastructure.
2. This standard will be considered in force for the original response as well as for any additions or changes to this Project. Due to this, there may be items listed in the Products section that are not required under the scope of this contract.
3. Products required by the Drawings but not listed in Part 2, will be evaluated as a performance specification based on the information provided on the Drawings.

2.3 LABELS

- A. Labels
 1. Labels shall have a white background and black print.
 2. Provide alphanumeric, clearly typewritten labels at all designated points as follows:
 - a) Horizontal Cables
 - 1) 4 pair UTP cables
 - i) Standard of quality shall be Brady PTL-31-642
 - 2) 4 pair STP cables
 - i) Standard of quality shall be Brady PTL-21-642
 - 3) RG-6 Coaxial
 - i) Standard of quality shall be Brady PTL-31-642
 - b) Telecommunications outlet port
 - 1) Standard of quality shall be Panduit PLL-46-Y2-1
 - c) Telecommunications outlet faceplate:
 - 1) Standard of quality shall be Panduit JLEFPS-1
 - d) Patch panel ports
 - 1) Standard of quality shall be Panduit JLCPL-1

- e) Patch Panels
 - 1) Standard of quality shall be Brady PTL-20-422
- f) Backbone cables
 - 1) 100 pair Copper cables
 - i) Standard of quality shall be Brady PTL-34-642
 - 2) Fiber Optic Cables
 - i) Standard of quality shall be Brady PTL-21-642
 - 3) Cable Bundles
 - i) Standard of quality shall be Brady PTL-12-109
 - 4) 110 style blocks
 - i) Standard of quality shall be Panduit DSL-110
 - ii) Use with Panduit P110LH
 - 5) Telecommunications Backboards
 - i) Standard of quality shall be Brady PTL-37-422
 - 6) Racks and Cabinets
 - i) Standard of quality shall be Brady PTL-42-422

PART 3 EXECUTION

3.1 GENERAL

- A. This section is designed to provide the vendor with a standard of quality and functionality for the installation of technology systems infrastructure. Not all procedures will be necessary for the installation of this Project. However, this standard will be considered in force for the original response as well as for any additions or changes to this Project.
- B. Contractor SHALL work with Owners Telecommunications representative to gain approval of labeling plan BEFORE any cable labeling is started.
- C. Jacks in patch panels shall be installed with room numbers in sequential numerical order and in floor order.

3.2 INSTALLATION

- A. Labels
 - 1. Apply all labels shall be installed parallel to the dominate visual lines of the product being labeled.
 - 2. Labels shall be clearly legible and appropriately sized for the application.
 - 3. Provide alphanumeric, clearly typewritten labels at all designated points as follows:
 - a) See for graphical representation of labeling scheme.
 - b) Horizontal cabling:
 - 1) Cabling to ER/TR from outlets and devices
 - i) ER/TR # - Outlet Room Number - Patch Panel #/Port #.
 - ii) Example: ER01-211-B22 where Equipment Room is identified as ER01, the cable travels to room 211 and the cable is landed on patch panel B position 22 (of 48) in the ER.
 - iii) Locate label on cable jacket between 3 and 6 inches of each end of the cable.
 - 2) Cabling between horizontal outlets/devices
 - i) Label local input cables.
 - ii) Locate label on cable jacket between 3 and 6 inches of each end of the cable.
 - iii) Label each cable as to its signal type, purpose, and destination. Add a numeric suffix to uniquely identify multiple cables of duplicate signal type, purpose or destination.
 - c) Telecommunications outlet ports and faceplates:
 - 1) ER/TR# - Outlet Room Number – Patch panel #/ Jack #.

- 2) Example: ER01-211 faceplate number and B22 through B25 jack numbers for a 4 port faceplate where Equipment Room is identified as ER01, the cable is landed on patch panel B position 22 through 25 (of 48) in the ER and travels to room 211.
- 3) Locate the faceplate label, excluding the jack designation at the top of the faceplate. Locate the individual jack designation numbers immediately above each jack on the faceplate.
- 4) Label local input terminations as follows: F Connector – Camera, RCA yellow – Local Video, RCA white – L Audio, RCA red – R Audio, BNC – Local Video, Horizontal UTP – Local Control.
- d) Patch panels and patch panel ports:
 - 1) Label each patch panel A-Z, top-to-bottom
 - i) Locate label on the front upper left corner of all patch panels
 - 2) Locate on the front of all patch panels, directly above or below (as indicated by the manufacturer) each jack position (1 through 24) in the patch panel; place the room number corresponding to the room number used on the faceplate for each port.
 - 3) Labeling shall be in numerical order and correspond to the telecommunications outlet faceplate scheme.
- e) Backbone cabling:
 - 1) Service designation – ER#/TR#.
 - 2) Service designation – CB = Copper Backbone, FB = Fiber Backbone, VB = Video Backbone. Example: CB – ER01/TR02.
 - 3) Locate label on cable jacket within 6 inches of each end of the cable and at key pull points along pathway.
- f) Cross-connect blocks, 110 style
 - 1) Locate on the front of all patch panels directly above or below (as indicated by the manufacturer) each position in the block.
 - 2) Labeling shall be in numerical order and correspond to the telecommunications outlet faceplate scheme or opposite end labeling dependant on use.
 - 3) Label the upper left corner of each block designating the service of that particular block. Do not terminate mixed services on the same block.
- g) Cross-connect blocks, 66 style
 - 1) Locate on the front of all patch panels directly above or below (as indicated by the manufacturer) each position in the block.
 - 2) Labeling shall be in numerical order and correspond to the telecommunications outlet faceplate scheme or opposite end labeling dependant on use.
 - 3) Label the upper left corner of each block designating the service of that particular block. Do not terminate mixed services on the same block.
- h) Communications Backboards (TBB)
 - 1) Backboard # with the prefix TBB, followed by the numeric backboard number in the room, followed by the suffix identifying the room in which the backboard is located. Example: TBB-01-ER-xxx.
 - 2) Label each 4'x8' sheet and each partial sheet, in numerical order left-to-right as facing the front of the backboards.
- i) Equipment Racks
 - 1) Device ID. Example: ER01 – 02.
 - 2) Label each cabinet/rack in numerical order left-to-right as facing front of cabinet/rack bays.
- j) Telephone Patch Cables
 - 1) Labeled with the same unique identifier at both ends of the assembly.

3.3 TRAINING

- A. Conduct a walk through of the project site and demonstrate the presence and location of all key labeling elements used.
- B. Furnish handouts to all owner personnel attending training that clearly depicts the labeling schema used on the project.

END OF SECTION 27 05 53

ISU Science Rooms 018, 022, 138
Indiana State University
D&A#26057

IDENTIFICATION FOR
COMMUNICATIONS SYSTEMS
27 05 53 - 6
R.E. Dimond & Associates, Inc.

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SECTION 27 08 10 - VERIFICATION TESTING OF STRUCTURED CABLING

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. Supplementary to Division 1, Refer to Division 27 Section(s) for additive information where applicable.

1.2 SUMMARY

- A. Section Includes:
 - 1. The work covered by this Specification Section includes any and all requirements for this type work required for proper Commissioning of work specified in each related Division 27 Specification Section and/or as shown on the Drawings.
 - 2. Provide all labor, materials, tools, field-test instruments and equipment required for the complete testing of the work called for in the Contract Documents.
 - a) This Section is a "Common Work Results" Section that includes information that is applicable and "Related" to all Division 27 Sections.
- B. Related Sections
 - 1. All Division 27 Sections
- C. Related Drawings
 - 1. Technology (T-Series) Drawings

1.3 REFERENCES

- A. All testing procedures and field-test instruments shall comply with applicable requirements of:
 - 1. ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
 - 2. ANSI/EIA/TIA-455-50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
 - 3. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
 - 4. ANSI/TIA/EIA-455-133A, Measurement of Fiber or Cable Length Using an OTDR.
 - 5. ANSI/TIA/EIA-455-61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
 - 6. ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
 - 7. ANSI/TIA/EIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
 - 8. ANSI/TIA/EIA-568-C.1, Commercial Building Telecommunications Cabling Standard,
 - 9. TIA/EIA TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems.
- B. ANSI/TIA/EIA-568-C.2 – Balanced Twisted Pair Telecommunications Cabling and Components Standard
- C. ANSI/TIA/EIA-568-C.3 – Optical Fiber Cabling Components Standard
- D. ANSI/TIA/EIA-568-C.4 – Standard on Coaxial Cabling Components
- E. "TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL" published by the Building Industry Consulting Services International (BISCI).

1.4 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

A. General

1. Testing shall be carried out in accordance with this document.
2. Testing shall be performed on each cabling link (connector to connector).
3. Testing shall not include any active devices or passive devices within the link other than cable, connectors, and splices.
 - a) Link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
4. Contractor shall maintain and provide to ISU a Microsoft Excel spreadsheet in electronic format of all connections installed with the following fields filled out. **NO DATA PORTS WILL BE ACTIVATED UNTIL THIS SHEET IS PROVIDED FULLY FILLED OUT TO OWNER:**
 - a) Room Number
 - b) Jack Label
 - c) Wire label
 - d) IDF Room Number
 - e) Rack Label for patch panel
 - f) Patch Panel label
 - g) Patch panel port
 - h) Cable Length
 - i) Data switch rack label (if connected to data switch)
 - j) Data switch label (if connected to data switch)
 - k) Data switch port number (if connected to data switch)

B. Copper (Twisted Pair) Testing

1. Copper Cat 6A Installation: field test requirements upon completion of the installation
 - a) General Requirements (Category 6A)
 - 1) Every cabling link in the installation shall be tested in accordance with the field test specifications defined in ANSI/TIA/EIA-568B-2.10 "*Transmission Performance Specifications for 4-pair 100Ω Category 6A Cabling*". This document will be referred to as the "TIA Cat 6A Standard."
 - 2) The installed twisted-pair horizontal links shall be tested from the MDF/IDF (ER/TR) in the telecommunications room to the telecommunication wall outlet in the work area against the "*Permanent Link*" performance limits specification as defined in the TIA Cat 6A Standard.
 - 3) One hundred percent of the installed cabling links must be tested and must pass the requirements of the standards mentioned above and as further detailed in Part 3. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation (below).
 - b) Qualifications
 - 1) Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BiCSI or the ACP (Association of Cabling Professionals).
 - c) Coordination/Verification:
 - 1) **A representative of the Owner shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase five business days before testing commences.**
 - 2) A representative of the Owner may elect to select a random sample of 5% of the installed links. The representative (or his authorized delegate) shall test

these randomly selected links and the results are to be stored in accordance with the prescriptions in Section A.3. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the end-user representative **shall repeat 100% testing and the cost shall be borne by the installation contractor.**

C. FIBER OPTIC Testing

1. GENERAL

- a) The testing Tier shall be as indicated on the Detail Drawings.
 - 1) Testing Tiers requirements are as described below.
 - 2) If not otherwise noted:
 - i) All fiber optic Intra-Building Links shall be tested as Tier 1.
 - ii) All fiber optic Inter-Building Links shall be tested as Tier 2.
- b) Every fiber optic cabling link in the installation shall be tested in accordance with the field test specifications defined by the Telecommunications Industry Association (TIA) standards ANSI/TIA/EIA-568-C.1, *“Commercial Building Telecommunications Cabling Standard, Part 1, General Requirements,”* and TIA/EIA TSB140, *“Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems.”*
- c) ANSI/TIA/EIA-568-B.1, defines the passive cabling network, to include cable, connectors, and splices (if present), between two optical fiber patch panels (connecting hardware). The test does not, however, include the performance of the connector at the interface with the test equipment.
- d) 100% of the installed cabling links must be tested and must pass the requirements as specified within this document. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance Part 3.
- e) The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests in Part 3.
- f) A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.

2. Qualifications

- a) Trained technicians who have successfully attended an appropriate training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization.
 - 1) Manufacturer of the fiber optic cable and/or the fiber optic connectors.
 - 2) Manufacturer of the test equipment used for the field certification.
 - 3) Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas)

3. Coordination/Verification

- a) The Owner or the Owner's representative shall be invited to witness and/or review field-testing.
 - 1) **The Owner or the Owner's representative shall be notified of the start date of the testing phase five (5) business days before testing commences.**
 - 2) The Owner or the Owner's representative will select a random sample of 5% of the installed links. The Owner or the Owner's representative shall test these randomly selected links and the results are to be stored in accordance

with Part 3 of this document. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, ***the installation contractor under supervision of the representative shall repeat 100% testing at no cost to the Owner.***

- 3) All tests shall be documented including OLTS dual wavelength attenuation measurements for multimode and singlemode links and channels and OTDR traces and event tables for multimode and singlemode links and channels.
4. Acceptance of test results.

- a) Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in compliance with the following test limits:

- 1) Optical loss testing

- i) Backbone (multimode and singlemode) link

- (A) The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA/EIA-568-B.1.

- (1) Link Attenuation (dB) = Cable_Attn (dB) + Connector_Attn (dB) + Splice_Attn (dB)
- (2) Cable_Attn (dB) = Attenuation_Coefficient (dB/km) * Length (Km)
- (3) Connector_Attn (dB) = number_of_connector_pairs * connector_loss (dB)
- (4) Maximum allowable connector_loss = 0.75 dB
- (5) Splice_Attn (dB) = number_of_splices * splice_loss (dB)
- (6) Maximum allowable splice_loss = 0.3 dB
- (7) The values for the Attenuation_Coefficient (dB/km) are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Multimode 62.5/125 µm	850	3.5	1300	1.5
Multimode 50/125 µm	850	3.5	1300	1.5
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

- ii) Horizontal (multimode) link

- (A) The acceptable link attenuation for a multimode horizontal optical fiber cabling system is based on the maximum 90 m (295 ft) distance.
- (B) The horizontal link may be tested using a fixed upper limit for attenuation of 2.0 dB. This value is based on the loss of two (2) connector pairs, one pair at the telecommunications outlet/connector and one pair at the horizontal cross-connect, plus 90 m (295 ft) of optical fiber cable.
- (C) A horizontal link in an Open Office Cabling network with a consolidation point may be tested using a fixed upper limit for attenuation of 2.75 dB.

- iii) Centralized (multimode) link

- (A) The acceptable link attenuation for a multimode centralized optical fiber cabling system is based on the maximum 300 m (984 ft) distance.
- (B) The centralized link may be tested using a fixed upper limit for attenuation of 3.3 dB. This value is based on the loss of three (3) connector pairs, one pair at the telecommunications

- outlet/connector, one pair at the consolidation point and one pair at the horizontal cross-connect, plus 300 m (984 ft) of optical fiber cable.
- (C) A horizontal link in an Open Office Cabling network with a consolidation point may be tested using a fixed upper limit for attenuation of 4.1 dB.
- 2) OTDR testing
 - i) Reflective events (connections) shall not exceed 0.75 dB.
 - ii) Non-reflective events (splices) shall not exceed 0.3 dB.
 - 3) Magnified endface inspection
 - i) Fiber connections shall be visually inspected for endface quality.
 - ii) Scratched, pitted or dirty connectors shall be diagnosed and corrected.
 - b) All installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described in Part 3. Any link or channel that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation in accordance with Part 3.
 - c) Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

1.5 SUBMITTALS

A. General

- 1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal. Product Data and Shop Drawings are not to be submitted separately.
- 2. Samples shall be submitted with or immediately following submission of Product Data submittals.

B. Equipment Data

- 1. Manufacture datasheets for all twisted pair test equipment
- 2. Manufacturers datasheets for fiber optic field-test instruments including optical loss test sets (OLTS; power meter and source), optical time domain reflectometer (OTDR) and inspection scope as applicable.

C. Quality Assurance / Control Submittals

- 1. RCDD Certification for the staff member responsible for this project.
- 2. Resume of the last 10 projects of the RCDD responsible for this project
- 3. BICSI Technician's certificate for each lead Technician(s) on the project

D. Closeout Submittal

- 1. Copper (Twisted Pair) Test Result Documentation
 - a) The test result information for each link shall be recorded in the memory of the field tester upon completion of the test.
 - b) The test result records saved by the tester shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that these results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test. The popular 'csv' format (comma separated value format) does not provide adequate protection and shall not be acceptable unless specified by the end user.
 - c) The database for the completed job, including twisted-pair copper cabling links if applicable, shall be stored and delivered on USB flash drive. This USB flash drive

shall include the software tools required to view, inspect, and print any selection of test reports.

- d) Circuit IDs reported by the test instrument shall match the specified label ID.
 - e) A copy of the test results shall be provided that lists all the links that have been tested with the following summary information. The copy may be delivered on paper or electronically as specified by the end user.
 - 1) The identification of the link in accordance with the naming convention defined in the overall system documentation
 - 2) The overall Pass/Fail evaluation of the link-under-test
 - 3) The date and time the test results were saved in the memory of the tester
 - f) General Information to be provided in the electronic data base containing the test result information for each link:
 - 1) The identification of the customer site as specified by the end-user
 - 2) The overall Pass/Fail evaluation of the link-under-test
 - 3) The name of the standard selected to execute the stored test results
 - 4) The value of the NVP of the cable installed; used for length calculations
 - 5) The date and time the test results were saved in the memory of the tester
 - 6) The brand name, model and serial number of the tester
 - 7) The revision of the tester software and the revision of the test standards database in the tester
 - g) The detailed test results data to be provided in the electronic database for each tested link must contain the information as set forth in Part 3.
2. Fiber Optic Test Result Documentation
- a) The OLTS and OTDR test result information for each link shall be recorded in the memory of the field tester upon completion of the test.
 - b) The test result records saved by the tester shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that these results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test. The popular 'csv' format (comma separated value format) does not provide adequate protection and shall not be acceptable unless specified by the end user.
 - c) The database for the completed job, including twisted-pair copper cabling links if applicable, shall be stored and delivered on USB flash drive. This USB flash drive shall include the software tools required to view, inspect, and print any selection of test reports.
 - d) Circuit IDs reported by the test instrument shall match the specified label ID.
 - e) A copy of the test results shall be provided that lists all the links that have been tested with the following summary information. The copy may be delivered on paper or electronically as specified by the end user.
 - 1) The identification of the link in accordance with the naming convention defined in the overall system documentation
 - 2) The overall Pass/Fail evaluation of the link-under-test
 - 3) The date and time the test results were saved in the memory of the tester
 - f) General Information to be provided in the electronic data base containing the test result information for each link:
 - 1) The identification of the customer site as specified by the end-user
 - 2) The overall Pass/Fail evaluation of the link-under-test
 - 3) The name of the standard selected to execute the stored test results
 - 4) The value of the 'index of refraction' used for length calculations
 - 5) The date and time the test results were saved in the memory of the tester
 - 6) The brand name, model and serial number of the tester
 - 7) The revision of the tester software and the revision of the test standards database in the tester

- g) The detailed test results data to be provided in the electronic database for each tested optical fiber must contain the following information
 - 1) The identification of the link/fiber in accordance with the naming convention defined in the overall system documentation
 - 2) Tier 1:
 - (A) The insertion loss (attenuation) measured at each wavelength, the test limit calculated for the corresponding wavelength and the margin (difference between the measured attenuation and the test limit value).
 - (B) The link length shall be reported for each optical fiber for which the test limit was calculated based on the formulas above.
 - 3) Tier 2:
 - i) All Tier 1 test results.
 - ii) The overall OTDR loss (attenuation) and length.
 - iii) The OTDR event loss at each wavelength and event location.
 - iv) The OTDR trace at each wavelength.
 - 4) Tier 3:
 - i) All Tier 1 and 2 test results.
 - ii) A picture of the magnified connector endface.
 - iii) The pass status based upon visual inspection.

PART 2 PRODUCTS

A. Copper (Twisted Pair) Test Equipment

1. Category 6A Compliance

- a) The test equipment (tester) shall comply with the accuracy requirements for level III field testers as defined in the TIA Cat 6A Document. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy *plus* adapter contribution) are specified in Table B.2.10 of the TIA Cat 6A Standard.
 - b) The test plug shall fall within the values specified in E.3.2.2 Modular test plug NEXT loss requirements of the TIA Cat 6A Standard.
 - c) The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
 - d) The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
 - e) The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Part 3). Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.
 - f) A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks.
2. Utilize the appropriate test equipment as manufactured by Datacom Technologies, Fluke, MicroTest, Scope, WaveTek, WireScope or approved equal. Print test results from the

test unit used. Documentation shall include meter catalog number, serial number, manufacturer, cable identifier, Equipment Room/Telecommunications Room identifier, cable type, NVP settings, meter readings, test date, calibration information, and operator responsible for tests.

B. Fiber Optic Test Equipment

1. The test equipment shall be within the calibration period recommended by the manufacturer.
2. Fiber optic test jumpers and adapters shall be of high quality and shall not show excessive wear.
3. Optical Loss Test Set (OLTS)
 - a) An OLTS is comprised of two components: an optical light source and an optical power meter. After making a reference measurement, the source and meter are located at opposite ends of the fiber under test. A source and meter may be contained within the same package to enable bi-directional testing without swapping end test equipment.
 - b) Multimode optical fiber light source
 - 1) Provide dual LED light sources with central wavelengths of 850nm (± 30 nm) and 1300nm (± 20 nm).
 - 2) Output power of -20dB minimum.
 - 3) Shall meet the requirements of ANSI/TIA/EIA-526-14A. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50B, Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-B.1) with a Category 1 light source.
 - c) Singlemode optical fiber light source
 - 1) Provide dual laser light sources with central wavelengths of 1310nm (± 20 nm) and 1550nm (± 20 nm).
 - 2) Output power of -10dB minimum.
 - 3) Shall meet the requirements of ANSI/EIA/TIA-526-7.
 - d) Power Meter
 - 1) Provide 850nm, 1300nm, 1310nm and 1500nm wavelength test capability
 - 2) Shall meet the requirements of ANSI/EIA/TIA-526-14A and ANSI/EIA/TIA-526-7.
 - 3) Power measurement uncertainty of ± 0.25 dB.
 - 4) Store reference power measurement.
 - 5) Save at least 100 results in internal memory.
 - 6) PC interface (serial or USB)
 - e) Optional requirements that lead to faster, more efficient testing
 - 1) Dual-wavelength single-adapter light source
 - 2) Dual-fiber automated testing
 - 3) Fiber length measurement using time-of-flight technology
 - 4) Automated loss budget calculation and pass/fail analysis
 - f) Optical Time Domain Reflectometer (OTDR)
 - 1) Shall have a bright, color transmissive LCD display with backlight.
 - 2) Shall have rechargeable Li-Ion battery for 8 hours of normal operation.
 - 3) Weight with battery and module of not more than 4.5lb and volume of not more 200in³.
 - 4) Internal non-volatile memory and removable memory device with at least 16MB capacity for results storage.
 - 5) Serial and USB ports to transfer data to a PC.
 - 6) Multimode OTDR
 - i) Wavelengths of 850nm (± 20 nm) and 1300nm (± 20 nm).

- ii) Event deadzones of 1m maximum at 850nm and 2m maximum at 1300nm.
 - iii) Attenuation deadzones of 6m maximum at 850nm and 15m maximum at 1300nm.
 - iv) Distance range at least 2000m.
 - v) Dynamic range at least 10dB at 850nm and 1300nm.
- g) Optional requirements
 - 1) Integrated OLTS
 - 2) Integrated optical power meter
 - 3) Integrated video microscope
- 4. Fiber Microscope
 - a) Magnification of 250X or 400X for endface inspection
 - b) Optional requirements
 - 1) Video camera and display showing magnified endface image
 - 2) Camera probe tips permitting inspection through adapters
 - 3) Capability to save image
 - c) Standard of Quality Shall be Westover Scientific

PART 3 EXECUTION

3.1 GENERAL

- A. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
- B. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

3.2 COPPER (TWISTED PAIR) TESTING

- A. General
 - 1. Field-test instruments shall have the latest software and firmware installed.
 - 2. Link test results from the Test Equipment shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
 - 3. Testing shall be performed on each cabling segment (panel to connector or connector to connector).
 - 4. Testing of the cabling shall be performed using high-quality test cords of the same Category and manufacturer as the cabling under test.
- B. Performance Test Parameters (Category 6A)
 - 1. The test parameters for Cat 6A are defined in TIA Cat 6A standard, which refers to the ANSI/TIA/EIA-568B-2.10 standard. Test results shall at a minimum show alien attenuation crosstalk ratio far-end (AACRF), alien far-end crosstalk (AFEXT), alien near-end crosstalk (ANEXT), power sum alien attenuation crosstalk ratio far-end (PSAACRF), power sum alien far-end crosstalk (PSAFEXT), and power sum alien near-end crosstalk (PSANEXT).

3.3 OPTICAL FIBER CABLE TESTING

- A. General
 - 1. Field-test instruments shall have the latest software and firmware installed.
 - 2. Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.

3. Fiber endfaces shall be inspected at 250X or 400X magnification. 250X magnification is suitable for inspecting multimode and singlemode fibers. 400X magnification may be used for detailed examination of singlemode fibers. Scratched, pitted or dirty connectors shall be diagnosed and corrected.
 - a) It is preferable that the endface images be recorded in the memory of the test instrument for subsequent uploading to a PC and reporting.
 4. Testing shall be performed on each cabling segment (connector to connector).
 5. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.
 6. Testing of the cabling shall be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length. The test cords for OTDR testing shall be approximately 100 m for the launch cable and at least 25 m for the receive cable.
- B. Performance Test Parameters
1. Three tiers of certification are available that vary in thoroughness of infrastructure analysis.
 - a) Tier 1: optical loss testing
 - b) Tier 2: optical loss and OTDR testing
 - c) Tier 3: optical loss and OTDR testing and magnified endface inspection
 2. Tier 3 certification is recommended unless otherwise specified by the end-user.
 3. Optical loss testing (Tiers 1, 2 and 3)
 - a) Backbone link: The backbone link shall be tested bi-directionally at both operating wavelengths to account for attenuation deltas associated with wavelength. Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation (Section C.3.iv) shall be used to determine limit (acceptance) values.
 - 1) Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A, Method B, One Reference Jumper or the equivalent method.
 - 2) Singlemode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper or the equivalent method.
 - 3) The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA/EIA standard 568-B
 - 4) Link Attenuation (dB) = Cable_Attn (dB)+ Connector_Attn (dB) + Splice_Attn (dB)
 - i) Cable_Attn (dB) = Attenuation_Coefficient (dB/km) * Length (Km)
 - ii) Connector_Attn (dB) = number_of_connector_pairs * connector_loss (dB)
 - iii) Maximum allowable connector_loss = 0.75 dB
 - iv) Splice_Attn (dB) = number_of_splices (S) * splice_loss (dB)
 - v) Maximum allowable splice_loss = 0.3 dB
 - vi) The values for the Attenuation_Coefficient (dB/km) are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km))
Multimode 62.5/125 µm	850	3.5	1300	1.5
Multimode 50/125 µm	850	3.5	1300	1.5

Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

- 5) Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- 6) The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1; or the equivalent method. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.
- b) Horizontal (multimode) link: The acceptable link attenuation for a multimode horizontal optical fiber cabling system is based on the maximum 90 m (295 ft) distance. The horizontal optical fiber cabling link segments need to be tested at only one (1) wavelength. Because of the short length of cabling, attenuation deltas due to wavelength are insignificant. The horizontal link should be tested at 850 nm or 1300 nm in one direction in accordance with ANSI/EIA/TIA-526-14A, Method B, One Reference Jumper method.
 - 1) The horizontal link may be tested using a fixed upper limit for attenuation of 2.0 dB. This value is based on the loss of two (2) connector pairs, one pair at the telecommunications outlet/connector and one pair at the horizontal cross-connect, plus 90 m (295 ft) of optical fiber cable.
 - 2) A horizontal link in an Open Office Cabling network with a consolidation point may be tested using a fixed upper limit for attenuation of 2.75 dB.
- c) Centralized (multimode) link: The acceptable link attenuation for a multimode centralized optical fiber cabling system is based on the maximum 300 m (984 ft) distance. The centralized optical fiber cabling link segments need to be tested at only (1) wavelength. Because of the short length of cabling, attenuation deltas due to wavelength are insignificant. The horizontal link should be tested at 850 nm or 1300 nm in one direction in accordance with ANSI/EIA/TIA-526-14A, Method B, One Reference Jumper method. Testing at 850 nm is recommended unless otherwise specified by the end user.
 - 1) The centralized link may be tested using a fixed upper limit for attenuation of 3.3 dB. This value is based on the loss of three (3) connector pairs, one pair at the telecommunications outlet/connector, one pair at the consolidation point and one pair at the horizontal cross-connect, plus 300 m (984 ft) of optical fiber cable.
 - 2) A horizontal link in an Open Office Cabling network with a consolidation point may be tested using a fixed upper limit for attenuation of 4.1 dB.
- d) Optional requirements:
 - 1) Each horizontal and centralized link shall be tested bi-directionally since the direction of the signal transmission often cannot be predicted at the time of installation. This is especially true for non-polarized connectors.
 - 2) Each horizontal and centralized link shall be tested at both 850nm and 1300nm to confirm no attenuation differences due to wavelength even over short links.
4. OTDR Testing (Tiers 2 and 3).
 - a) Backbone, horizontal and centralized links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
 - 1) Backbone multimode: 850nm and 1300nm
 - 2) Backbone singlemode: 1310nm and 1550nm

- 3) Horizontal multimode: 850nm or 1300nm
 - 4) Centralized multimode: 850nm or 1300nm (850nm recommended unless otherwise specified by the end user)
 - b) Each fiber link and channel shall be tested in one direction.
 - c) A launch cable shall be installed between the OTDR and the first link connection. The launch cable shall be approximately 100m (328ft) in length and of the same fiber type as the link under test.
 - d) A receive cable shall be installed after the last link connection. The receive cable shall be at least 25m (82ft) in length and of the same fiber type as the link under test.
 - e) Reflective events (connections) exceeding 0.75 dB shall be identified, recorded and remedied to be less than 0.75 dB.
 - f) Non-reflective events exceeding 0.3 dB shall be identified recorded and remedied to be less than 0.3 dB. . Non-reflective events shall only be accepted for splices along the cabling. There shall be no losses acceptable for cable bends.
 - g) Optional requirements
 - 1) Bi-directional link testing.
 - 2) Segment attenuation coefficient if segment length > 1000m (3280ft). The segment attenuation coefficient shall not exceed 3.5 dB/km at 850nm and 1.5 dB at 1300 dB. Fibers exceeding these attenuation coefficients shall be replaced.
- 5. Magnified Endface Inspection (Tier 3)
 - a) Fiber connections shall be visually inspected for endface quality. High loss and reflectance can result from improperly terminated, poorly polished or dirty connectors.
 - b) Fibers shall be inspected at 250X or 400X magnification. 250X magnification is suitable for inspecting multimode and singlemode fibers. 400X magnification may be used for detailed examination of singlemode fibers.
 - c) Scratched, pitted or dirty connectors shall be diagnosed and corrected.
 - d) Optional requirements
 - 1) The endface image shall be saved and included in the test documentation package.
- 6. Length Measurement
 - a) The length of each fiber shall be recorded.
 - b) It is preferable that the optical length be measured using an OLTS or OTDR.
- 7. Polarity Testing
 - a) Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with subclause 10.3 of ANSI/TIA/EIA-568-B.1. The polarity of the paired duplex fibers shall be verified using an OLTS.
- C. Performance Test Parameters (OSP Cable)
 - 1. Campus Backbone OSP Fiber Optic cable testing.
 - a) Fiber optic cabling: Test all fiber optic cabling completely in accordance with ANSI/TIA/EIA-568-A, Annex H.
 - 1) All fibers shall be proof tested by the manufacturer at a minimum load of 6000 kPa. All fibers shall be 100 percent attenuation tested by the manufacturer for compliance with the specified performance requirements. Provide manufacturer's test results and performance certification before installation.
 - 2) Perform 100 percent attenuation test on all fiber optic cabling on the reel after receipt and before installation. Submit results to Owner for comparison against manufacturer's certified test results.

- 3) If any test results fail to meet the manufacturer's certified test results or are non-compliant with this Section, the cable shall be rejected.
- 4) Test and document all fiber optic cables from both ends on each terminated strand with a properly calibrated Optical Time Domain Reflectometer (OTDR) as manufactured by Siecor or approved equal. Documentation shall include OTDR catalog number, serial number, manufacturer, strand identifier, meter readings, test date, calibration information, and operator responsible for tests. All OTDR testing shall be fully compliant with ANSI/EIA/TIA-455-8.
- 5) Provide 100 meters of like fiber to project OTDR cable examination beyond the "dead zone."
- 6) Test and record all fiber losses and submit to Owner for approval. Provide all test information on printouts and on electronic files. Perform test as segments of the fiber installation are completed and as directed by the Owner

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SECTION 27 15 13 - COMMUNICATIONS COPPER HORIZONTAL CABLING

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. Supplementary to Division 1, Refer to Division 27 Section(s) for additive information where applicable.

1.2 SUMMARY

- A. Section Includes:
 - 1. Supply and installation of a complete and working Horizontal Cabling Systems for
 - a) Voice / Telephone
 - b) Data / Network
 - 1) Including Data provisions for Other Systems (i.e. Video Surveillance, Access Control, Control Data, Intrusion Detection, etc.).
 - 2. System includes but is not limited to:
 - a) Horizontal cabling.
 - b) Station outlets including frames, connector modules, and cover plates.
 - c) Patch panels
- B. Related Sections
 - 1. All Division 27 Sections
 - 2. Common Work Results
 - a) Division 27 – “Operation and Maintenance of Structured Cabling and Enclosures”
 - b) Division 27 – “Basic Materials and Methods”
 - c) Division 27 – “Grounding and Bonding for Communications Systems”
 - d) Division 27 - “Pathways for Communications Systems”.
 - e) Division 27 – “Firestopping for Communications Systems”
 - f) Division 27 – “Identification for Communications Systems”
 - g) Division 27 – “Commissioning of Structured Cabling”
 - 3. Interrelated Sections
 - a) Division 27 – “Communications Cabinets, Racks, Frames and Enclosures”
 - b) Division 27 – “Communications Cable Management and Ladder Rack”
- C. Related Drawings
 - 1. Technology (T-Series) Drawings

1.3 REFERENCES

- A. ANSI/TIA/EIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises.
- B. ANSI/TIA/EIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
- C. ANSI/TIA/EIA-568-C.2 – Balanced Twisted Pair Telecommunications Cabling and Components Standard
- D. ANSI/TIA/EIA-568-C.4 – Standard on Coaxial Cabling Components
- E. ANSI/TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces.
- F. ANSI/TIA/EIA-606-A – The Administrative Standard for the Telecommunications Infrastructure of Commercial Building.
- G. “TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL” published by the Building Industry Consulting Services International (BISCI).

1.4 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. The system shall be a 4 pair UTP copper Horizontal cabling system.
1. Provide, test, and label all cables and terminations devices as described below and as shown on the plans.
 2. The system shall be an ANSI/TIA/EIA 568-B Category 6A compliant Unshielded Twisted Pair (UTP) horizontal cabling system.
 3. The Horizontal voice cabling systems shall be a Category 6A compliant system.
 4. The Horizontal data cabling system shall be a Category 6A compliant system.
 5. System shall meet or exceed the requirements for the PanGen System Warranty 25-year warranty and shall include the 25-year PanGen System Warranty. Contractor shall provide PanGen System Warranty documentation at project close out. **Or**, cabling manufacturer and/or contractor shall provide a total system warranty equal to or better than the PanGen System Warranty 25-year warranty. System Warranty documentation shall be provided to Owner Telecommunications department at project close out.
 6. See related Drawings for specific Project requirements.
 7. The system shall consist of total connectivity for a complete and permanent installed communications link.
 8. Refer to detail drawings for terminations standards and positioning of termination devices. Provide, test, and label all cables and terminations devices as described below and as shown on the plans.
 9. The cable distance between the termination point with a Communications Room(s) and the station outlet(s) shall be no greater than 90 meters (295 ft).
 10. The total channel distance shall not exceed 100 meters (328 feet) distance between equipment in the Communications room and station equipment, including all patch cables and station attachment cables
 11. All system cables shall be continuous between points of termination, without splices.
 12. All system cables shall be UL/NEC rated for the location, manner and site conditions in which the cables are installed. This includes, but is not limited to:
 - a) Use of the cable rated for the application
 - b) Not exceeding fill capacities of raceways
 - c) All cable used shall be in compliance with Local, State, and Federal laws (at minimum the NFPA published "National Electric Code") as to acceptability for placement in the designed pathway. This includes, but is not limited to, cable fill capacities of raceways and plenum vs. non-plenum construction. **ONLY Plenum station cable shall be installed on the Indiana State University campus.** The Contractor shall provide and install the appropriate cable for the appropriate conditions.

1.5 SUBMITTALS

- A. General
1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal. Product Data and Shop Drawings are not to be submitted separately.
 2. Samples shall be submitted with or immediately following submission of Product Data submittals.
- B. Items to be submitted for approval prior to commencement of work:
1. Product Data
 - a) Manufacture datasheets for all cable
 - b) Manufacture datasheets for all connectors

- 1) Data sheets shall include
 - i) Manufacturer name
 - ii) Manufacturer model number (as it appears on manufacturer's product data sheet)
 - iii) Manufacturer product description
 - iv) Paragraph number of this section where the product is specified.
 - v) Picture or Drawing of item
- C. Quality Assurance / Control Submittals
 1. RCDD Certification for the staff member responsible for this project.
 2. Resume of the last 10 projects of the RCDD responsible for this project
 3. BICSI Technician's certificate for each lead Technician(s) on the project
- D. Closeout Submittal
 1. Communication Room Rack Layouts, drawing to scaled, depicting devices and rack space occupied by each installed component.
 2. A diagram of the labeling scheme used on the Project.
 3. Additional closeout documentation as required in Division 1 and Division 27 "General Requirements for Communications".
 4. Contractor shall provide PanGen System Warranty documentation at project close out. **Or**, cabling manufacturer and/or contractor shall provide a total system warranty equal to or better than the PanGen System Warranty 25-year warranty.

1.6 WARRANTY

- A. Additional requirements: All cabling and connectivity products manufacturers, including patch cords, shall have in place an agreement recognizing each other for complete execution of warranty as specified. All performance and applications warranties shall be channel rated.
 1. The cable manufacturer and the connectivity products manufacturer shall have a partnership agreement established in order to provide the required warranty.
 2. Required warranty:
 - a) The ANSI/TIA/EIA 568-B Proposed Category 6A compliant cable system shall include as a minimum a 25-year PanGen System Warranty. **Or**, cabling manufacturer and/or contractor shall provide a total system warranty equal to or better than the PanGen System Warranty 25-year warranty.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

- A. General
 1. This section is designed to provide the Contractor with a minimum standard of quality and functionality for the products used for telecommunications infrastructure.
 2. This standard will be considered in force for the original response as well as for any additions or changes to this Project. Due to this, there may be items listed in the Products section that are not required under the scope of this contract.
 3. Products required by the Drawings but not enumerated will be evaluated as a performance specification based on the information provided on the Drawings.

2.2 CABLES

- A. General
 1. All cables on this Project shall be color-coded. ***See Detail drawings for color code.

2. CMP (OFNP) and CMR (OFNR) references below are as required by the NEC published by the National Fire Protection Association.
 - a) Cables not specifically identified otherwise, shall be provided with CMP classification.
 - b) Exceptions:
 - 1) Proper cable classification is ultimately determined by building construction; reductions in classification for cables, not clarified or altered by addendum to the specifications, shall require a contract cost deduction through a change order.
- B. Twisted Pair Cables
 1. Electrical Requirements:
 - a) All Twisted Pair cable is required to have the appropriate Category classification as defined by EIA/TIA/ANSI 568C. The compliance to these electrical characteristics must be third party verified by the manufacturer. Part 1 of this specification Section will define the appropriate Category for each cable.
 - b) Recognized Categories:
 - 1) Category 1-2, Category 3, Category 5e, Category 6, Category 6A
 - 2) All requirements and testing parameters as set forth by EIA/TIA 568C.
 2. Construction
 - a) All Twisted pair cable will be properly constructed for the environmental conditions and to meet all applicable codes.
 - b) The following basic construction types are recognized for this Project:
 - 1) Premise Distribution 4 pair Cables - Category 6A
 - i) Fully ANSI/EI/TIA 568C.1 Category 6A compliant
 - ii) Cable shall have 2 individual insulated 24 AWG solid copper conductors formed into a twisted pair.
 - iii) Cable must be constructed of four individually insulated Unshielded Twisted Pairs (UTP)
 - iv) The cable construction must be available in plenum (CMP) and non-plenum riser (CMR) rated constructions.
 - v) This cable construction is used in indoor pathways primarily as horizontal cabling but may also be used as backbone cable.
 - vi) Standard of quality shall be as manufactured by Panduit Cable PUP6AM04BU-UG .
 - (A) Additional approved manufacturer(s):
 - (B) General Cable 7132849
 - (C) CommScope 2091B BLU C6A 4/23 U/UTP W1000 | 760107201
 - (D) Belden 10GXW13
 - (E) Mohawk M59146

2.3 TERMINATION HARDWARE

- A. General
 1. Suggested layout of termination hardware is indicated on the Drawings. Contractor shall coordinate layout of termination hardware with the Owner's Representative before installation.
 2. Provide one single manufacturer for all twisted-pair termination hardware used together in a permanent link or whenever a Category Certification is required.
 3. Termination devices on this Project shall be color-coded. ****See Detail Drawings for details.
 4. Terminate all UTP cabling utilizing the T568B wiring configuration.

5. The manufacturer of the cable and the manufacturer of the connectivity products shall have a partnership agreement established in order to provide the required warranty. See Warranty requirements above and in related Section 27 00 01.00. Contractor shall provide Owner warranty documentation at project close out.

All devices shall be UL listed as required by the NEC published by the National Fire Protection Association.

6. All RJ-45 twisted pair termination devices are required to have the appropriate Category classification as defined by EIA/TIA/ANSI 568B. The compliance to these electrical characteristics must be third party verified by the manufacturer. Part 1 of this specification Section will define the appropriate Category for each cable.

a) Recognized Categories:

- 1) Category 1-2, Category 3, Category 5e, Category 6, Category 6A.
- 2) All requirements and testing parameters as set forth by the latest update to EIA/TIA 568B.

B. Station Outlet

1. The following basic termination devices are available and recognized for this Project.

a) Flush Faceplate – Single Gang

- 1) Sloped faceplate Frame
- 2) Four position minimum on each faceplate
- 3) Electrical Ivory color unless otherwise specified
- 4) May be mounted on an outlet box, bracket, or raceway.
- 5) Must use module inserts below.
- 6) Standard of quality shall be Panduit CFPSL4xxY

b) Quad Jack Frame

- 1) Four position minimum on each frame
- 2) Electrical Ivory color unless otherwise specified
- 3) May be mounted on an outlet box, bracket, or raceway.
- 4) Will require a faceplate with standard duplex electrical outlet cut-out
- 5) Standard of quality shall be Panduit CFG4xx

c) Faceplate Blank Insert

- 1) Provide blanks for all un-used positions in faceplates, surface boxes, or jack frames.
- 2) Color to match outlet faceplate as described above; Electrical Ivory color unless otherwise specified
- 3) Standard of quality shall be Panduit CMBxx-X

d) Wall-Phone Jack

- 1) Stainless Steel faceplate with mounting posts for keyhole slot telephone mounting
- 2) May be mounted on an outlet box, bracket, or raceway.
- 3) Standard of quality shall be Panduit KWP6PY.

e) Category 6A jack insert RJ-45

- 1) Fully compliant ANSI/TIA/EIA 568B Category 6A RJ45 modular jack.
- 2) Color shall be Blue for all locations identified as being voice locations. Color shall be Electrical Ivory for all locations identified as data locations. Coordinate with Owner's Representative or Architect/Engineer.
- 3) Standard of quality shall be Panduit CJ6X88TGxx

C. Communications Room Equipment Rack(s)

1. The following basic termination devices are available and recognized for this Project.

a) UTP Cat 6A Patch Panel 24 port

- 1) Panel shall be black steel with PCB connection between interfaces
- 2) Shall provide 24 ports in 1.75" of rack space (1 RU).
- 3) Must have labeling areas on front and rear

- 4) Fully compliant ANSI/TIA/EIA 568B Category 6A
- 5) RJ45 jack interface on front and 110 style IDC connections on rear
- 6) Mountable in EIA standard 19" rack/cabinet rails.
- 7) Standard of quality shall be Panduit CPPL24WBL 24-Port Modular Patch Panel with Labels fully loaded with Panduit CJ6X88TGBL Category 6A Jack Modules.

PART 3 EXECUTION

3.1 GENERAL

- A. This section is designed to provide the vendor with a standard of quality and functionality for the installation of technology systems infrastructure. Not all procedures will be necessary for the installation of this Project. However, this standard will be considered in force for the original response as well as for any additions or changes to this Project.

3.2 INSTALLATION

- A. Coordination
 1. Review and coordinate proper pathways prior to installation.
- B. General
 1. Cable routing shall follow building structure lines and shall be installed with adequate length to reach to any location within the equipment racks with at least 5 feet of service loop at each end.
 2. At point of final terminations, excess cable and the service loop shall be stored and dressed neatly.
 - a) At the station end of the cable the service loop shall be stored above the ceiling line at an accessible point and support with an approved device designed for that purpose.
 - b) Within a Communications Room the service loop shall be dressed and stored within the ladder rack.
 3. Strain relief techniques shall be applied to all cables to lessen the risk of physical cable damage and to provide proper aesthetic value.
 4. Route all cabling and pathways parallel to building surfaces and at 90 degrees angles to the rafters and trusses.
 5. Cable runs shall be continuous and without splices.
 6. Wiring shall be free from grounds, shorts, opens, and reversals. Strain relief shall be provided at all connection points.
- C. Protection
 1. Maintain protection of all cabling throughout the entire duration of the project. Cabling shall not be left hanging or coiled where it potentially obstructs the Work of other trades. Cabling shall be bundled, supported, and protected up out of the way of other trades any time it is determined necessary to ensure the safety of personnel and protection of the cable.
 2. Do not terminate cables designated for different services onto the same patch panel unless otherwise clearly indicated on the drawings. Coordinate with Owner before any terminations are made.
 3. Do not exceed minimum bend radius or pulling tension specifications set forth by the product manufacturer.
 4. Cable Separation and Organization
 - a) Horizontal cables of all service types (i.e. Voice, Data, Control, RF, etc....) shall be organized and kept segregated within cable trays, ladder rack, wire management and other pathways to the degree physically possible.

- b) Cables of different services shall not be intertwined.
 - c) Terminate all cabling on specified termination hardware in numerical order and on specified outlets.
- D. Labeling
 - 1. Every cable shall have a label applied to the jacket at each end.
 - 2. Each terminating device and port shall have a unique identifier.
 - 3. Label all cabling and terminations as specified and indicated on related drawings.
- E. Use of Raceways
 - 1. Install cabling within conduit and in surface raceway where specified in this or related sections and as indicated on the drawings.
 - 2. Cabling shall be installed in a concealed manner. Cables may be visible only in the following areas;
 - a) Equipment Rooms
 - b) Telecommunications Rooms
 - c) Building spaces equipped with cable trays, but without finished ceilings to conceal the cables.
 - 3. Install cabling in Cable Tray / and Ladder rack where specified and/or indicated on the drawings.
 - 4. Support cables using approved products and methods whenever conduit, surface raceway and cable tray are not specified. Cable supports shall be attached directly to building structure.
- F. Cabling on backboards and in Equipment racks
 - 1. Neatly dress, support, and securely attach all cabling.
- G. Termination
 - 1. Terminate each end of every cable provided.
 - 2. Terminate all UTP cabling utilizing the T568B wiring configuration.
 - 3. Terminate each cable from a station outlet in numerical order on adjacent ports on the specified termination hardware within the appropriate Communications Room.
 - 4. Terminate cables using the tools and connectors specified and as recommended by the cable/connector manufacturer.
- H. Separation from Sources of Interference
 - 1. Route cables at least 1.2m (4 foot) from motors or transformers; 30 cm (1 foot) from conduit and cables used for AC power distribution; 12 cm (5 inches) from fluorescent lighting fixtures.
- I. Cable Supports
 - 1. Where cabling is not supported by cable tray or conduit, provide necessary cable support as specified. Provide nylon cable tie at the support to contain cabling within the support. Do not bundle cable between supports. Provide cable support as specified at intervals not to exceed 5 feet. Do not secure cabling to the support. Do not use cable supports with round surfaces (i.e. bridal rings).
- J. Horizontal cabling
 - 1. The length of patch cords and cross connect jumpers installed in the Telecommunications Room shall be 5 m (15 ft) total or less.
 - 2. The length of patch cords and cross connect jumpers installed in the Equipment Room shall be 5 m (15 ft) total or less.
 - 3. Locate telecommunications outlets so that the cable assembly required to reach work area equipment will be no more than 5 m (15 ft) long.

4. Provide service loops on all cables at the station end of 2 feet (coiled above the ceiling and with a minimum of 6 inches at the telecommunications outlet coiled in the box or raceway).
5. Provide service loop at the Equipment Room/Telecommunications Room end of 5 feet coiled above the ceiling or neatly bundled in ladder rack above the cabinet/rack.
6. Install telecommunications outlets securely at work area locations.
7. Any necessary electrical components (e.g., impedance-matching devices) at outlets shall be located outside the faceplate via a standard plug connection.
8. Provide surface raceway on all walls where existing pathway has not been provided and cables cannot be concealed inside the wall cavity. Do not conceal cabling inside of block walls. Install surface raceway "level" straight and securely anchored to walls with screws, bolts, or anchors as appropriate.
9. Provide a 6-inch service loop on each horizontal UTP cable that breaks out from the harness for termination and do not violate the minimum bend radius of the cable.

3.3 TESTING

- A. All cables shall be fully tested and verified compliant with these specifications.
 1. See: "Commissioning of Structured Cabling" for UTP Horizontal performance testing parameters and procedures.
- B. The Owner reserves the right to have a representative present during any or all testing procedures. Verification testing of copper and fiber will be performed at or near Project completion by the Consultant for quality assurance.
- C. Upon verification testing, if the Consultant finds the test results do not match the Contractor's results, the Consultant or a third party may at the Owner's request retest all of the cabling and submit those results to the Owner and deduct the verification testing costs from the Contractor's Contract amount.

END OF SECTION 27 15 13

SECTION 27 16 00 - COMMUNICATIONS CONNECTING CORDS, DEVICES, AND ADAPTERS

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. Supplementary to Division 1, Refer to Division 27 Section(s) for additive information where applicable.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cable Assemblies, Devices, and Adapters for Communications
 - a) Voice / Telephone
 - b) Data / Network
 - 2. General requirements are as follows:
 - a) Provide cable assemblies and devices with electrical/optical properties to match the designed infrastructure.
 - 3. Special requirements are as noted on Drawings.
 - 4. All Work shall fully comply with these specifications and related Drawings and all manufacturers recommended installation practices.
- B. Products Supplied But Not Installed Under This Section
 - 1. None
- C. Products Installed But Not Supplied Under This Section
 - 1. None
- D. Related Sections
 - 1. All Division 27 Sections
- E. Related Drawings
 - 1. Technology (T-Series) Drawings

1.3 SYSTEM DESCRIPTION

- A. Provide the following cable assemblies (cords), Devices, and adapters: **(only provide if specifically requested by Owner)**
 - 1. Telephone Patch Cables
 - a) Category 6A cables, 3-5 feet in length as required for the Equipment Room/Telecommunications Room end.
 - b) Confirm Color for telephone cables
 - c) Labeled with the same unique identifier at both ends of the assembly.
 - d) Provide a quantity of 1 for each horizontal telephone cable installed.
- B. Labels:
 - 1. Provide alphanumeric, clearly typewritten labels at all designated points as follows:
 - 2. See Detail Drawings for graphical representation of labeling scheme.

1.4 SUBMITTALS

- A. General
 - 1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal. Product Data and Shop Drawings are not to be submitted separately.

2. Samples shall be submitted with or immediately following submission of Product Data submittals.
- B. Items to be submitted for approval prior to commencement of work:
 1. Product Data
 - a) Manufacture datasheets for all cable assemblies
 - b) Manufacture datasheets for all devices
 - c) Manufacture datasheets for all adapters
 - 1) Data sheets shall include
 - i) Manufacturer name
 - ii) Manufacturer model number (as it appears on manufacturer's product data sheet)
 - iii) Manufacturer product description
 - iv) Paragraph number of this section where the product is specified.
 - v) Picture or Drawing of item
 - C. Closeout Submittal
 1. Cable color code utilized for patching.
 2. Labeling scheme utilized for cable assemblies.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

- A. General
 1. As required in Division 27 Section 27 00 01 "General Requirements for Communications"
 2. This section is designed to provide the Contractor with a minimum standard of quality and functionality for the products used for telecommunications infrastructure.
 3. This standard will be considered in force for the original response as well as for any additions or changes to this Project. Due to this, there may be items listed in the Products section that are not required under the scope of this contract.
 4. Products required by the Drawings but not listed in Part 2, will be evaluated as a performance specification based on the information provided on the Drawings.

2.2 CABLES

- A. Copper Cable Assemblies (Twisted Pair)
 1. Category 6A Copper patch cables
 - a) Copper patch cables shall be ANSI/TIA/EIA 568A Proposed Category 6A compliant with eight position RJ45 modular plugs on each end. Use T568B wiring. Apply an identifying label to each end of the cable assembly (same identifier on each end of the cable and a unique identifier for each patch cable on the Project regardless of installed location).
 - b) Color Coding:

1) Critical Building Systems	Red
2) Voice Over IP	Orange
3) Classroom	Black
4) Administrative	Yellow
5) Cross-Over connections	Blue
6) Straight-Through uplinks	Green
7) Network Management	Purple
8) IP Video	White
9) Work Area (Attachment)	Gray
 - c) UTP Cable Assemblies Category 6A, coordinate with Owner prior to purchasing cables. In most cases data patch cables will be six inch.

- 1) Standard of quality shall be Panduit
 - i) 6 inch with labels added
 - ii) 3 foot with labels added
 - iii) 5 foot with labels added
 - iv) 7 foot with labels added
 - v) 10 foot with labels added
 - vi) 14 foot with labels added
 - vii) 20 foot with labels added
- 2) Additional Approved Manufacturers:

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. This section is designed to provide the vendor with a standard of quality and functionality for the installation of technology systems infrastructure. Not all procedures will be necessary for the installation of this Project. However, this standard will be considered in force for the original response as well as for any additions or changes to this Project.

3.2 INSTALLATION PRACTICES

- A. Standards: The minimum criteria for proper installation can be found in the *TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL* published by the Building Industry Consulting Services International. The vendor must refer to this publication for cable installation practices. This Specification may take exception to optional statements within this manual. Treat any conflict per this Specification under discrepancies or Conflicts.
- B. The following items should be considered to be minimum standards for this Project:
 1. The vendor is responsible for receiving, handling, storing, and protecting all materials used on this Project until the Project is signed as complete.
- C. General Requirements:
 1. Throughout the entire installation the Contractor must maintain complete protection of all cabling. Cabling shall not be left hanging or coiled where it potentially obstructs the Work of other trades. Cabling shall be bundled, supported, and protected up out of the way of other trades any time it is determined by the Architect/Engineer to be necessary.

3.3 LABELING

- A. Provide labeling as specified in Part I.
- B. Label all items listed in quantities required by the drawings and specifications.
- C. Apply all labels straight and legible.

END OF SECTION 27 16 00

ISU Science Rooms 018, 022, 138
Indiana State University
D&A#26057

COMMUNICATIONS CONNECTING
CORDS, DEVICES AND ADAPTERS
27 16 00 - 4
R.E. Dimond & Associates, Inc.

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SECTION 27 41 10 - AUDIO AND VIDEO SYSTEMS CABLING

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. Supplementary to Division 1, Refer to Division 27 Section 27 00 10 - "General Requirements for Communications" for additional information and work that is applicable to this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Analog and digital video cable
 - 2. Analog and digital audio cable
 - 3. Remote control cabling
 - 4. Low voltage power cable
 - 5. Communications cabling
 - 6. Connectors and related materials used in the termination of cables used in the establishment of low-voltage interconnectivity between audio and video systems equipment and devices.
- B. Related Sections
 - 1. All Division 27 Sections
 - 2. Common Work Results
 - a) Division 27 – "Operation and Maintenance of Structured Cabling and Enclosures"
 - b) Division 27 – "Basic Materials and Methods"
 - c) Division 27 - "Pathways for Communications Systems".
 - d) Division 27 – "Firestopping for Communications Systems"
 - e) Division 27 – "Identification for Communications Systems"
 - f) Division 27 – "Commissioning of Structured Cabling"
 - 3. Interrelated Sections
 - a) Division 27 – "Communications Coaxial Horizontal Cabling"
 - b) Division 27 – "Communications Coaxial Backbone Cabling"
 - c) Division 27 – "RF Broadband Video Distribution Systems"
- C. Related Drawings
 - 1. All Technology Drawings (T-series)

1.3 DEFINITIONS

- A. Devices: As used with this section, devices shall refer to product(s) that are assembled to the front, side, rear, top or bottom of a custom plate/panel. Sample "devices" include, but are not limited to connectors, switches, lamp assemblies, meters, faders, and potentiometers.
- B. Components: As used with this section only, components shall refer to passive and active electronic parts used as part of an assembly that are otherwise considered plates, panels, hardware or devices.
- C. RGB: Red, Green, Blue
- D. RGBS: Red, Green, Blue, Sync
- E. RGBHV: Red, Green, Blue, Horizontal Sync, Vertical Sync
- F. Y-C: Chrominance, Luminance
- G. S-Video: Chrominance, Luminance

- H. DCR = Direct Current Resistance
- I. DVI = Digital Video Interface
- J. HDMI = High Definition Media Interface
- K. SDI = Serial Digital Interface
- L. HDSDI = High Definition Serial Digital Interface

1.4 REFERENCES

- A. National Electric Code
- B. NFPA

1.5 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. Intra-Classroom AV Structured Cabling System
 - 1. Classrooms shall be equipped with fully connectorized plates installed at various locations in the room that enable passage of signals from one plate location to another through the use cabling installed within building cavities and/or dedicated pathways. See drawings for locations and details of plates and interconnect requirements.
 - 2. Work of this section includes, but is not limited to:
 - a) Supply and installation of all multi-service specialty plates as specified herein and/or shown on the drawings. These plates include, but are not necessarily limited to:
 - 1) Local Input connection plates ("LI")
 - 2) Projector Locations ("PR")
 - b) Supply and installation of video distribution amplifiers for use at the various "LI" plate locations.
 - c) Supply and installation of select AV related cables as specified and necessary for the owner to connect to the plates provided under this section.
 - d) Land cables installed under other sections that share space on the multi-service plates provided in this section.
 - e) Fully test each and every interconnection path between plates.
- B. Furnish custom manufactured plate and panel assemblies wherever a related section does not specify the use of a standard pre-manufactured assembly. These specifications apply to all like products not specified by brand and model.
- C. Review all drawings, including system diagrams, details, plans and others to ascertain quantities and configurations
- D. Pre-wire plate/panel assemblies
 - 1. Pre-wiring of passive and active electronic components physically attached to or otherwise defined as part of the plate/panel assembly.
 - 2. Supply and installation of connectors and pigtails used for interconnectivity of assembly to work specified elsewhere.
- E. Work Excluded
 - 1. Plate/panel assemblies expressly specified by manufacturer and model number within other Division 27 specifications.

1.6 SUBMITTALS

- A. Only one contractor (the Division 27 Prime Contract holder) shall furnish the submittals for this section. The submittal shall be inclusive of all materials to be furnished under this section.
- B. Provide datasheets of all models of cable and connectors to be supplied.
- C. Assemblies only from pre-approved manufacturers shall be deemed acceptable. Contractor fabricated products shall not be permitted.

- D. All assembly products furnished under this section shall be from a single manufacturer.
- E. Shop Drawings
 - 1. Scaled engineering level datasheets for each plate/panel assembly.
 - a) Drawing scale shall be 1/2-inch = 1-inch or 1-inch = 1-inch
 - b) Paper size: 8-1/2-inches by 11 inches or 11-inches by 17-inches as appropriate for the assembly
 - c) Each datasheet shall clearly indicate all of the following:
 - 1) The manufacturer of the assembly.
 - 2) Plate/panel material, finish, and color.
 - 3) Plate/panel dimensions.
 - 4) Mounting hole quantity, sizing and spacing.
 - i) Not required when using "standard" electrical "gang" plate sizes and standard EIA rack mount panels.
 - 5) Properties of all Text nomenclature.
 - i) Font
 - ii) Font Sizes
 - iii) Colors
 - iv) Line widths
 - 6) Properties of all non-text nomenclature
 - 7) Detailed list of devices used within the assembly.
 - 2. Schematic diagram of all assemblies
 - a) Wiring for those assemblies that have interconnections between devices and components, and for assemblies that feature consolidated connectivity points (screw terminals, pigtails, in-line connectors).
 - b) Device ID uniquely identifying the plate/panel keying it to a specific location at the project site, and on the system.
- F. Quality Assurance
 - 1. Samples of plates and panels shall be furnished for review upon the request of the designer.

1.7 QUALITY ASSURANCE

- A. Wire, cable, connectors, supplied and installed, shall not exceed the rated capacities and general operating ranges and conditions published by the product's manufacturer and within the limitations and guidelines
- B. Wire, cables and connectors supplied shall be used only for the purposes of carrying signals of the type(s) for which they are specified and/or approved by the Designer.
- C. Products shall be supplied and installed in accordance with applicable codes.
- D. Pre-approved alternate manufacturers and model numbers notwithstanding, all product supplied of a given type shall be of the same make and model. For example: All non-plenum rated microphone cable supplied for permanent install use be the same make and model across all sections and systems that are relate to this section. This applies to all wire, cable, connectors and other materials furnished under this section.
- E. Where this Contractor chooses to have its sub-contractor(s) furnish its own cabling, it is the responsibility of this Contractor to coordinate the uniform supply of product across all contractors to meet the intent of this section. Should there be technical merit to deviate from this the Contractor shall obtain approval in writing from the designer prior to procuring and installing product.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Wire/cable

1. West Penn Wire and Cable
2. Belden
3. Commscope
4. Cables To Go (Rapid Run)
- B. Connectivity
 1. Panel Crafters (Liberty Wire and Cable)
 - a) Internet: www.panelcrafters.com, www.libertycable.com
 - b) Phone: (800) 530-8998
 2. Pro-Co Sound
 - a) Internet: www.procosound.com
 - b) Phone: (800) 253-7360
 3. Rapco
 - a) Internet: www.rapco.com
 - b) Phone: (800) 325-0266
 4. RCI Custom Products
 - a) Internet: www.rcicustom.com
 - b) Phone: (240) 912-0130
 5. Whirlwind
 - a) Internet: www.whirlwindusa.com
 - b) Phone: (585) 663-8820
 6. Wireworks Corporation
 - a) Internet: www.whirlwindusa.com
 - b) Phone: (908) 686-7400
 7. Cables To Go (Rapid Run)
 - a) Internet www.rapidrun.com
 - b) Phone (800) 222-5911

2.2 GENERAL

- A. Contractor shall use these specifications in conjunction with the information provided on the drawings, in related specification sections and from supplied equipment manufacturers to determine the quality, performance and quantity of materials to be furnished.
- B. Wherever there is a conflict between these specifications and the drawings; between different drawings; between parts of these specifications; and between these specifications, the drawings and/or the specific manufacturer recommendations, the Contractor shall presume that the higher quality, higher quantity, and more stringent (the most costly) requirement shall apply. Where the contractor has sought and has received the approval from the Designer (prior to procuring materials or furnishing work) the potentially less stringent requirement(s) may be considered. A credit of appropriate value will be considered a requirement for the approval of any less stringent solution not approved prior to bid.
- C. Where specific manufacture/brands and models are listed in these specifications and/or on the drawings, the Contractor shall presume that these products set the reference Standard-of-quality.
- D. All furnished cable of a given type shall be of the same manufacture make, model and color, unless otherwise specified and/or approved by the Designer in advance of installation.

2.3 CABLES

- A. General
 1. All cables shall be UL listed, and NEC type accepted for the location, application and method of installation in which they are to be used.

2. All cables shall meet NEC 300-volt rating, unless otherwise noted higher.
3. This specification lists multiple types of products within many product categories, each product with different physical and/or performance characteristics. It is incumbent upon the Contractor to furnish the correct type of cable for the application based upon the criteria established throughout these specifications, including but not limited to System Performance criteria enumerated in related sections.
4. Where applicable codes require the use of a cable not specifically listed in these specifications, the contractor shall furnish product meeting the applicable code requirements. Furnished cables shall meet all other requirements of the application(s) in which they are used. Contractor shall utilize the specifications of similar products, where present, as a performance guideline when choosing unlisted code-compliant products. Where similar types of products are not listed, contractor shall choose the requisite code-compliant cable model to provide based upon the recommendations of the manufacturer whose product(s) are being interconnected.
5. Where code requirements dictate use of a plenum rated cable, and a non-plenum rated version of the cable is listed, contractor shall furnish the listed cable with an appropriately sized code-compliant conduit in which to encase the furnished cable as it is installed.

2.4 WIRE, CABLE AND CONNECTORS

A. General

1. Plenum cable is required on this project for all cable.
2. Model numbers listed indicate the standard of quality and electrical performance for cables used on this project.
3. The following cable manufactures are approved for use on this project: West Penn, Belden, Liberty
4. Where below-grade/below-floor cables will be subject to continuous contact with water, Contractor shall provide cable rated for such use by the manufacture.
5. Not all cable and connectors required for installation may be specified. Contractor shall supply connectors and cables of such type appropriate to the application where otherwise not enumerated. Contractor responsible for all providing all cable necessary to provide a complete and working system.
6. All cable provided shall meet all applicable codes governing the project site. Where multiple model numbers are listed for a given cable type, Contractor shall use the version meeting applicable codes. Where a cable of a higher rating is required by code, Contractor shall provide a cable of equal electrical/optical performance with the appropriate UL/NEC rating.

B. HDMI "Runner" Cable Assembly

1. Pre-connectorized cable assembly (pull-able)
2. Standard of Quality shall be Cables to Go (RapidRun) 40861 (35') or 40862 (50').
 - a) Additional approved manufacturers: Extron, Liberty Wire and Cable

C. Composite Video Coax Cable

1. Miniature coaxial construction
2. 25AWG bare copper center conductor
3. 75-ohm nominal impedance
4. Bare copper braided shield with 95% coverage
5. Nominal capacitance conductor to shield 16.2pf/ft
6. 82% velocity of propagation
7. Standard of quality shall be West Penn 25825 CMP; CMR equivalent West Penn 825.
 - a) Additional approved manufacturers: Belden, Liberty Wire and Cable.

D. Audio Cable

1. Two 22AWG insulated pairs.
2. One 24 AWG drain wires.
3. 100% overall shield coverage with aluminum polyester foil
4. 10.5 ohms per 1000'
5. Standard of quality shall be West Penn 25510 CMP; CMR equivalent West Penn 510.
 - a) Additional approved manufacturers Belden, Liberty Wire and Cable

2.5 CONNECTIVITY

A. General:

1. All plates furnished under this section shall be constructed of 1/8" thick clear anodized aluminum. All plates shall feature soft beveled edges.
2. Plates with provisions for décora-style jack frames shall include back panel relief milling to accommodate the jack frame.
3. Nomenclature shall be engraved and black backfilled.
4. All plates shall be furnished by a single manufacture to ensure consistent appearance throughout the project.
5. All plates to be provided with countersunk through holes for standard electrical device plate mounting screws.

B. Faceplates

1. Flush Faceplate – Double Gang Stainless Steel
 - a) Double gang
 - b) Two "Decora Style" openings
 - c) 302 grade Stainless Steel
 - d) May be mounted on an outlet box, bracket, or raceway.
 - e) Must use Decora Style Module Frames below.
 - f) Standard of quality shall be Leviton 84409-40
 - 1) Additional approved manufacturers:
2. "Decora" style jack frame
 - a) Four position minimum on each frame
 - b) May be mounted on an outlet box, bracket, or raceway.
 - c) Will require a faceplate with "Decora" cut-out
 - d) Standard of quality shall be Panduit CFG4xx
3. Faceplate Blank Insert
 - a) Provide blanks for all un-used positions in faceplates, surface boxes, or jack frames.
 - b) Color to match outlet faceplate as described above
 - c) Standard of quality shall be Panduit CMBxx-X
4. Category 6A jack insert RJ-45
 - a) Fully compliant ANSI/TIA/EIA 568C Category 6A RJ45 modular jack.
 - b) See Drawings for color-coding requirements.
 - c) Standard of quality shall be Panduit CJ6X88TGxx
5. F style bulkhead Insert
 - a) Female to Female 75-ohm bulkhead connector.
 - b) Color to match outlet faceplate as described above; Electrical Ivory color unless otherwise specified
 - c) Standard of quality shall be Panduit CMFxx
6. HDMI Active wallplate

- a) Decora style opening
- b) Pre-connectorized pigtail
- c) Standard of Quality shall be Cables to Go (RapidRun) 40855
 - 1) Additional approved manufacturers: Extron, Liberty Wire and Cable
- 7. RCA Feed-through Style Insert
 - a) Female to Female RCA bulkhead connector
 - b) Color to match outlet faceplate as described above; Electrical Ivory color unless otherwise specified
 - c) Standard of quality shall be Panduit CMRPyxx where y is replaced with R for red, Y for yellow, and W for white
- 8. 3.5mm Stereo Jack Insert (Audio)
 - a) 3.5mm bayonet stereo audio jack, solder type
 - b) Color to match outlet faceplate as described above; Electrical Ivory color unless otherwise specified
 - c) This insert will be used with audio cable; two pair per insert.
 - d) Standard of quality shall be Panduit CM35MSSxx

2.6 DISCREET CONNECTORS

- A. HDMI Pigtail Cable Assembly
 - 1. Pre-connectorized cable assembly with HDMI device interface; attaches to (pull-able) "runner" cable.
 - 2. Standard of Quality shall be Cables to Go (RapidRun) 40868 (6').
 - a) Additional approved manufacturers: Extron, Liberty Wire and Cable
- B. Connectors
 - 1. General
 - a) All connector types shall be approved by the Designer for their intended use.
 - b) Where a connector type is not enumerated within this section, but instead is depicted on the drawings or otherwise required by the system, the following manufacturers are approved for use: Neutrik, Switchcraft, Canare, and AMP.
 - c) Where a specific connector-type is listed within this specification only the listed model(s) shall be deemed acceptable.
 - d) For consistency in appearance and performance all connectors of a given type shall be from a single manufacturer, model and series (as applicable).
 - 2. Audio/Video Connectors
 - a) 3.5mm Mini Phone Tip-Sleeve (TS) and Tip-Ring-Sleeve (TRS) Type
 - 1) Switchcraft "Tini-Jax" Series
 - 2) Supply with accessory insulating Switchcraft S1564 swedged fiber washer and S2207 insulating shoulder washer.
 - b) RCA Phono
 - 1) Switchcraft 3501FR.
 - 2) Solder based connections.
 - 3) Supply with accessory S1028 insulating flat washer and S1029 insulating shoulder washers.
 - i) Provide white insulators to designate "Left" audio channels.
 - ii) Provide white insulators to designate "Mono" audio channels.
 - iii) Provide red insulators to designate "Right" audio channels.
 - iv) Provide black insulators to for general purpose use.
 - v) Provide yellow insulators to indicate video use.
 - 3. Control Connectors
 - a) Category 6 RJ-45 modular plug for solid cable.

- 1) Each plug will use an insulation displacement pressure termination method with specifically designed installation tool.
- 2) The plug shall be 8 position and 8 conductor.
- 3) The plug shall be specifically designed for 24-gauge solid copper conductors.
- 4) The strain relief of the plug shall be designed for clamping on round cable.
- 5) Standard of quality shall be AMP 5-1375204-x
 - i) Additional approved manufacturers

2.7 MISCELLANEOUS ITEMS

A. Isolation Audio Transformers

1. Where installed unbalanced audio cable lengths would otherwise exceed 20 feet, Contractor shall install isolation and balancing transformers within each audio channel.
2. Approved manufactures: Sescom Transformer, Jensen Transformer

PART 3 EXECUTION

3.1 GENERAL

A. Connection Plates

1. Secure all plates with oval-countersink head Phillips drive machine screws.
2. Terminate and mount all connector plates at locations where shown on plans.
3. Install plates square and plumb.
4. Where décora-style jack frames are used, secure jack frames so they are installed secure and flush to plate, without movement
5. Permanently label all plate connections on the front of the plate. Custom plates shall be fabricated by one of the listed manufacturers and may not be Contractor fabricated without pre-bid approval.

3.2 CABLE SELECTION

- A. Where the drawing(s) or related specification(s) identify the use of specific products, the Contractor shall furnish the products specifically identified.
- B. Where the drawing(s) or related specifications(s) identify the use of a general classification of product, the Contractor shall furnish one or more the products with the referenced classification. Where multiple products are included under the classification, the contractor shall use the criteria or performance guidelines in this specification and in the related specification to determine which product shall be provided.
- C. Where the drawing(s) or other specification sections do not identify a product model, or specific product type, the contractor shall utilize this specification section, equipment manufacturer recommendations, and industry references and standards to determine which products to provide.

3.3 CABLE INSTALLATION

A. Isolation and Balancing transformers:

1. Transformers shall be wired so as to provide a balanced, RF interference and ground-loop free signal transmission audio path between plates.
2. Transformer shall be provided with appropriate length conductors added to them to permit secure connection to connectors.
3. Transformer case shall be insulated from ground using a piece of appropriately sized and applied piece of heat shrinkable tubing.

B. Cable Separation

1. Cables carrying different signals of different nominal operating level shall be kept separated to reduce the risk of undesirable cross-talk interference between cables.

2. As a general rule, for each 25dBV difference in nominal level between cables, Contractor shall provide 6 inches of separation between cables. For example: cables with a 90dBV level difference shall be separated by at least 18 inches (where 0dBV=1Volt).
 3. Contractor shall provide additional separation as determined necessary to prevent or remedy any crosstalk which adversely affects the performance and usability of the system or that exceeds specific crosstalk performance outlined in these specifications.
- C. Cable and Conductor Identification
1. Use 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.
 2. All cables shall be labeled at both ends using computer generated type-written permanent self laminating wire labels. Cables should clearly correlate to cabling as shown on the installation and record drawings.
- D. Drain wire and shield preparation
1. Non-insulated conductors (typically the shield and/or shield drain wire) that are an integral part of a multi-conductor cable shall be individually insulated as they exit the jacket of the cable. Apply high-temperature heat shrinkable plastic tubing of the appropriate size over the conductor.
 2. Unless otherwise required for conductor color code coordination contractor shall use Green color heat shrink. White and Clear may be used where necessary to coordinate with other conductors.
- E. Grounding and bonding
1. As a matter of standard practice, the non-signal carrying shield drain wire of audio cables shall be "grounded" at one end only and left floating from ground at the other.
 2. Un-terminated shields and drain wires shall not be cut off. Rather these conductors should be insulated and prepped for termination but then folded back and secured on the cable. These conductors shall remain intact reserved for future use and for selective use in remedying grounding anomalies.

3.4 LABELING

- A. All wires and cables shall be labeled with permanent and unique numeric/alpha -numeric labels.
1. All cables shall be labeled behind the plate
 2. Cables shall be labeled within 3-6 inches from point of termination.
 3. Use computer and laser-printer generated self-laminating labels. Nomenclature shall be bold type and clearly legible.
 4. Record cable labeling on as-built drawings.
 5. Audio, Video and Control cables that originate and end within the same room may use the same may be labeled in a "typical" fashion that is consistent with other rooms wired identically.
 6. Cables that begin in one room and end in another room shall be uniquely labeled
- B. Where not specified or shown on the drawings, the Contractor shall submit it desired labeling scheme for review and approval. Contractor shall make any adjustments to the labeling scheme directed by the Designer. Nomenclature used for labeling may vary by system.

3.5 TERMINATION INSTALLATION

- A. Assembly
1. Devices with through mounting holes shall be secured to plates/panels using threaded machine screws. Pop rivets are not acceptable.
 - a) Phillips drive flat-head countersink screws shall be used where the device manufacturer provides a countersunk through mounting hole. The size of the

- head shall match the size of the countersink. Screw head shall not stand proud of the countersink and no sharp exposed edges of the screw shall exist.
- b) Philips truss head machine screws shall be used for mounting devices without countersunk mounting holes
 - c) Thread-lock compound shall be applied to screw threads used to secure devices to the plate/panel. Low-strength blue Loctite™ or equal shall be used.
- 2. Devices designed to be mounted without the use of through mounting holes shall be secured using the means expressly provided and/or recommended by the device manufacturer.
 - 3. All devices shall be mounted parallel to the edges of the plate/panel.
 - 4. All devices shall be secure and with no movement or rotation other than that which is part of the intended assembly or device design.
- B. Assembly Wiring
- 1. Wiring shall be neatly and professionally attached to all devices. Appropriate strain relief techniques shall be applied to all pigtails to ensure zero mechanical strain on device connections.
 - 2. Different color wires shall be used in the assembly to aid in identification of circuits. Clearly legible and permanent labels shall be affixed to cables and conductors to aid in identification of circuit and signal paths.
- C. Component Mounting
- 1. Components that are part of plate/panel assembly shall be securely, neatly, and professionally attached.
 - 2. Custom mounting brackets and standoffs shall be used where applicable.
- D. Mounting
- 1. Plate/Panels shall be mounted plumb and square and shall be securely attached to substructure and/or back box.

3.6 ACCEPTANCE TESTING

- A. In the presence of the Designer the Contractor shall demonstrate the presence of all specified equipment, cabling and installation methods. The Contractor shall demonstrate the operation of the system and shall be prepared to make any electronic, physical or software related adjustments to the system or any of its components to the satisfaction of the Designer, as required to achieve full compliance with the specifications.
- B. The contractor shall have available at the project site test equipment, cables, tools and personnel necessary to demonstrate full compliance with these specifications. The Contractor shall have presented a copy of the most up-to-date as-built documentation by this time.
- C. This Contractor shall provide all required labor services required by the Designer to completely verify and test the systems in the presence of the Designer.
- D. 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 the Specifications and complies with applicable standards.
- E. Should the Designer be required to return to the project site to perform acceptance testing more than once, the Contractor shall be responsible for additional costs incurred by Designer, up to a maximum of \$1500 per day, plus travel and expenses.

3.7 DEMONSTRATION AND TRAINING

- A. Contractor shall furnish training of the owner's staff (educators) covering the intent and use of all products furnished on this section. Contractor shall furnish minimum of (24) Hours of training. Contractor shall assume that minimum of (8) independent trips to the project site will be required.

1. Training shall cover the following:

- a) Use and operation of the Smart Boards.
- b) Showing the educators where the specialty plates are within their rooms
- c) Hands on demonstration of hooking up equipment to the specialty plates, including passing of signals through all signal paths and viewing/listening to signals on the location display/audio system.

3.8 CLOSEOUT DOCUMENTATION

- A. Datasheets for each and every cable and custom plate/panel assembly shall be included in the record documents for the project. All information required under Submittals as well as any as-built changes shall be clearly and concisely reflected on these datasheets.
- B. Datasheets shall be assembled into the O&M manual for the specific systems and section to which they apply.

END OF SECTION 27 41 00

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SECTION 27 41 11 - INSTRUCTIONAL CLASSROOM AUDIO AND VIDEO SYSTEMS

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. Supplementary to Division 1, Refer to Division 27 Section 27 00 10 - "General Requirements for Communications" for additional information and work that is applicable to this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Instructional classroom audio/video systems complete and functional as indicated.
- B. Related Sections
 - 1. All Division 27 Sections
 - 2. Common Work Results
 - a) Division 27 – "Operation and Maintenance of Structured Cabling and Enclosures"
 - b) Division 27 – "Basic Materials and Methods"
 - c) Division 27 - "Pathways for Communications Systems".
 - d) Division 27 – "Firestopping for Communications Systems"
 - e) Division 27 – "Identification for Communications Systems"
 - f) Division 27 – "Commissioning of Structured Cabling"
- C. Related Drawings
 - 1. All Technology Drawings (T-series)

1.3 DEFINITIONS

- A. Devices: As used with this section, devices shall refer to product(s) that are assembled to the front, side, rear, top or bottom of a custom plate/panel. Sample "devices" include, but are not limited to connectors, switches, lamp assemblies, meters, faders, and potentiometers.
- B. Components: As used with this section only, components shall refer to passive and active electronic parts used as part of an assembly that are otherwise considered plates, panels, hardware or devices.
- C. RGB: Red, Green, Blue
- D. RGBS: Red, Green, Blue, Sync
- E. RGBHV: Red, Green, Blue, Horizontal Sync, Vertical Sync
- F. Y-C: Chrominance, Luminance
- G. S-Video: Chrominance, Luminance
- H. DCR = Direct Current Resistance
- I. DVI = Digital Video Interface
- J. HDMI = High Definition Media Interface
- K. SDI = Serial Digital Interface
- L. HDSDI = High Definition Serial Digital Interface

1.4 REFERENCES

- A. National Electric Code
- B. NFPA

1.5 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

A. Classroom audio/video systems complete to include:

1. Television displays
2. Ceiling-mounted video projectors
3. Control panels
4. Lecterns
5. Scalers
6. Switchers
7. Cabling system
8. Custom input plates
9. Software complete as indicated
10. Cameras
11. Confidence monitors
12. Touch panels
13. Microphones
14. Speakers

1.6 SUBMITTALS

- A. Only one contractor (the Division 27 Prime Contract holder) shall furnish the submittals for this section. The submittal shall be inclusive of all materials to be furnished under this section.
- B. Provide datasheets of all models of cable and connectors to be supplied.
- C. Assemblies only from pre-approved manufacturers shall be deemed acceptable. Contractor fabricated products shall not be permitted.
- D. All assembly products furnished under this section shall be from a single manufacturer.
- E. Shop Drawings
 1. Scaled engineering level datasheets for each plate/panel assembly.
 - a) Drawing scale shall be 1/2-inch = 1-inch or 1-inch = 1-inch
 - b) Paper size: 8-1/2-inches by 11 inches or 11-inches by 17-inches as appropriate for the assembly
 - c) Each datasheet shall clearly indicate all of the following:
 - 1) The manufacturer of the assembly.
 - 2) Plate/panel material, finish, and color.
 - 3) Plate/panel dimensions.
 - 4) Mounting hole quantity, sizing and spacing.
 - i) Not required when using "standard" electrical "gang" plate sizes and standard EIA rack mount panels.
 - 5) Properties of all Text nomenclature.
 - i) Font
 - ii) Font Sizes
 - iii) Colors
 - iv) Line widths
 - 6) Properties of all non-text nomenclature
 - 7) Detailed list of devices used within the assembly.
 2. Schematic diagram of all assemblies
 - a) Wiring for those assemblies that have interconnections between devices and components, and for assemblies that feature consolidated connectivity points (screw terminals, pigtails, in-line connectors).

- b) Device ID uniquely identifying the plate/panel keying it to a specific location at the project site, and on the system.

F. Quality Assurance

- 1. Samples of plates and panels shall be furnished for review upon the request of the designer.

1.7 QUALITY ASSURANCE

- A. Wire, cable, connectors, supplied and installed, shall not exceed the rated capacities and general operating ranges and conditions published by the product's manufacturer and within the limitations and guidelines
- B. Wire, cables and connectors supplied shall be used only for the purposes of carrying signals of the type(s) for which they are specified and/or approved by the Designer.
- C. Products shall be supplied and installed in accordance with applicable codes.
- D. Pre-approved alternate manufacturers and model numbers notwithstanding, all product supplied of a given type shall be of the same make and model. For example: All non-plenum rated microphone cable supplied for permanent install use be the same make and model across all sections and systems that are relate to this section. This applies to all wire, cable, connectors and other materials furnished under this section.
- E. Where this Contractor chooses to have its sub-contractor(s) furnish its own cabling, it is the responsibility of this Contractor to coordinate the uniform supply of product across all contractors to meet the intent of this section. Should there be technical merit to deviate from this the Contractor shall obtain approval in writing from the designer prior to procuring and installing product.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Wire/cable

- 1. West Penn Wire and Cable
- 2. Belden
- 3. Commscope
- 4. Cables To Go (Rapid Run)

B. Connectivity

- 1. Panel Crafters (Liberty Wire and Cable)
 - a) Internet: www.panelcrafters.com, www.libertycable.com
 - b) Phone: (800) 530-8998
- 2. Pro-Co Sound
 - a) Internet: www.procosound.com
 - b) Phone: (800) 253-7360
- 3. Rapco
 - a) Internet: www.rapco.com
 - b) Phone: (800) 325-0266
- 4. RCI Custom Products
 - a) Internet: www.rcicustom.com
 - b) Phone: (240) 912-0130
- 5. Whirlwind
 - a) Internet: www.whirlwindusa.com
 - b) Phone: (585) 663-8820
- 6. Wireworks Corporation

- a) Internet: www.whirlwindusa.com
- b) Phone: (908) 686-7400
- 7. Cables To Go (Rapid Run)
 - a) Internet www.rapidrun.com
 - b) Phone (800) 222-5911

2.2 GENERAL

- A. Contractor shall use these specifications in conjunction with the information provided on the drawings, in related specification sections and from supplied equipment manufacturers to determine the quality, performance and quantity of materials to be furnished.
- B. Wherever there is a conflict between these specifications and the drawings; between different drawings; between parts of these specifications; and between these specifications, the drawings and/or the specific manufacturer recommendations, the Contractor shall presume that the higher quality, higher quantity, and more stringent (the most costly) requirement shall apply. Where the contractor has sought and has received the approval from the Designer (prior to procuring materials or furnishing work) the potentially less stringent requirement(s) may be considered. A credit of appropriate value will be considered a requirement for the approval of any less stringent solution not approved prior to bid.
- C. Where specific manufacture/brands and models are listed in these specifications and/or on the drawings, the Contractor shall presume that these products set the reference Standard-of-quality.
- D. All furnished cable of a given type shall be of the same manufacture make, model and color, unless otherwise specified and/or approved by the Designer in advance of installation.

2.3 INSTRUCTIONAL AUDIO VIDEO SYSTEMS

A. Science Classroom

- 1. Classroom equipment to include:
 - a) Ceiling mounted Dante microphones. Re-use existing Shure MXA 910.
 - b) Ceiling mounted Dante speakers. Provide Shure MXN-6 speaker system.
 - c) Provide Wavlink WL-UG63PD2-Pro docking station complete.
 - d) Provide Screenbeam 1100 Plus complete.
 - e) Provide Aver TR335 PTZ auto tracking camera complete.
 - f) Provide Extron DTP3 CrossPoint 884 IPCP A complete.
 - g) Provide DTP HCM1 4K 230 Rx (one per ceiling mounted TV).
 - h) Provide Extron TLP Pro 835T complete.
 - i) Provide Aten US3344i 4x4 USB switch complete.
 - j) Provide Sony VPL PHZ51 projector complete. Re-use existing.
 - k) Provide Aver BU113G2 CamStream 4K HDMI to USB adapter complete.
 - l) Provide Audinate Dante ADP-USB-AU-2X2 USB adapter complete.
 - m) Provide Middle Atlantic Racklink 915R PDU complete.
 - n) Provide Netgear GS524PP 24-port Gigabit Ethernet PoE network switch.
 - o) Provide Sony EZ20L 55" TV complete. Include Sanus VLT7 mount to secure TV to structural beam.
 - p) Provide Middle Atlantic CFR-12-23 Cabinet Frame Rack to house all equipment in casework.

PART 3 EXECUTION

3.1 GENERAL

- A. Provide all systems equipment, cabling, terminations, and software complete and functional as indicated and as recommended by the manufacturer. See drawings for more information.

B. Connection Plates

1. Secure all plates with oval-countersink head Phillips drive machine screws.
2. Terminate and mount all connector plates at locations where shown on plans.
3. Install plates square and plumb.
4. Where décora-style jack frames are used, secure jack frames so they are installed secure and flush to plate, without movement
5. Permanently label all plate connections on the front of the plate. Custom plates shall be fabricated by one of the listed manufacturers and may not be Contractor fabricated without pre-bid approval.

3.2 CABLE SELECTION

- A. Where the drawing(s) or related specification(s) identify the use of specific products, the Contractor shall furnish the products specifically identified.
- B. Where the drawing(s) or related specifications(s) identify the use of a general classification of product, the Contractor shall furnish one or more the products with the referenced classification. Where multiple products are included under the classification, the contractor shall use the criteria or performance guidelines in this specification and in the related specification to determine which product shall be provided.
- C. Where the drawing(s) or other specification sections do not identify a product model, or specific product type, the contractor shall utilize this specification section, equipment manufacturer recommendations, and industry references and standards to determine which products to provide.

3.3 CABLE INSTALLATION

- A. Isolation and Balancing transformers:
 1. Transformers shall be wired so as to provide a balanced, RF interference and ground-loop free signal transmission audio path between plates.
 2. Transformer shall be provided with appropriate length conductors added to them to permit secure connection to connectors.
 3. Transformer case shall be insulated from ground using a piece of appropriately sized and applied piece of heat shrinkable tubing.
- B. Cable Separation
 1. Cables carrying different signals of different nominal operating level shall be kept separated to reduce the risk of undesirable cross-talk interference between cables.
 2. As a general rule, for each 25dBV difference in nominal level between cables, Contractor shall provide 6 inches of separation between cables. For example: cables with a 90dBV level difference shall be separated by at least 18 inches (where 0dBV=1Volt).
 3. Contractor shall provide additional separation as determined necessary to prevent or remedy any crosstalk which adversely affects the performance and usability of the system or that exceeds specific crosstalk performance outlined in these specifications.
- C. Cable and Conductor Identification
 1. Use 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.
 2. All cables shall be labeled at both ends using computer generated type-written permanent self laminating wire labels. Cables should clearly correlate to cabling as shown on the installation and record drawings.
- D. Drain wire and shield preparation

1. Non-insulated conductors (typically the shield and/or shield drain wire) that are an integral part of a multi-conductor cable shall be individually insulated as they exit the jacket of the cable. Apply high-temperature heat shrinkable plastic tubing of the appropriate size over the conductor.
2. Unless otherwise required for conductor color code coordination contractor shall use Green color heat shrink. White and Clear may be used where necessary to coordinate with other conductors.

E. Grounding and bonding

1. As a matter of standard practice, the non-signal carrying shield drain wire of audio cables shall be "grounded" at one end only and left floating from ground at the other.
2. Un-terminated shields and drain wires shall not be cut off. Rather these conductors should be insulated and prepped for termination but then folded back and secured on the cable. These conductors shall remain intact reserved for future use and for selective use in remedying grounding anomalies.

3.4 LABELING

- A. All wires and cables shall be labeled with permanent and unique numeric/alpha -numeric labels.
1. All cables shall be labeled behind the plate
 2. Cables shall be labeled within 3-6 inches from point of termination.
 3. Use computer and laser-printer generated self-laminating labels. Nomenclature shall be bold type and clearly legible.
 4. Record cable labeling on as-built drawings.
 5. Audio, Video and Control cables that originate and end within the same room may use the same may be labeled in a "typical" fashion that is consistent with other rooms wired identically.
 6. Cables that begin in one room and end in another room shall be uniquely labeled
- B. Where not specified or shown on the drawings, the Contractor shall submit it desired labeling scheme for review and approval. Contractor shall make any adjustments to the labeling scheme directed by the Designer. Nomenclature used for labeling may vary by system.

3.5 TERMINATION INSTALLATION

A. Assembly

1. Devices with through mounting holes shall be secured to plates/panels using threaded machine screws. Pop rivets are not acceptable.
 - a) Phillips drive flat-head countersink screws shall be used where the device manufacturer provides a countersunk through mounting hole. The size of the head shall match the size of the countersink. Screw head shall not stand proud of the countersink and no sharp exposed edges of the screw shall exist.
 - b) Philips truss head machine screws shall be used for mounting devices without countersunk mounting holes
 - c) Thread-lock compound shall be applied to screw threads used to secure devices to the plate/panel. Low-strength blue Loctite™ or equal shall be used.
2. Devices designed to be mounted without the use of through mounting holes shall be secured using the means expressly provided and/or recommended by the device manufacturer.
3. All devices shall be mounted parallel to the edges of the plate/panel.
4. All devices shall be secure and with no movement or rotation other than that which is part of the intended assembly or device design.

B. Assembly Wiring

1. Wiring shall be neatly and professionally attached to all devices. Appropriate strain relief techniques shall be applied to all pigtails to ensure zero mechanical strain on device connections.
2. Different color wires shall be used in the assembly to aid in identification of circuits. Clearly legible and permanent labels shall be affixed to cables and conductors to aid in identification of circuit and signal paths.

C. Component Mounting

1. Components that are part of plate/panel assembly shall be securely, neatly, and professionally attached.
2. Custom mounting brackets and standoffs shall be used where applicable.

D. Mounting

1. Plate/Panels shall be mounted plumb and square and shall be securely attached to substructure and/or back box.

3.6ACCEPTANCE TESTING

- A. In the presence of the Designer the Contractor shall demonstrate the presence of all specified equipment, cabling and installation methods. The Contractor shall demonstrate the operation of the system and shall be prepared to make any electronic, physical or software related adjustments to the system or any of its components to the satisfaction of the Designer, as required to achieve full compliance with the specifications.
- B. The contractor shall have available at the project site test equipment, cables, tools and personnel necessary to demonstrate full compliance with these specifications. The Contractor shall have presented a copy of the most up-to-date as-built documentation by this time.
- C. This Contractor shall provide all required labor services required by the Designer to completely verify and test the systems in the presence of the Designer.
- D. 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 the Specifications and complies with applicable standards.
- E. Should the Designer be required to return to the project site to perform acceptance testing more the once, the Contractor shall be responsible for additional costs incurred by Designer, up to a maximum of \$1500 per day, plus travel and expenses.

3.7DEMONSTRATION AND TRAINING

- A. Contractor shall furnish training of the owner's staff (educators) covering the intent and use of all products furnished on this section. Contractor shall furnish minimum of (24) Hours of training. Contractor shall assume that minimum of (8) independent trips to the project site will be required.
 1. Training shall cover the following:
 - a) Use and operation of the Smart Boards.
 - b) Showing the educators where the specialty plates are within their rooms
 - c) Hands on demonstration of hooking up equipment to the specialty plates, including passing of signals through all signal paths and viewing/listening to signals on the location display/audio system.

3.8CLOSEOUT DOCUMENTATION

- A. Datasheets for each and every cable and custom plate/panel assembly shall be included in the record documents for the project. All information required under Submittals as well as any as-built changes shall be clearly and concisely reflected on these datasheets.

- B. Datasheets shall be assembled into the O&M manual for the specific systems and section to which they apply.

END OF SECTION 27 41 00

SECTION 28 05 00 – COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.01 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. Division 28 Specifications and Drawings.

1.02 SUMMARY

- A. Basic materials, methods and installation guidelines applicable to the work of all Division 28 documents.
- B. The information included in this Section apply too and are additional requirements for all of Division 28 documents.
- C. Thoroughly review entire bid documents, including all drawings and specifications prior to bidding and include all indicated work in bid.

1.03 REQUIREMENTS

- A. Project Coordination
 - 1. Commence coordination immediately upon award of contract. Coordination includes providing and extracting related information to and from other trades for review. Failure to coordinate in a timely manner shall not result in any subsequent additional reimbursement, special allowances or additional construction time being made for any facet of the project. Work fabricated or installed before properly coordinating with all other trades shall be done at the Contractor's own risk.
 - 2. Work in harmony with all building trades, so as not to cause any delays. Sequence, coordinate, and integrate installations of communications materials and equipment with all other applicable trades for efficient flow of the Work. In addition, contact and coordinate/facilitate work of local communications service providers for incoming communications services. Execute connections with local services providers complete as indicated.
 - 3. The drawings indicate the approximate location and arrangement of required work. The drawings shall be followed as closely as possible in coordination and in execution of the work.
 - 4. Participate in coordination efforts and in preparation of coordination drawings prior to fabrication or installation of any equipment, materials, etc. Coordinate actual clearances of all installed equipment.
 - 5. Conflicts in equipment and materials shall be corrected prior to installation. Should there be a conflict with the drawings of other trades, work with the trades to correct the conflict while coordinating the project. If the conflict cannot be resolved, refer the matter to the owner's representative for a final decision as to method or material. Refer to drawings of all other trades for details, dimensions and locations of other work and route their work so as not to conflict with any other branch. Any work installed or equipment placed in position by this contractor creating a conflict shall be readjusted to the satisfaction of the Owner's representative at the expense of this contractor.
 - 6. All products furnished of a given type shall be by a single manufacturer; shall bear the same brand name; shall be of the same finish color and texture; and shall be from the same product model series, unless otherwise noted.

7. Plans are diagrammatic indicating design intent and indicating required size, points of termination and, in some cases, suggested routes of raceways, etc. However, it is not intended that drawings indicate fully coordinated conduit routing, all necessary offsets, etc. Provide all cable assemblies, etc. as straight as possible and symmetrical (perpendicular to or parallel with) with architectural items and in a consistent elevation. Do not provide work installed diagonal to building members.
- B. Shop Drawings, Product Data, and Samples
1. All submittals shall be submitted electronically in PDF format unless otherwise directed by the A/E or Owner.
 2. Provide complete master material list.
 3. Provide the following information for each product:
 - a. The manufacturer's name (Brand) and full model number.
 - b. Product Information Sheets "Datasheets": Include catalog information, sizing, and technical data on each item to be used on the Project.
 - c. Each product datasheet must reference the specific paragraph for which the product is being submitted. Each product must be listed in the exact same order as it appears in the Section for which the products are being submitted.
 - d. Datasheets shall each include a clearly identifiable label applied in upper corner of each sheet that clearly references the specification section and drawing (as applicable) to which it applies. Labels shall be consistently affixed in the same location on all sheets unless the labels will obstruct pertinent technical information.
 4. All datasheets shall be original manufacturer datasheets.
 5. Where datasheets depict multiple products, versions or options, the Contractor shall highlight (indicate with an arrow) all applicable model(s), version(s) and option(s) applying to the specific product the Contractor will be providing. Exact catalog number must be indicated. The submitted items must be from "approved materials" as specified in each Specification Section.
 6. Do not combine with submittals from any other Division.
- C. Operation and Maintenance Manuals
- a. Prepare Operations and Maintenance Manuals in accordance with Section 01 77 00 Contract Closeout.
 - b. Operations and Maintenance (O&M) manuals shall be provided for each item of equipment. Flash drives shall be file folder indexed for each piece of equipment. O&M submittals shall include but not be limited to the following:
 - a. Installation instructions and schematic drawings.
 - b. Operating and maintenance instructions.
 - c. Complete parts list with manufacturer's model numbers.
 - d. Complete set of approved shop drawings.
 - e. Complete wiring diagrams showing all connections and internal wiring diagrams of all equipment, including module diagrams. Factory typical wiring diagrams are not acceptable.
- D. Building Codes:
1. National Electrical Code (NFPA 70)
 2. Life Safety Code (NFPA 101)
 3. Uniform Building Code (Or adopted State Code)
 4. Federal Communications Commission (FCC) Part 68

5. State specific agencies:
 - a. Administrative Building Council
 - b. State Board of Health
 - c. State Fire Marshal
 - d. Local Codes (City, County, etc.)
 - e. Local Utility Company requirements

E. Standards

1. American National Standards Institute/Telecommunications Industry Association – ANSI/TIA 568C Commercial Building Telecommunications Cabling Standard.
2. American National Standards Institute/Telecommunications Industry Association – ANSI/TIA 569D Commercial Building Standard for Telecommunications Pathways and spaces.
3. American National Standards Institute/Telecommunications Industry Association – ANSI/TIA 606B The Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.
4. American National Standards Institute/Telecommunications Industry Association – ANSI/TIA 607C Commercial Building Grounding and Bonding Requirements for Telecommunications.
5. American National Standards Institute /Building Industry Consulting Services International – ANSI/BICSI 005-2016, Electronic Safety and Security (ESS) System Design and Implementation Best Practices.
6. ASIS – Security Management Standard: Physical Asset Protection (PAP)
7. ASIS – Facilities Physical Security Measures Guideline (FPSM)

F. Permits

1. Contractor shall obtain and pay for all permits or certificates of inspection and approval required for his branch of the work.
2. Permits shall be posted in a prominent place at the building site properly protected from weather and physical damage.

G. Definitions

1. Wherever the word "Install" appears on the drawings or in these Division 28 specifications it shall mean to supply all labor, tools and incidental materials necessary to handle, store, mount, terminate, program, configure and adjust product as necessary to fulfill project requirements.
2. Wherever the word "Provide" appears on plan drawings or in Division 28 specifications, it shall be interpreted to mean that the Contractor shall "Furnish and Install", including all necessary accessories, miscellaneous materials and labor necessary to render the respective system fully operational.
3. Wherever the word "Work" appears in Division 28 specifications or on communication technology drawings, it shall be interpreted to mean any and all labor, materials, accessories, services, etc. necessary to fulfill project requirements.
4. Wherever the word "Furnish" appears on the drawings or in these Division 28 specifications it shall mean to supply the specified labor or specified product, including all associated shipping, storage and warranty expenses.
5. Wherever the words "Site", "Project Site", or "Premises" appears in Division 28 specifications or its related drawings, it shall be interpreted to mean all real estate, buildings

and structures where work will be performed and where products will be installed and reside.

6. Wherever the phrase "Standard of Quality" appears in Division 28 specifications or its related drawings, the Contractor shall interpret this to mean that the listed Manufacturer and Catalog number for each item has the physical, functional, and operational attributes to provide the designed functionality.

H. Quality Assurance

1. Contractor shall have a minimum of five (5) years of experience in the installation of Communication Technology system(s) of similar size, type, scope and contract value.
2. The lead technician(s) on the Project shall have a thorough understanding of the following:
 - a. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 568B Commercial Building Telecommunications Cabling Standard.
 - b. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and spaces.
 - c. American National Standards Institute/Telecommunications Industry Association – ANSI/TIA/EIA 606 The Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.
 - d. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
 - e. American National Standards Institute /Building Industry Consulting Services International – ANSI/BICSI 005-2016, Electronic Safety and Security (ESS) System Design and Implementation Best Practices
 - f. ASIS – Security Management Standard: Physical Asset Protection (PAP)
 - g. ASIS – Facilities Physical Security Measures Guideline (FPSM)
3. Contractor shall be a (factory trained) certified installer for all systems provided in Division 28.
 - a. This minimum requirement shall apply to each Division 28 section independently. If Contractor is incapable of meeting the percent of product value requirement for each section, Contractor shall use a Subcontractor that can meet the percent of product value requirement, in whole, for all products and work of that section for which This Contractor is not qualified.
 - b. The specific Contractor or Subcontractor meeting the requirements for a specific section shall be responsible for the supply of the products, supplemental engineering services and submittals as well as performing all technical labor associated with the installation, training and warranty servicing of work of that section.
4. Contractor shall have substantial business operations located within a 100-mile radius of the project site with a full-time employee staff actively engaged in the supply, installation and service of systems and equipment of the type and scope herein specified.
5. Contractor shall have full-time employee service staff based within a 100-mile radius of the project site.
6. Contractor shall provide any additional information requested by the Owner as determined appropriate by the Owner to validate a Contractor's (or its Subcontractor's) ability to perform and warranty the specified work in the quality, manner and time frame required.
7. Superintendent/Project Manager

- a. This Contractor shall furnish the services of an experienced superintendent/Project Manager who shall be constantly in charge of the work, together with the qualified Foremen and specialists as required to properly install, connect, adjust, start, operate and test the work involved.
 - b. The superintendent's/Project Manager's qualifications shall be subject to the review and acceptance by the A/E and Owner. Unless the A/E or Owner grants prior special permission, the same communication Superintendent/Project Manager shall be utilized throughout the duration of the project and be responsible for the complete scope of the Contract.
- I. Product Delivery Requirements
1. The Contractor shall not procure, deliver or install any product until after the contractor's submittal has been reviewed by the A/E and Owner and the submittal has been returned to the Contractor's marked "Reviewed No Exceptions Taken", "Reviewed as Noted" or "Rejected Resubmit". Advance procurement, delivery or installation of product prior to the return of submittal is entirely at the Contractor's own risk. Contractor should schedule its work and procurement accordingly.
 2. Prior to procurement of any equipment or materials, Contractor shall review the model numbers, compatibility and interoperability of all products.
 3. Prior to procurement, Contractor shall, through coordination with other trades and through field measurements and project site inspections, verify that products to be supplied can be physically installed as planned.
 4. No claim for additional payment will be considered for the return of any equipment determined incompatible, or procured without adhering to the aforementioned conditions, including claim for reimbursement of manufacturer's "restock" fees.
 5. Contractor shall factor all of these conditions into its bid and plan its scheduling and resource needs accordingly to ensure that all work shall be performed according to the Owner's schedule and requirements of this Contract.
- J. Product Storage and Handling Requirements
1. The Contractor is responsible for receiving, handling, storing, and protecting all materials used on this Project until Substantial Completion.
 2. Pack components in factory-fabricated protective containers.
 3. Units shall be delivered in sections of such size as will pass through available openings.
 4. Until ready for installation, store products in original factory containers.
 5. Products shall be stored in a clean, dry space and as additionally recommended by the product manufacturer.
 6. Keep products out of the weather and away from construction traffic and debris, including drywall finish dust.
 7. Do not exceed structural capacity of the floor or platform on which the products are stored.
 8. Until final acceptance of the system, protect all supplied products from damage resulting from moisture, fumes, dirt, dust and debris or any other source of potential damage.
 9. Handle all products with care before, during and after installation so as to prevent damage.
 10. Replace any products damaged prior to final acceptance with new replacement products.
 11. Replacement shall be at Contractor's expense.
 12. Contractor is responsible for the safety and good condition of the materials and equipment

installed until final acceptance by the Owner.

13. Save original product shipping containers and related packaging materials for major products until final acceptance.
14. Prior to disposal, check with owner to determine if the owner wishes any of the packaging materials.

K. Examination and Preparation

1. Contractor shall visit the Site to familiarize himself with the local conditions under which the work is to be performed and correlate his observations with the requirements of the Contract Documents. No allowance shall be made for claims for concealed conditions which the Contractor, in exercise or reasonable diligence in observations of the Site and review of the local conditions under which the work is to be performed, learned or should have learned of, unless otherwise specifically agreed by A/E and Owner in writing.
2. Before ordering any materials or doing any work, the Contractor shall verify all measurements and be responsible for correctness of same. No extra charge or compensation will be allowed for duplicate work or material required because of an unverified difference between an actual dimension and the measurement or size indicated in the drawings or specifications. Any discrepancies found shall be submitted in writing to the A/E and Owner for consideration before proceeding with the work.
3. This Contractor must verify all dimensions locating the work and its relation to existing work, all existing conditions and their relation to the work and all manmade obstructions and conditions, etc. affecting the completion and proper execution of the work as indicated in the Contract Documents.

L. Installation

1. Provide all required labor, materials, equipment and Contractor's services necessary for complete installation of systems required to comply with the requirements of authorities having jurisdiction, as indicated on Drawings, and as specified.
2. Work shall be functional and complete in every detail, including any and all items required to complete the system, whether or not these items have been enumerated or shown on the Drawings.
3. Special attention shall be given to access to working and controlling parts. Adjustable parts shall be within easy reach. Removable parts shall have space for removal.
4. Each Contractor shall be fully knowledgeable of the details of all Work to be performed by other trades and take necessary steps to integrate and coordinate his Work with other trades.
5. Wherever tables or schedules show quantities of materials, they shall not be used as a final count. These figures serve only as a guide for the Contractor. Each Contractor shall be responsible for furnishing all materials on the Drawings or as specified.
6. The Consultant and Owner's Representative have full power to condemn or reject any Work, materials or equipment not in accordance with these Specifications and Construction Drawings or the manufacturer's specifications or drawings approved by the Owner or Consultant.
7. Work or equipment that is rejected shall be removed and replaced to the satisfaction of the A/E and Owner at the Contractor's expense. Work or equipment that is rejected shall be so stated in writing by the A/E or Owner.
8. Such decisions that the A/E or Owner may make with respect to questions concerning the quality, fitness of materials, equipment, and workmanship shall be binding upon the parties

thereto.

9. All Work shall fully comply with these specifications and related Drawings and all manufacturers recommended installation practices.
10. All Work shall be performed with the best practices of the trade for performance, functionality, safety, endurance, and aesthetics.
11. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the schedule.
12. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible, as appropriate to the application.
13. Set all equipment to accurate line and grade, level all equipment and align all equipment components.
14. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.
15. No equipment shall be hidden or covered up prior to inspection by the owner's representative. All work that is determined to be unsatisfactory shall be corrected immediately.
16. All work shall be installed level and plumb, parallel and perpendicular to other building systems and components.
17. Install all equipment and materials in strict accordance with manufacturer's written instructions. Bring any conflicts between the manufacturer's written instructions and these specifications to the attention of the A/E for recommendations.
18. Upon completion of installation of equipment and communication circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with re-testing.

M. Cutting and Patching

1. Where demolition of existing surfaces are required by the Work, the same shall be restored to at least as good a condition as they were before.
2. Contractor shall be responsible for painting, patching, repairing and replacing any building surface, furnishing, wall/floor/ceiling covering that is damaged or penetrated in the process of performing work on the project site.
3. Additional work required to repair work performed under this Contract shall be at the expense of This Contractor.
4. The Division 28 contractor shall do all cutting as required for the admission of Division 28 work. Unless directed otherwise in field, provide all related patching and painting to match surrounding methods, materials and colors. Any damage done by this contractor to the building during the progress of this contractor's work shall be made good at this contractor's expense.

N. Site Maintenance

1. During the progress of the work, the Contractor shall clean and leave the premises and all portions of the building in a clean and safe condition. This cleaning shall occur on a daily basis.

O. Final Cleaning

1. Clean all parts of the apparatus and equipment. Exposed parts, which are to be painted, shall be cleaned of cement, plaster and other materials and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all corners and cracks scraped out.

P. Closeout Requirements

1. Upon the Designer's receipt of and approval of the Contractor's pre-test submittal, the Contractor shall contract the Designer to schedule acceptance testing. Contractor shall allow not less than 10-business days of advance notice to the Owner.
2. In the presence of the Owner, the Contractor shall demonstrate the presence of all specified products, cabling and installation methods. The Contractor shall demonstrate the operation of the system (and any requested sub-component thereof) and shall be prepared to make any electronic, physical or software related adjustments to the system or any of its sub-components to the satisfaction of the Owner, as required to achieve full compliance with the specifications.
3. The contractor shall have available at the project site all test equipment, cables, tools and personnel necessary to demonstrate full compliance with these specifications as determined necessary by the designer.
4. During the acceptance testing the Contractor shall have a clean and fresh copy of the contractor's most up to date as-built record documentation, printed to scale.
5. This Contractor shall provide all required labor services required to completely verify and test the systems in the presence of the Owner.
6. Verify that each system, as a whole system, meets these Specifications and complies with all applicable standards.
7. Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense.

Q. Warranties

1. Specified materials and workmanship provided shall be fully guaranteed by the Contractor for one year from the transfer of title via notice of substantial completion against any defects in materials or workmanship.
2. Extended (additional) warranty(s) may be required and will be identified in the individual Specification Section and will be considered additive to this base Contractor Warranty.
3. Requirements for Manufacturer's Warranties, required by a Specification Section, shall run concurrent to this base Warranty by the Contractor but may exceed the Contractor's Warranty Period.
4. Manufacturer's Warranties shall also begin upon Substantial Completion.
5. The Warranty shall begin upon Substantial Completion.
6. This warranty shall in no manner cover equipment that has been damaged or rendered unserviceable due to negligence, misuse, acts of vandalism, or tampering by the Owner or anyone other than employees or agents of the Contractor.
7. The Contractor's obligation under its warranty is limited to the cost of repair of the warranted item or replacement thereof, at the Contractor's option.
8. Insurance covering said equipment from damage or loss is to be borne by the Contractor until full acceptance of equipment and services.
9. Individual specification sections may have additional warranty requirements for the work in that section. The warranty above will cover all materials and work where not covered by an extended warranty listed in the individual specification section.

10. Specified materials and workmanship provided shall be fully guaranteed by the Contractor against any defects in materials or workmanship.
11. Contractor shall provide a full "System Warranty" which shall cover all materials, labor and related product shipping expenses for a period of five years from the date of Owner acceptance.
12. Supplied products with manufacturer's warranties of less than the System Warranty term shall be extended by the Contractor for the full specified term.
13. During this period the Contractor will remedy (at no cost to the owner) any problem with the system, or any of its related components that is the result of defective materials, settings, workmanship, or loss or programming.
14. Any defective items or work shall be removed and replaced at the Contractor's expense to the satisfaction of the owner's representative and the Owner.
15. The period of the Contractor warranty(s) for any items herein are not exclusive remedies, and the Owner has recourse to any warranties of additional Scope given by the Contractor to the Owner and all other remedies available by law or in equity.
16. Additional Warranty requirements may be added by an individual Specification Section.
17. Scope of these extended (additional) warranty(s) will be identified in the individual Specification Section and will be considered additive to this base Contractor Warranty.
18. Requirements for Manufacturer's Warranties, required by a Specification Section, shall run concurrent to this base Contractor Warranty by the Contractor.
19. Manufacturer's Warranties shall also begin on Substantial Completion.

R. Demonstration and Training

1. Each Division 28 section may specify special Training requirements.
2. Training requirements will be for a quantity of hours, allow for multiple trips.
3. If no special requirements are specified in the individual section, provide for 4 hours and 2 trips for basic overview, operation and maintenance information per section.
4. Train Owner's maintenance personnel on the procedures and schedules involved in operating, general troubleshooting, and preventative maintenance of the system.
5. Contractor shall require all attendees to sign-in for each training session. The sign-in form shall summarize the training to be conducted, specification section and subsection being trained on, as well as the starting time and duration of training. Following training, a representative of the owner shall sign the form, acknowledging the same. Contractor shall retain the original copy of these forms and turn over a photocopy of the form to the owner's representative as evidence of training. Training conducted without this official record of training shall not be considered as part of the Contractor's training obligation.
6. Schedule training with the Owner's representative, at least 14 days in advance.

PART 2 - PRODUCTS

2.01 ASSIGNMENT OF MISCELLANEOUS WORK

- A. Excavating and backfilling for telecommunications work shall be by telecommunications contractor.
 1. Properly support banks of excavation with safety sheet pile. Install necessary guards. Provide adequate pumping equipment and keep excavation free of water.
 2. Excavate pipe trenches to proper depth. Where rock is encountered, excavate to 6 inches

- below pipe and refill to 6 inches above pipe with compacted granular fill. Granular fill shall consist of dune sand, gravel or other suitable material containing not more than 10 percent by weight passing #200 sieve and 100 percent passing 1-inch sieve.
3. Excavation for utilities shall not be backfilled until all required tests are performed and approved by Engineer and the utility company.
 4. Whenever underground feeders are run below footings and grade beams, contractor shall backfill the void with poured, steel-reinforced concrete to elevation of bottom of footing or grade beam. Backfill within building lines shall be made with granular fill or compacted backfill material laid in 6-inch layers and tamped to specified compaction after each layer.
 5. Backfill under paved area shall be made with granular fill compacted backfill material laid in 12-inch layers and tamped to compaction after each layer.
 6. Backfill under open yards or fields shall be made with non-compacted backfill laid in layers not to exceed 24 inches deep. Sand trenches may be allowed to settle naturally and shall be refilled back to grade as required during first year after final acceptance.
 7. Contractor shall refill, regrade and refinish any area that becomes unsatisfactory due to settlement within one year after final acceptance.
 8. Contractor shall verify all existing grades, inverts, utilities, obstacles and topographical conditions prior to any trenching, excavation or underground installation. In event existing conditions are such as to prevent installation in accordance with Drawings, contractor shall immediately notify Engineer.
 9. Provide appropriate plastic marker tape buried directly above underground electric and communication lines continuously along length of lines. Marker tape shall be located 12 inches below finished grade, but no closer than 12 inches above underground lines. Tape shall be a minimum of 6 inches wide.
 10. Refer to Division 31 Section "Earth Moving," for additional requirements. In event of conflict between this section and Division 31 Section "Earth Moving," Division 31 Section "Earth Moving" shall apply, unless otherwise indicated by A/E.
- B. Provide sleeved penetrations for all cabling access where applicable.
1. Where conduits pass through walls, roofs, ceilings, or floors, contractor shall set sleeves when floors, walls, ceilings or roofs are constructed. If any holes are cut in finished work where sleeves have been omitted, cutting shall be done with a concrete coring machine or other approved means and only with consent of Engineer. All such holes are to be carefully cut and shall not be larger than necessary. These holes are to be entirely covered by escutcheon plates when work is completed. Sleeves shall be made of pipe or rolled sheet steel no lighter than No. 18 gauge.
 2. Where conduits pass through sleeves in exterior walls above grade, annular space shall be caulked with oakum and filled inside and out with non-hardening, waterproof sealant finished off flush with both faces of wall.
 3. Provide penetration seals for all conduits penetrating the building wall below grade.
 - a. Description: The pipe to wall penetration closures shall be "Link-Seal" or equal, as manufactured by PSI/Thunderline Corporation – Houston, TX. Seals shall be modular type, consisting of synthetic rubber shaped to continuously fill the annular space between the pipe and wall opening. After the seal assembly is positioned in the sleeve, the rubber sealing elements shall provide an absolutely water-right seal between the pipe and wall opening. The seal shall be constructed as to provide insulation between the pipe and wall, thus reducing changes of cathodic reaction between these two members.
 - b. Wall Opening: Provide "Century-Line" sleeves or equal as manufactured by

PSI/Thunderline Corporation – Houston, TX. Contractor shall determine the required inside diameter of each individual wall opening of sleeve before ordering, fabricating or installing. The inside diameter of each wall opening shall be sized as recommended by the manufacturer to fit the pipe and Link-Seal to assure a water-tight joint. Sizing (correct Link-Seal model and number of links per seal) may be obtained through manufacturer's catalog. If pipe O.D is non-standard due to coating, insulation, etc. consult Thunderline's factory for engineering assistance and recommendation before proceeding with wall opening detail.

- c. Holes through Structural members: Holes required for conduit of size 5-inches and smaller shall be cut in field at expense of this contractor. Obtain structural engineer's approval in writing prior to any cutting.
- d. Pitch Pockets: Required for conduit penetrating roof. Seal sleeves and provide flashing.
- e. Painting of telecommunications cabling and components is not permitted. Notify painting contractor that painting of telecommunications cabling and components is not permitted. Protect cabling as necessary to avoid painting.

2.02 MATERIALS AND EQUIPMENT

- A. Equipment shall be new, listed by UL and shall conform to NEMA and ICEA standards.
- B. Materials used for like service shall be by same manufacturer.
- C. All materials and equipment, including any hangers, supports, fastenings or accessory fittings, shall have corrosion protection suitable for atmosphere in which they are installed, whether located indoors or out. Care shall be taken during installation to assure integrity of corrosion protection.
- D. All screws, bolts, nuts, clamps, fittings or other fastening devices shall be made up tight. All bolts, screws, nuts and other threaded devices shall have standard threads and heads so they may be installed and replaced, when necessary, without special tools.

2.03 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 A/E and Owner a minimum of ten (10) days prior to receiving bids. Approval will be issued by Addendum if granted.
- B. A Specification followed by one or more manufacturers and "or approved equal" is open to all equal products or materials; however, Contractor shall supply one of listed manufacturers at no additional cost if Engineer finds substituted product unsatisfactory.

2.04 CAULKING AND FIRESTOPPING

- A. In addition to the requirements in Division 07 Section "Penetration Firestopping," comply with this Article.
- B. All raceway and sleeve penetrations of fire barriers shall be sealed to achieve fire resistance equivalent to fire separation.
 - 1. Maintain fire rating per ASTM E-814 and UL 1479.
 - 2. This assembly must also maintain a watertight seal between floor or wall and pipe.
- C. For other penetrations through non-rated walls, partitions, floors and ceilings, caulk the space between raceways and raceway sleeves with non-staining, waterproof gun grade compound. Apply caulking compound by the gun method using nozzles of a proper size to fit the width of joint. Prepare the joint for caulking by packing it tightly with a resilient foam or rope yarn.
- D. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Maintain fire rating per ASTM E-814 and UL 1479.

2. Penetration sealant:
 - a. 3M Brand "Moldable Putty Pads": and "Moldable Putty Stix"
 - b. 3M Brand "Fire Barrier" Caulk, Putty or Penetrating Sealing Systems
 - c. Dow Corning "Fire Stop Foam: and "Fire Stop Sealant" systems
 - d. Insta-Foam Products, Inc. "Insta-Fire Seal Silicone RTV Foam"
 - e. Standard Oil Engineering Materials Company, "Frye Putty"
 - f. Chase technology "Chase Foam #CTC PR-855"
3. Intumescent Sealant for use at openings and sleeves involving flexible cable.
 - a. 3M Brand "Fire Barrier" caulk or putty, FS-195 Wrap Strip and CS-195 Composite Sheet.
 - b. Dow Corning "Fire Stop Intumescent Wrap Strip"
 - c. Fox Couplings, Inc. "The Fox Cast-in-Place Coupling"
4. Performance Characteristic: Firestopping materials shall conform to both Flame (F) and Temperature (T) ratings as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test.
 - a. °F Rating shall be a minimum of one hour but not less than the fire resistance rating of the assembly being penetrated.
 - b. Conduct the fire test with a minimum positive pressure differential of 0.01 inches of water column.
5. Quality Assurance: Installer qualifications – a firm specializing in firestopping installation with not less than two years of experience or trained and approved by firestopping manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRONIC SAFETY AND SECURITY SYSTEMS

A. General

1. All work installed in finished areas shall be concealed.
2. Install systems, materials, and equipment to conform with approved documents.
3. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.
4. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
5. Verify all dimensions by field measurements. Take measurements and be responsible for exact size and locations of all openings required for the installation of work. Proposed dimensions are reasonably accurate and should govern in setting out work. Where detailed method of installation is not indicated or where variations exist between described work and approved practice, direction of the owner's representative on job shall be followed.
6. Workmanship throughout shall conform to the standards of best practice. Marks, dents or finish scratches will not be permitted on any exposed materials, fixtures or fittings. Inside of panels and equipment boxes shall be left clean.
7. Use caution not to exceed the allowed bend radius for respective cables and not to compromise the integrity of the cables during installation by pulling cable management devices too tightly, damaging cables, etc. Raceway/Cabling bending radii shall be minimum as directed by cable manufacturer. Use pulling compound or lubricant, where necessary;

compound must not deteriorate conductor or insulation.

B. Cable

1. Provide color-coded jackets to identify different systems.
2. Neatly comb out multiple cable bundled runs to remove tangling and crossing of cables within the bundles. Neatly dress all cable work and provide vertical and horizontal cable management (or other approved method) for properly dressing all work at racks, control panels, backboards etc.
3. Provide spacing between cable bundles to help dissipate heat. Do not cinch cables into tight bundles.
4. Nylon cable ties are not permitted. Bundle cables with "Velcro" style cable straps with a minimum of 1-inch width.
5. All cables shall be supported every 5 feet (or less) and within 12" of device boxes, outlets, racks/cabinets and cable tray.
6. Use separate J-Hook cable support systems for cables belonging to different systems and for cables carrying different operating levels.
7. Loosely secure cables at each J-Hook.
8. Cables shall not be directly or indirectly supported by a suspended ceiling or any other surface, support, material or structure not permissible for this use by all applicable codes and standards.
9. Cables carrying signals of different nominal operating level shall be kept separated to reduce the risk of undesirable cross-talk interference between cables.
10. Keep length of parallel runs to a minimum. Cross cables of different nominal levels at 90 degrees.
11. Provide additional separation as necessary to prevent and remedy any crosstalk.
12. Contractor shall take all precautions necessary to keep low-voltage cable away from sources of EMI and RF interference. Where close proximity is absolutely necessary to satisfactory appearance, performance or installation of the Work, provide all necessary shielding necessary to ensure that ingress interference is minimal and has no negative impact of the Work.
13. Provide a minimum of 12 inches cable slack where terminating at a device outlet to facilitate installation and servicing of devices. Longer working lengths shall be provided as appropriate to the application.
14. All termination types shall correctly match the cable and device termination point. Connectors of the appropriate type, size, color and rating shall be used to match with the mating equipment.
15. Tools as recommended by each specific connector manufacturer shall be used in attachment of all connectors.
16. When spade connectors are the required to be used for audio circuits operating at $\leq +8\text{dBv}$ nominal, solder type spade connectors only shall be permitted.
17. No more than two spade connectors shall be permitted under a single terminal. Fewer should be used when recommended by the specific manufacturer's equipment or connector.
18. Wire Nuts
 - a. Wire nuts shall not be used in any audio circuit, except, when necessary, in the following:

- 1) 25 Volt Constant-Voltage loudspeaker circuits.
 - 2) 70.7 Volt Constant-Voltage loudspeaker circuits.
 - b. Wire nuts shall not be used in any data or voice communications or remote-control circuit.
 - c. Wire nuts shall not be used in any circuit which radiates RF energy.
 - d. Contractor must advise and gain prior approval of the Owner for any circuit which the Contractor desires to use wire nuts as the means of termination.
19. Drain Wires, Non-insulated Ground Wires and Shields
- a. Drain or non-insulated ground conductors shall be insulated with appropriately sized heat-shrinkable insulated sleeving immediately upon exit from the jacket of the cable. Contractor shall use GREEN colored sleeving unless otherwise necessary to resolve specific color-coding conflicts on a given cable. This methodology shall apply to ALL methods of termination, including inline connectors, device plates, direct equipment terminations etc... Sleeving shall be applied to twisted and braided shields once the internal conductors have been combed out or otherwise removed from the center of the shield.
 - b. Wherever a cable contains a non-insulated conductor within a jacketed cable, the conductors, as they exit the manufacturer's jacket, shall have a piece of heat shrinkable sleeving applied equally over the jacket and the exposed insulated conductors. The length of this sleeving shall be 1" for all cable diameters of .250" or less. For cables diameters larger than .250" the length of the sleeving shall be approximately equal to 4 times the diameter of the cable jacket. Note: This added sleeving is recommended but not mandatory when cable termination occurs fully within the confines of a fully insulated and strain relieved connector. Black shall be used unless otherwise necessary for specific cosmetic or cable identification purposes.
 - c. A heat-gun of the appropriate temperature, size, type and rating for shrinking the tubing shall be used as recommended by the manufacturer of the sleeving used. Open flame (i.e. matches, cigarette lighters, torches) and direct metal conduction (i.e. soldering iron) methods to shrink the sleeving shall not be permitted. Sleeving which is burnt or otherwise marred shall be removed and replaced.
 - d. There shall not be any non-insulated exposed conductors within a device backbox, junction box, or equipment rack/cabinet.
20. Unused Conductors
- a. Unused conductors shall not be "clipped" or removed from any jacketed cable. Conductors which are not required or used at the end of a jacketed cable shall be kept intact. Conductors shall be fully insulated from one and other to prevent shorts which could occur at either end of the cable. Conductor ends shall also be insulated to prevent shorts to other conductive materials which could come in contact with the conductor.
 - b. Unused conductors shall be kept the same length as the longest conductor of the cable being used.
 - c. Attention shall be paid to the proper preparation of all cables and all conductors of these cables. There shall not be nicks to cable jackets, conductor insulation, or the conductors themselves.
 - d. Special attention should be paid to nicked conductors. Should a conductor be nicked during preparation or termination the cable shall be reworked/replaced to remove the nick.
 - e. Any voice, data, or coaxial cable that is cut, disconnected, or not terminated at both ends shall be completely removed end to end. Any labels at either end shall be erased. Record drawings shall reflect the removal of these cables.

3.02 ATTACHING TO BUILDING CONSTRUCTION

- A. Attach supports to structural members (beams, joists, etc.) rather than to floor or roof slabs. Do not attach to ceiling support wires.
- B. Where equipment and raceway are suspended from existing concrete or masonry construction, use expansion shields to attach supports to construction. Expansion shield bolt diameter shall be same size as support rod diameter, hereinafter specified. Expansion shields shall be Star Double, Star Gloxin, Star Loxin or approved equal.
- C. Where existing masonry is not suitable to receive and hold expansion shield or where other means of attachment is advantageous, submit alternate method for approval by Engineer.
- D. Equipment to be installed in groups shall not be mounted directly to masonry or concrete walls. Mount 1- by 1-inch structural channel such as Unistrut, to wall and secure equipment to these channels.
- E. Where raceways are suspended from structural steel building framing or supporting members, provide beam clamps for attaching piping device to building member.
- F. Obtain approval from Owner and structural engineer before cutting or welding to structural members, or before hanging heavy equipment.

3.03 ESCUTCHEONS

- A. Provide chrome plated escutcheons on material, leaving and entering walls, floors, ceilings, etc.

3.04 EQUIPMENT INSTALLATION

- A. 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.

3.05 OCCUPATIONAL SAFETY & HEALTH STANDARDS

- A. All work shall comply with current requirements of U.S. Department of Labor-Occupational Safety & Health Administration, entitled Occupational Safety and Health Standards; National Consensus Standards and Established Federal Standards.

3.06 DEMOLITION

- A. In addition to the requirements in Division 02 Section "Selective Demolition," comply with this Article.
 - 1. Scope of Work: Provide demolition required for removal of systems and equipment made obsolete by this Project and as determined by the Architect/Engineer.
 - 2. Work Included:
 - a. Non-destructive removal of systems, materials, and equipment for reuse or salvage as shown on Drawings or requested by Owner.
 - b. Removal of all debris from site and legal disposal of same.
 - c. Removal of all abandoned or obsolete exposed materials and equipment for a clean and finished installation.
 - d. Removal of all abandoned or obsolete raceways, wiring, cabling, or electrical devices of any kind.
- B. Conditions
 - 1. Coordination: Adjacent areas need to remain in operation and services to these areas need to be maintained. A schedule will be worked out prior to beginning work and as many criteria

for operation as possible will be explained. Contractor cooperation shall be expected in all conditions.

- a. Phasing: Prior to commencing demolition in any area of the work, notify the Owner and Architect/Engineer five (5) working days in advance to insure that no adjacent occupied areas will be disrupted.
- b. Demolition phasing must be approved by Architect/Engineer prior to commencement of operations.
- c. Removal of debris and construction traffic will be limited to specified areas. Confirm all operations with Architect/Engineer prior to commencement of work.

2. Adjacent Materials:

- a. During the execution of the work, primary consideration shall be given to protecting from damaging the structure, furnishings, finishes, and the like which are not specifically indicated to be removed and disposed.
- b. Existing items or surfaces to remain which are damaged as a result of this work shall be refinished, repaired, or replaced to the satisfaction of the Architect/Engineer and Owner at no additional cost.

C. Materials

1. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described but required for proper completion of the work, they shall be as selected by the Contractor subject to approval of the Architect/Engineer. Materials used and workmanship shall match surrounding areas as much as possible, unless otherwise directed.

D. Demolition

1. Site Inspection

- a. The Contract Documents do not propose to show all systems, materials, or equipment existing on the project that will require demolition.
- b. Before commencing the work of this Section, verify with the Architect/Engineer and Owner all systems, materials, and equipment to be removed and those to be preserved.

2. Scheduling

- a. Schedule all work in a careful manner with all necessary considerations for public and adjacent areas.
- b. Avoid interference with the use of adjacent areas and passage to and from these areas.

3. Abandoned Materials and Equipment: Items so indicated on Contract Documents to be removed and not indicated or specified to be saved or retained, shall be demolished, removed, demounted, or disconnected in the best possible manner to ensure that no damage will result to other adjacent items or surfaces to remain.

4. Salvage

- a. During removal of items so indicated, caution shall be used to eliminate damage to any equipment having salvage value.
- b. All reusable salvaged material shall remain the property of the Owner and be retained for his inspection. Only items so inspected and rejected by the Owner shall be disposed by the Contractor. All other such items shall be turned over and deposited as directed by the Owner.

5. Disposal and Clean Up

- a. Areas in which demolition and salvage work is being done shall be cleaned daily.

- b. Dirt, dust, debris, unsalvageable and reusable items, and the like shall be totally removed from the project site daily. Under no circumstances shall such refuse be allowed to collect for longer periods.
- c. Refuse shall not be allowed to block, or otherwise impair, circulation in corridors, stairs, sidewalks, or other traffic areas.

END OF SECTION 28 05 00

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SECTION 28 31 12 – ADDRESSABLE FIRE ALARM (RENOVATION OF EXISTING)

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section covers fire alarm system's initiating devices, notification appliances, controls, and supervisory devices.
- B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.

1.02 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: The equipment and service described in this specification are those supplied and supported by Johnson Controls Fire Protection, LP (Simplex).
- B. No Substitutions allowed; must match the Campus fire alarm network systems.

1.03 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. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
 - 1. Division 26: applicable sections apply
- C. The system and all associated operations shall be in accordance with the following Guidelines of the following Building Code: UBC IBC
 - 1. NFPA 72, National Fire Alarm Code
 - 2. NFPA 70, National Electrical Code
 - 3. NFPA 101, Life Safety Code
 - 4. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
 - 5. Other applicable NFPA standards
 - 6. Local Jurisdictional Adopted Codes and Standards
 - 7. ADA Accessibility Guidelines

1.04 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
 - 1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
 - 2. Wiring diagrams from manufacturer.
 - 3. Shop drawings showing system details including location of FACP, all devices, circuiting and details of Tru-Site graphic screens.
 - 4. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
 - 5. Record of field tests of system.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A factory authorized installer is to perform the work of this section.

- B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

- C. Exception: Notification Appliance Devices by COOPER Notification (Wheelock) are acceptable

PART 2 - PRODUCTS

2.01 ADDRESSABLE MANUAL PULL STATIONS

- A. Description: Addressable single- or double-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
- B. Protective Shield: Where required provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

2.02 SMOKE SENSORS

- A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
 - 1. Factory Nameplate: Serial number and type identification.
 - 2. Operating Voltage: 24 VDC, nominal.
 - 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 - 4. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
 - 5. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
 - 6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 - 7. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
 - 8. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
 - 9. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
 - 10. Removal of the sensor head for cleaning shall not require the setting of addresses.
- B. Type: Smoke sensors shall be of the photoelectric or combination photoelectric / heat type.
- C. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.

D. Duct Smoke Sensor:

1. Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.
2. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
3. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
4. Duct Housing shall provide a relay control trouble indicator Yellow LED.
5. Compact Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
6. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
7. Duct Housing shall provide a magnetic test area and Red sensor status LED.
8. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
9. Each duct sensor shall have a Remote Test Station with an alarm LED and test switch.

2.03 HEAT SENSORS

- A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
- B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
- C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.
- D. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

2.04 ADDRESSABLE CIRCUIT INTERFACE MODULES

- A. Individual addressable modules (IAMs)
 1. Both power and communications from a two-wire MAPNET II or IDNet circuit. They provide location specific addressability to a single initiating device (such as single station smoke detector alarm contacts or heat detector contacts) or multiple devices at the same location by monitoring normally open dry contacts and the wiring to an end-of-line resistor.
 - a. Total wiring distance from IAM to supervision resistor(s) of up to 500 ft (152 m)
 - b. Monitored connection is compatible with Simplex® 2081-9044 Overvoltage Protectors for outdoor wiring or electrically noisy applications
 - c. For use in indoor locations up to 158° F (70° C) such as attic spaces or similar applications.
 2. Model 4090-9001 is packaged in a thermoplastic housing and provides screw terminal connections and a status indicating LED. (*ISU Standard choice*)
 - a. Enclosed design minimizes dust infiltration
 - b. Mounts in standard single gang electrical box

- c. Screw terminals for wiring connections
- d. Visible LED flashes to indicate communications
- e. Optional covers are available to allow LED to be viewed after installation (requires mounting bracket, ordered separately)
- 3. Model 4090-9051 is an encapsulated package with wire leads. It does not provide a status indicating LED.
- 4. IDNet communications provides current limited monitoring:
 - a. Provides monitoring of tamper switch (supervisory) and waterflow switch (alarm) on same circuit using one point
 - b. Available with IDNet communications only
 - c. Multiple operation modes are available and are selectable at the control panel:
 - a. Contact closure status can be tracked
 - b. Momentary contact closure conditions can be selected at the panel to be latched or tracked.
- B. Individual Addressable Relay Module (Relay IAM)
 - 1. IDNet Relay IAMs allow fire alarm control panels to control a remotely located Form "C" contact using IDNet addressable communications for both data and module power. Typical applications would be for switching local power for control functions such as elevator capture, or control of HVAC components, pressurization fans, dampers, etc. Relay status is also communicated requiring only one device address.
 - a. A single addressable point provides control and status tracking of a Form "C" contact
 - b. Contact Rating
 - 1) Power Limited 2A @ 24VDC resistive
 - 2) Power Limited 1A @ 24VDC inductive
 - 3) Non-power limited 0.5A @ 120VAC resistive
 - c. Low power latching relay design allows IDNet communications to supply both data and module power
 - d. Relay is set to OFF on initial power up and upon loss of IDNet communications
 - e. Enclosed design minimizes dust infiltration
 - f. Mounts in standard 4" (102 mm) square electrical box, optional adapter bracket is available to mount in a 4 11/16" (119 mm) square electrical box
 - g. Screw terminals for wiring connections
 - h. Visible LED flashes to indicate communications
 - i. Optional covers are available to allow LED to be viewed after installation
- C. Dual Contact Relay IAM (Individual Addressable Module)
 - 1. Same as Addressable Relay Module (Relay IAM) , item B above, except with two form C contacts on common relay.

2.05 STANDARD ALARM NOTIFICATION APPLIANCES

- A. Alarm notification appliances by Simplex Grinnell and COOPER Notification (Wheelock) are acceptable. Match existing fire alarm device styles when possible.
- B. Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd.

Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

- C. Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480.
 - 1. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC using and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.
 - 2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
 - 3. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
 - 4. The S/V installs directly to a 4" square, 1 ½ in. deep electrical box with 1 1/2" extension for Simplex devices and a 4" square 1 ½ in. deep for Wheelock devices.
- D. Speaker: Speaker notification appliances shall be listed to UL 1480.
 - 1. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted / shielded wire.
 - 2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
 - 3. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
 - 4. The Speaker installs directly to a 4" square, 1 ½ in. deep electrical box with 1 1/2" extension for Simplex devices and a 4" square 1 ½ in. deep for Wheelock devices.
- E. Notification Appliance Circuit provides synchronization of strobes at a rate of 1Hz. The capability to synchronize multiple notification appliance circuits shall be provided.
- F. Accessories: The contractor shall furnish the necessary accessories.
- G. NAC Power Extender
 - 1. The IDNet NAC Power Extender panel shall be a stand-alone panel capable of powering a minimum of 4 notification appliance circuits. Notification appliance circuits shall be [Class B Style Y][Class A Style Z] rated at 2 amps each. Panel shall provide capability to be expanded to 8 notification appliance circuits.
 - 2. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.
 - 3. The NAC extender panel may be mounted close to the host control panel or can be remotely located. The IDNET Addressable NAC Extender Panel when connected to an addressable panel shall connect to the host panel via an IDNet communications channel. Via the IDNET channel each output NAC can be individually controlled for general alarm or selective area notification.
 - 4. For IDNet connected NAC extender panels up to five panels can be connected on a single [Class A wired] IDNet channel.
 - 5. When connected to a conventional (non-addressable panel) one or two standard notification appliance circuits from the main control panel may be used to activate all the circuits on the NAC power extender panel.
 - 6. Alarms from the host fire panel shall signal the NAC power extender panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble

conditions to the host panel.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.
- B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
 - 1. Factory trained and certified personnel.
 - 2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
 - 3. Personnel licensed or certified by state or local authority.

3.02 WIRING INSTALLATION

- A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AH) and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
- B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- C. Paint fire alarm system junction boxes covers red.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
 - 1. Factory trained and certified.
 - 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 - 3. International Municipal Signal Association (IMSA) fire alarm certified.
 - 4. Certified by a state or local authority.
 - 5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
- C. Pre-testing: Determine, through pre-testing, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
- D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.
- E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.
- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies

with applicable standards.

- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.
- H. Final Test, Certificate of Completion, and Certificate of Occupancy:
- I. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.

3.04 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.05 SPECIAL INSTALLATION INSTRUCTIONS

- A. Existing devices shall be protected during the construction phase for re-use. Contractor to protect all existing fire alarm devices during entire renovation project to prevent dust and debris infiltration. Devices not protected shall be cleaned by the fire alarm system manufacturer's service representative. Any devices damaged beyond repair / cleaning will be replaced with new at no cost to the Owner. Plastic bagging of devices is acceptable.
- B. Coordinate with the Owner for disabling fire alarm devices during construction. Turn over any fire alarm devices not slated for re-use to the Owner.
- C. Include in the Bid all costs associated with reprogramming of the existing fire alarm system and Owner's Tru-Site fire alarm network for this Project.
- D. Wiring to devices above suspended ceilings may be exposed plenum rated cable. Wiring to exposed surface mounted devices or wiring concealed in walls to devices shall be in metal raceway.
- E. New devices shall match existing devices being re-used. If devices are not available to match existing all new devices of that type shall be provided.

END OF SECTION 28 31 12

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Indiana State University
D&A#26057

ADDRESSABLE FIRE ALARM
(RENOVATION OF EXISTING)
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R.E. Dimond & Associates, Inc.

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